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Introduction

This Biological Assessment (BA) for the Fernow Experimental Forest (FEF) documents potential effects of proposed projects on Federally listed threatened and endangered (T&E) species, as well as sensitive species determined by the U.S. Forest Service (USFS), that occur or could potentially occur on the FEF.

This BA presents the most current information available regarding these species, and will enable FEF scientists to determine if existing standards and guidelines regarding threatened and endangered species must be adjusted or additional mitigation measures are needed to protect these species during project implementation.

The objectives of the BA are to:

1. Comply with requirements of the Endangered Species Act (ESA), as amended, that actions by Federal agencies will not jeopardize the existence of these species or adversely modify their critical habitat.
2. Assess effects of current FEF projects on threatened, endangered, and sensitive species known to exist on the project site.
3. Document current mitigation measures on the FEF that benefit these species.
4. Provide biological input to ensure FEF compliance with the National Forest Management Act (NFMA), FSM2670, and the ESA, as amended.

Framework for this BA

Federal agencies must comply with the ESA of 1973, as amended. Compliance includes a requirement to consult with the US Department of Interior Fish and Wildlife Service (USFWS) on projects that may affect federally listed threatened, endangered, or proposed species.

The first purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."

The Forest Service manual directs that the Forest Service will:

- Manage habitats and activities to achieve recovery objectives for T&E species.
- Place top priority on conservation and recovery of T&E and proposed species and their habitats.
- Prescribe measures to prevent adverse modification of critical habitats. Protect individuals from harm.

ESA defines "critical habitat" as specific areas within a species' occupied geographic area, at the time it is listed, which are essential to its conservation and which may require special management considerations or protection. Critical habitat also covers specific areas outside the geographic area occupied at the time of listing, which the Secretary of Interior determines essential for conservation of the species. When "critical habitat" is used in this Biological Assessment, it carries the ESA definition.

Threatened and Endangered Species Not Evaluated

Not all of the federally listed species in West Virginia (WV) will occur on the FEF due to lack of suitable habitat or other factors. These species are discussed below. In addition, only the sensitive species that occur, or could potentially occur on the FEF will be covered in this BA. A likelihood of occurrence list for threatened, endangered, and sensitive species on the FEF is included in the appendices (Appendix 1).

Bald Eagle:

In 1999, the bald eagle (*Haliaeetus leucocephalus*) was proposed to be removed from the USFWS list of endangered and threatened wildlife. Currently, the 48 states are divided into 5 recovery regions for the bald eagle, and a Recovery Plan was written for each region. The FEF is included in the Northern States recovery region. However, no suitable nesting or foraging habitat for the bald eagle exists on the FEF due to the absence of substantial bodies of water and open areas (Buckalew and Hall 1994, Hamel 1992). No record of a documented occurrence of the bald eagle exists for the FEF, and therefore the bald eagle is not analyzed in this BA. Any future discovery of a bald eagle nest will be documented and the nest will be protected following ESA guidelines.

Gray Wolf:

The FEF is in the historic range of the gray wolf (*Canis lupus*), however the last confirmed occurrence of this species was 1900. The West Virginia Division of Natural Resources (WVDNR) considers the gray wolf extirpated from the state, and it will not be discussed in this BA. The FEF will consult with USFWS and WVDNR if there is a documented occurrence of this species in the future.

Eastern Cougar:

According to WVDNR records, the last confirmed occurrence of eastern cougar (*Felis concolor cougar*) was 1887. The WVDNR and USFWS consider this species extirpated from WV, therefore, it is not covered in this BA. Although there are a few reports of cougar in WV, these sightings are believed to be misidentified, escaped, or released captive animals. Any documented occurrence of native eastern cougars on the FEF will be reported to the USFWS and WVDNR, and protection for this species will follow ESA guidelines.

Shale-barren rockcress:

The shale-barren rockcress (*Arabis serotina*) occurs on shale barrens in eastern WV (Strausbaugh and Core 1977). There is no suitable habitat on the FEF for this species, and it is considered absent on the forest.

Small whorled pogonia:

The small whorled pogonia (*Isotria medeoloides)* prefers open, dry, deciduous woods with acidic soil. Tree species commonly associated with this species include white oak (*Quercus alba*), white pine (*Pinus strobus*), flowering dogwood (*Cornus floridana*), and witch hazel (*Hamamelis virginiana*). Small whorled pogonia has been found in the Marlinton/White Sulphur Ranger District of the MNF in southeastern WV, however, the forest and soil types associated with this flower does not occur on the FEF. Therefore, small whorled pogonia is considered absent on the FEF.

Virginia spirea:

Virginia spirea (*Spiraea virginiana*) grows along rocky, flood-scoured riverbanks. There are no waterways with these habitat conditions on the FEF, and this species does not occur on the FEF.

Consultation History

Based on surveys, three T&E species are found on the FEF: Virginia big-eared bat, Indiana bat, and running buffalo clover.

Virginia big-eared bat:

A single male Virginia big-eared bat (*Corynorhinus townsendii virginianus*) was captured during late summer mist net surveys on the FEF in 1995. A January 2003 winter survey of Big Springs Cave documented two Virginia big-eared bats using Big Springs Cave as a winter hibernacula. However, no formal consultation with USFWS has occurred to date. In July 1998, Mr. Bill Tolin, Endangered Species Biologist, USFWS, reviewed and approved the FEF Biological Assessment for proposed projects during the 1999 and 2000 fiscal years. In August 2000, the Northeastern Research Station requested formal consultation with the USFWS as part of the 2000 FEF Environmental Assessment. In November 2000, the USFWS issued their Biological Opinion, approving the FEF BA for proposed projects during the 2000-2005 fiscal years.

Indiana bat:

Winter surveys for Indiana bats (*Myotis sodalis*) in Big Springs Cave have been conducted periodically since 1952 (Appendix 2). The USFS gated the cave in 1973 to protect the winter hibernacula of this endangered species. In 1995, WVDNR, in conjunction with USFWS, conducted surveys to determine the presence or absence of Indiana bats during the summer and fall months. Informal consultation with Mr. Tolin began in August 1997 following a decision by USFWS to change management guidelines concerning the Indiana bat. Mr. Tolin visited the FEF that month, and FEF scientists had several meetings and phone contacts with Mr. Tolin regarding proposed actions on the FEF. In July 1998, Mr. Tolin reviewed and approved the FEF BA for proposed projects during the 1999 and 2000 fiscal years. Informal consultation for proposed research activities for 2000 – 2005 was initiated on February 24, 2000. Formal consultation was requested in August 2000. In November 2000, the USFWS issued their Biological Opinion, approving the FEF BA for proposed projects during the 2000-2005 fiscal years.

Running buffalo clover:

Initial discovery of running buffalo clover (*Trifolium stoloniferum*) on the FEF occurred in June 1993. Mr. P.J. Harmon from WVDNR Natural Heritage Program confirmed the identification. Following informal consultation with Mr. Tolin, FEF scientists conducted a survey to locate other running buffalo clover populations on the FEF. This species was found on several compartments, mainly along existing skidroads underlain by limestone derived soils. This information was provided to USFWS as part of a meeting held on September 3, 1993, and documented in a memo of the same date (see file BA FY98 located at the Timber and Watershed Laboratory). After observing the association between this species and skid roads, a study plan was developed to assess the importance of disturbance to running buffalo clover populations in accordance with the Recovery Plan (USDI Fish and Wildlife Service 1989). Drafts were sent to Mr. Tolin, USFWS, Mr. Harmon, WVDNR, and other outside reviewers in October 1993. The study was approved and initiated in 1994. The FEF sent updates on the study to USFWS in June 1995, and annually since 1997. The FEF was also the site for a running buffalo clover nitrification study initiated in 1993 and completed in 1995. The principal investigators of this study were personnel from the Agricultural Research Service, while USFWS, WVDNR, and USFS were the cooperating agencies. In July 1998, Mr. Tolin reviewed and approved the FEF BA for proposed projects during the 1999 and 2000 fiscal years. In February 2003, Dr. Thomas Schuler, USFS Northeastern Research Station Project Scientist, was appointed to the running buffalo clover Recovery Team. An application for a Recovery Permit was submitted to the USFWS on August 28, 2000. A Notice of Receipt was published in the Federal Register on September 8, 2000, initiating a 30-day review period. In November

2000, the USFWS issued their Biological Opinion, approving the FEF BA for proposed projects during the 2000-2005 fiscal years.

Site Description

The FEF is a 4615 acre experimental forest (39.03^{o}N, 79.67^{o}W) in Tucker County, WV. This experimental forest is administered by the Northeastern Research Station, Timber and Watershed Lab, USFS. The ecological land type of the FEF is classified as the Allegheny Mountains Section of the Central Appalachian Broadleaf Forest (M221B) according to the Forest Service National Hierchical Framework of Ecological Units (McNab and Avers 1994).

The land type association has been designated as the Allegheny Front Sideslopes (BA10) (DeMeo et al. 1995) and the vegetation is mixed mesophytic (Braun 1950). Characteristic species include, but are not limited to northern red oak (*Q. rubra*), yellow-poplar (*Liriodendron tulipifera*), black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), bitternut hickory (*Carya cordiformis*), sweet birch (*Betula lenta*), red maple (*A. rubrum*), and American beech (*Fagus grandifolia*).

The topography is mountainous with elevations ranging from 1750 to 3650 ft above sea level. Mean annual precipitation is about 58 inches, distributed evenly throughout the year. The growing season is approximately from May through October with an average frost-free period of 145 days. Because of elevation, winters are more severe on the FEF than in lower surrounding areas. Annual snowfall is heavy, and temperatures between 10 and 20 degrees below zero (Fahrenheit) can occur.

Slopes ranging from 20 to 50 percent cover most of the area. The soils are predominately from the Belmont and Calvin soil series. Belmont soils range from moderately deep to deep, and are well-drained soils of medium texture and medium acidity. The Belmont soils are derived from shale, sandstone, and interbedded limestone. The Calvin series develops both above and usually below the Belmont series and is well drained and moderately permeable. However, Calvin soils are more strongly acid than Belmont soils due to the absence of limestone parent material.

The FEF encompasses almost the entire Elklick Run drainage – about 3.8 miles long and 2.3 miles across at the widest point. Elklick Run has seven major tributaries including Big Spring, which drains a headwater limestone formation. Headwater areas on two of these tributaries have been gauged to show how forest management influences streamflow.

Elklick watershed was initially logged between 1903 and 1911 during the railroad logging era (Fansler 1962, Trimble 1977, Schuler and Fajvan 1999). However, many trees were not removed due to insufficient size, undesirable species, or poor form. Sugar maple, American beech, birch, and hickory were some of the least desirable species. Additionally, merchantability standards were a function of the distance to the standard gauge railroad and certain portions of the FEF were cut more heavily. Forest fire may have been an important disturbance agent prior to initial logging and perhaps after logging, although actual documentation of past fires does not exist for the Elklick watershed. Most of the watershed was not farmed and the forest was able to regenerate following cessation of logging activities. The Federal government purchased the land in 1915 and dedicated it to forest and watershed research in 1933. Since that time, fire and grazing have been excluded. Chestnut blight (*Cryphonectria parasitica*) was the next major disturbance to the overstory. First noted in WV as early as 1909 (Brooks 1911), the blight resulted in a 25 percent reduction in standing volume on the experimental forest in the 1930's according to Weitzman (1949).

Silviculture and watershed research began in earnest in 1948 and continued without interruption to date. Treatments over the years have included a wide variety of disturbance levels from even-aged, uneven-aged, and two-aged management systems. Consequently, to accomplish research objectives, about 500,000 bd. ft. (International ¼") of timber has been harvested annually since 1948 from the FEF. Watershed research traditionally focused on the effects of logging and implications for management. More recently, scientists have added atmospheric deposition components to the watershed level studies. Federal, state, and university scientists continue to broaden research areas to include aquatic ecology, avian ecology, amphibian ecology, and small mammal ecology. More than 600 scientific publications have resulted from these efforts. In short, the charter of the FEF is to facilitate scientific research into the ecology of central Appalachian forests in order to improve the management of these forests.

Proposed Alternatives on the FEF

The Proposed Action and each alternative provide a different response to the significant issues for the FEF research program. Each of these alternatives represents a site-specific proposal developed through intensive interdisciplinary team evaluation. The team used information from the analysis of scoping comments to formulate different alternative approaches. Preliminary analysis and management direction were used further to refine the alternatives described here.

The Forest Service uses many mitigation and preventive measures in the planning and implementation of research activities. The application of these measures begins early in the research design phase of a project. The following items are listed to highlight some of the measures of processes that are common to alternatives; this is not a complete list.

Actions common to all studies:
Wildlife Habitat

- Tree felling would be conducted only during the dormant season (October through April).

- Tree species to be removed is dependent upon the specific silvicultural prescription. However, no butternut trees would be cut, and hickory trees, especially shagbark hickory (*C. ovata*) would be left where possible, without compromising the integrity of the research studies.

Soils and Water Quality

- Gravel would be applied to road surfaces as needed. Culverts would be replaced on haul roads and skid roads as needed. Culverts and ditches on all roads would be maintained as needed.

- Trees would be felled and winched to the landing using a truck crane or tractor and cable, to minimize soil disturbance. Logs would be skidded using a rubber tired skidder or tractor with a logging arch.

- Logging and skidding would not be done when conditions are excessively wet, to protect against unnecessary erosion and damage.

- After logging is complete, skid roads would be closed, and water control devices such as water bars and dips constructed to control the movement of water.

- All logging decks would be reclaimed, limed and seeded with a mixture of clover, rye, timothy, and various grasses to prevent erosion.

- All BMPs, as defined by the West Virginia Logging Sediment Control Act of 1992 would be followed during and after logging.

Riparian Habitat

- Perennial streams would be protected with a 100 foot-wide vegetative strip. A minimum of 75% crown closure would be maintained. There would be no vehicular traffic or herbicide use in the strip.

- Non-perennial streams would be protected with a 50 foot-wide vegetative strip. Within this strip, crown closure would generally be 60%. There would be no vehicular traffic or herbicide use in the strip.

- Trees would not be cut from within the stream channel or off the stream banks. Logging equipment is restricted or excluded in this area except at designated stream crossing points.

The Proposed Action and two other alternatives are considered in detail. The Alternatives are defined as Alternative A – No-Action, Alternative B - Proposed Action, and Alternative C – Management Action. The No-Action Alternative is defined as no experimental logging, burning or fertilizer treatments, and no use of herbicides to control invasive exotic plants at this time; the experimental areas would remain subject to natural changes only. Alternatives B and C satisfy the Purpose and Need; however, Alternative C is the preferred alternative.

Alternative A: No-Action Alternative

CEQ Regulations (40 CFR 1502.14d) require that a "No-Action" alternative be analyzed. This alternative represents the existing condition against which all other alternatives are compared. The emphasis of this alternative is to continue existing research studies, however without experimental manipulations. This Alternative does not include addition of any new research studies or allow the use of herbicides to control invasive exotic plant species. Thus, only data collection and monitoring would continue. This would prematurely end important long-term research and seriously impair development of new knowledge.

Alternative B: Proposed Action

The proposed action includes many projects that are repeat treatments in ongoing long-term research studies. Silvicultural treatments, which include some level of harvesting, would be applied on 492.7 acres. Single-tree selection would be applied to 169.8 acres, the diameter-limit method applied to 32.7 acres, patch clearcuts applied to 23.2 acres, the financial rate of return method applied to 189.9 acres, and the shelterwood method applied to 77.1 acres. Prescribed fire would be used in combination with the shelterwood method to promote oak regeneration, and in a new study, 178.5 acres would be treated with a combination of prescribed fire and overstory mortality treatments (herbicides and/or girdling) to enhance Indiana bat summer habitat and oak restoration. Additionally, an 84.7 acre watershed would be treated with ammonium sulfate fertilizer to induce artificial watershed acidification. The studies and compartment details are described below, and a map of the proposed research areas is included in Appendix 3.

Large area comparisons of forest management practices

(Study No. 4110-FS-NE-1103-2) was initiated in 1950. The primary objective of this study is to determine the effects of three uneven-aged silvicultural practices (single-tree selection, diameter-limit, patch clearcuts) on stand growth and yield, replicated two times on three oak site index classes (60, 70, and 80). Another objective is to determine the effects of the different silvicultural practices on species

composition and log quality across site quality classes. This research is critical to understanding the effects of current harvesting practices, particularly those used on private land, on long-term sustainability and diversity of central Appalachian hardwood forests, and for developing management guidelines and recommendations for these forests. (Compartments 5B, 7A, 7B, WS5A, 17A, 19A, 20A, 20C; 208.3 acres)

Compartments 5B, WS5A, and 20A (159.8 acres) would be treated with single-tree selection. Four parameters determine which trees are harvested or left in the stand: residual basal area (RBA) in square feet per acre for trees greater than 11 inches in diameter at breast height (dbh), the target distribution of stems in 2-inch diameter classes referred to as "Q", the largest diameter tree to retain in the stand, and cutting cycle. A Q of 1.3 (i.e., there are 1.3 times more stems in each successively smaller diameter class) is used for all sites. Compartments with site index 60 are assigned the parameter values 35 ft^2/ac RBA, largest retained tree is 20 inches dbh, and 15-yr cutting cycle. Compartments with site index 70 are assigned the parameter values 50 ft^2/ac RBA, largest retained tree is 26 inches dbh, and 10-yr cutting cycle. Compartments with site index 80 are assigned the parameter values 65 ft^2/ac RBA, largest retained tree is 32 inches dbh, and 10-yr cutting cycle.

Compartment 20C (27.7 acres) would be harvested using the diameter-limit method, the most common harvesting method used on nonindustrial private forestland in the eastern United States. All trees with dbh greater than 17 inches will be removed at each cutting cycle. Stands with site index 60 have a 20-yr cutting cycle while site index 70 and 80 stands have a 15-yr cutting cycle.

Compartments 7A, 7B, 17A, and 19A would be treated with a total of 23.2 acres in patch clearcuts. Various numbers of 0.4-ac regeneration openings are created in each compartment to promote uneven-aged stands of even-aged patches. Total acres treated each cycle are determined by compartment size, rotation length, and number of harvests during rotation. Site index 60 stands have a rotation length of 90 years and a 15-yr cutting cycle; 1/6th of the stand is treated each cycle. Site index 70 and 80 stands have a rotation length of 80 years and a 10-yr cutting cycle; 1/8th of the stand is treated each cycle.

Comparison of four cutting practice levels in Appalachian hardwood forest types
(Study No 4110-FS-NE-4101-8) was initiated in 1948. The original objective of this study was to compare "good", "fair', and "poor" cutting practices as they were perceived to be in the late 1940s. The study involved observing the long-term impact of four management alternatives (single-tree selection, intensive single-tree selection, diameter-limit harvest, and commercial clearcut) on wood volume production, stand quality and regeneration. More recently, the objectives have been broadened to include quantifying long-term stand dynamics, particularly species composition, and evaluating aesthetics. This study was set up with the four cutting treatments and a control on five 5-acre compartments along the Zero-grade Trail to provide added demonstration value. These are among the oldest forestry research plots in North America and receive many visitors. (Compartments 8B, 8C, 8D; 5 acres each, 15 acres total)

Compartment 8B would be treated using the diameter-limit method. All trees with dbh greater than 15.5 inches will be removed. Compartment 8C would be treated with single-tree selection. Only sawtimber-sized trees, those with dbh of 11 inches or greater, may be removed using the selection parameters of 70 ft^2/ac RBA, Q 1.3, largest retained tree is 32 inches dbh, and 10-yr cutting cycle. Compartment 8D would be treated with an intensive single-tree selection where trees with dbh of 5 inches or greater may be removed. The selection parameters applied are 85 ft^2/ac RBA, Q 1.3, largest retained tree is 32 inches dbh, and 10-yr cutting cycle.

Financial rate of return areas on the Fernow Experimental Forest

(Study No. 4110-FS-NE-4101-62) was initiated in 1971. The objective of this study is to determine the effects of financial rate of return harvests on growth and yield of hardwood stands, species composition and hardwood stand quality. The financial rate of return method is a selection system that uses economic guidelines for selecting trees to harvest in combination with silvicultural criteria such as desired residual stocking of potentially valuable trees and removal of poor quality or high risk (Trimble et al. 1974). The minimum size tree to cut varies by species and is dependent on the desired rate of return; generally, as the desired rate of return decreases the dbh of trees to retain increases. Two study areas each are being utilized for estimated rates of return of 2, 3, 4 and 6%. This will test of the utility and accuracy of these criteria for selection and evaluate the effects on stand characteristics over time. (Compartments 20B, 26A, 26B, 61; 189.9 acres)

Compartment 61 (118.4 acres) would be treated at the 3% financial rate of return, compartment 20B (25.3 acres) would be treated at the 4% rate, and compartments 26A and 26B (46.2 acres) would be treated at the 6% rate.

Evaluating prescribed fire as a silvicultural tool to promote oak regeneration in the central Appalachians

(4300-FS-NE-4353-12). The principal objective of this research is to determine the effectiveness of using prescribed fire and fencing in conjunction with a shelterwood regeneration method to regenerate oak. Secondary objectives include evaluating treatment effects on coarse woody debris, forest floor and litter characteristics, seedbank composition and abundance, spring ephemeral wildflowers, herpetofauna, and acorn predation by weevils. The study is intended to develop a silvicultural technique related to the use of prescribed fire, but also will examine changes in ecosystem properties than can be considered at the stand or subwatershed scale. (Compartments R1, R2; 77.1 acres)

The compartments would undergo spring or fall pre-shelterwood prescribed fires until an adequate number of oak seedlings are present. A shelterwood treatment would follow, resulting in approximately 50% residual stocking. The treatment would remove trees in the lower canopy with the goal of creating a predominantly oak overstory. The area would undergo a post-shelterwood prescribed fire 2 to 6 growing seasons after harvest.

For all burning studies, the burn plan and prescribed fires would be conducted according to state regulations administered by the West Virginia Division of Forestry. All personnel supervising and working on the fire would have received training in use of prescribed fire and in fire suppression. The on-site burn plan for all studies involving prescribed burn would be developed by personnel of the Monongahela National Forest with expertise and experience in both fire suppression and the use of fire as a management tool. Ignition patterns typically follow a pattern to minimize risk of fire becoming uncontrolled. A typical burn begins with lighting a backfire along the downwind perimeter of a burn. A backfire moves slowly and with relatively low flames because it burns into the wind. When the backfired portion of the burn is safe, flank fires are generally lit beginning at the backfire along burn perimeters parallel with the wind. Flank fires have moderate flame heights and speed because they move perpendicular to the wind. When the back and flank portions of the fire are safe, strip head fires are typically lit more quickly to consume the remaining fuel. The rate of spread and flame length of strip head fires can be controlled by the width of the strip. A conservative strip width will be used to gauge fire behavior and adjustments will be made accordingly to achieve desired fire behavior characteristics. In this case, a 4' flame length that spreads about 4 to 8 feet per minute would be the goal.

Artificial acidification of several small watersheds at or near the Fernow Experimental Forest
The effect of artificial watershed acidification on vegetation growth and nutrient status

(4300-FS-NE-4301-59), and (4300-FS-NE-4301-63). The objectives of this research are to determine changes in soil chemistry, soil leachate chemistry, and streamflow chemistry resulting from increased levels of nitrogen and sulfur deposition, and to evaluate the effects of these changes on vegetation growth and ecosystem nutrient status. Ammonium sulfate fertilizer will be applied to a watershed and the effects on ecosystem parameters will be determined. The study results will quantify the susceptibility of watersheds in the Central Appalachians to acidification by acid deposition. In addition, the data will be used to test watershed acidification models. This whole system manipulation approach will quantify the integrated response of a watershed to elevated sulfur and nitrogen loadings. (Compartment WS3; 84.7 acres).

Prescribed burning and variable intensity overstory mortality for enhanced wildlife habitat structure and long-term oak restoration

Proposed new research - study number yet to be assigned. The objectives of this research are to improve Indiana bat summer habitat, and in the longer term, to create a mosaic of sites to promote oak forest restoration or oak savanna creation. Through a series of prescribed burning and periodic overstory mortality treatments (herbicides and/or girdling), short-term improvements in bat roosting and forage habitat would be made. Over the longer period, overstory mortality treatments would focus on non-oak removals to create an all-oak live overstory; and only oak seedlings/saplings (or other fire tolerant species) would be present for future accession into the overstory. Unlike previous oak-fire-light studies, timber management would not be an immediate management goal.

This study would include seven compartments (7 replicates): John B. Hollow drainage (324.2 acres, 5 treatment areas), and two treatment areas consisting of portions of compartments 13 and 21 (31.3 and 30.9 acres, respectively). A study plan would be prepared and peer-reviewed prior to any treatments being implemented. A burn plan following guidelines adopted for prescribed burning in study 4300-FS-NE-4353-12 *Evaluating prescribed fire as a silvicultural tool to promote oak regeneration in the central Appalachians* will be followed.

Alternative C: Preferred Alternative

This alternative includes the same actions as Alternative B, and includes activities to control exotic, invasive species on the FEF. To address issues related to control of invasive exotic plants, herbicides would be applied on approximately 3 acres to control the spread of Japanese stiltgrass (*Microstegium vimineum*). Tree-of-heaven (*Ailanthus altissima*) would be treated with herbicides as needed, on an individual tree basis.

Threatened, Endangered, And Sensitive Species On The Proposal Area

Federally Listed Threatened and Endangered Species

Indiana bat

The USFWS listed the Indiana bat as endangered on March 11, 1967. The USFWS Recovery Plan was signed October 14, 1983 (USDI Fish and Wildlife Service 1983). In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan", which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision is being prepared.

Distribution and Habitat

The Indiana bat occurs throughout the eastern U.S., from Oklahoma, Iowa, and Wisconsin, east to Vermont and south to northwestern Florida (Hall 1962, Romme et al. 1995). During the winter months,

Indiana bats restrict themselves primarily to karst areas of east-central U.S. More than 85% of the Indiana bat population occupies nine Priority One hibernacula (Priority One hibernacula are defined as caves that have annual Indiana bat populations >30,000 since 1960), all of which are in Indiana, Kentucky, and Missouri. Priority Two hibernacula (Indiana bat populations >500 but < 30,000 since 1960) occur in the aforementioned states plus Arkansas, Illinois, New York, Ohio, Tennessee, Virginia and WV. Hibernacula with Indiana bat populations of <500 or records of single hibernating individuals are classified as Priority Three hibernacula. They occur in all aforementioned states plus Alabama, Connecticut, Florida, Georgia, Indiana, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Vermont, and Wisconsin (USDI Fish and Wildlife Service 1999).

T. Carter

Winter hibernacula monitoring shows Indiana bat populations are decreasing in portions of their core range (USDI Fish and Wildlife Service 1996), but not in WV, where estimated populations have been increasing since the early 1980's (WVDNR data 1998). Most significant caves are gated or fenced, to protect Indiana bat populations, and this action likely has been responsible for their increases. In the last decade, WV has seen a 45% increase in the number of hibernating Indiana bats, with the total in the state at approximately 9,500. This represents 3% of the entire hibernating Indiana bat population range-wide. Indiana bats hibernate in many WV caves, but the colonies typically are not large. Twenty-six WV caves provide adequate Indiana bat winter hibernacula. Indiana bat populations in these 26 caves range from a single bat observation to populations over 8,000.

Although WV is within the Indiana bat eastern maternity range, it is not within its core, and does not have confirmed maternity colonies. The majority of maternity colonies are in states west of WV, such as Kentucky, Ohio, and Indiana, although there are maternity colonies in some eastern states, such as New Jersey, North Carolina, and Virginia.

Hibernacula

Indiana bats begin arriving at hibernacula or hibernacula area (< 5 km radius of hibernacula) from mid-August to October (Kiser and Elliot 1996) and November (Hall 1962, Humphrey 1978). Breeding occurs during this time (LaVal and LaVal 1980); although, ovulation, fertilization, and implantation do not occur until females have left hibernacula in the spring (Thomson 1982). Intense foraging and fat deposition critical for the wintering period occurs after arrival at hibernacula, and prior to the bats entering hibernation in October (females) and November (males) (Humphrey 1978, Kiser and Elliot 1996).

During the early swarm, Indiana bats roost in the warmer portions of the hibernacula and forage nightly to build fat reserves (Hassel 1967, Kiser and Elliot 1996). These bats will periodically use tree roosts during the fall swarm (Menzel et al. 2001, Battle and Stone 2003). These roost trees often have significantly more hardwood and old-growth acreage, and significantly less conifer acreage then areas not utilized for fall roosting (Battle and Stone 2003).

Caves must posses certain characteristics to be suitable as Indiana bat hibernacula. Raesly and Gates (1986) compared microhabitat and microclimate variables between occupied and unoccupied caves and mines. They found that Indiana bat hibernacula tended to have larger openings, more cave passage length, and higher ceilings compared to unoccupied sites, in addition, occupied hibernacula have

noticeable airflow (Henshaw 1965). Tuttle and Kennedy (1999) hypothesized that Indiana bats prefer hibernacula with the lowest non-freezing temperatures possible. Core range (Indiana, Kentucky, and Missouri) mid-winter cave temperatures for Indiana bat cluster sites range from 2-5 ^{o}C (Hall 1962, Henshaw 1965, Henshaw and Folk 1966, Thomson 1982). However, Barbour and Davis (1969) and Humphrey (1978) found hibernacula temperatures ranging from –1.6-17 ^{o}C across the entire wintering season and hibernating range. Mid-South hibernacula temperatures in Arkansas and Oklahoma and mid-Atlantic hibernacula in Maryland, Virginia, and WV typically are warmer, i.e. 7-10 ^{o}C (Harvey and McDaniel 1986, Raesly and Gates 1986). Indiana bats prefer moist caves, with relative humidity ranging from 70 to nearly 100% in most hibernacula (Hall 1962, LaVal et al. 1976, Humphrey 1978, Tuttle and Kennedy 1999). Relative to cave conditions chosen by other bat species, Indiana bat clusters generally occupy open ceiling areas where ambient air temperature is lowest, cave wall temperature is lowest, relative humidity is highest, and airflow is highest. Indiana bat clusters can be as dense as 3000 individuals per m^2 (Barbour and Davis 1969).

The inactive hibernation period for Indiana bats is approximately 190 days (October-April for females, November-May for males), depending upon conditions in the hibernacula (Hall 1962).

Summer/maternity roosting habitat

Indiana bats emerge from the hibernacula from mid-April through May (Hobson and Holland 1995). Females generally leave the cave earlier than males (Humphrey 1978, LaVal and LaVal 1980).

Indiana bat roosts are placed into one of two categories: primary or alternate (Callahan et al. 1997). Primary roost trees are trees that are used by >30 bats on more than one occasion. Fewer individuals use alternate roosts. Both roost types are essential for meeting Indiana bat maternity and summer roost requirements. Some Indiana bat maternity colonies may use more than a dozen roosts (USDI Fish and Wildlife Service 1996, Foster and Kurta 1999), and maternity colonies may contain up to 100 individuals, including young (Brack 1983, Jordon 1986). Male Indiana bats stay near the winter hibernacula during the summer, and occasionally may roost in the hibernacula or other caves during the summer (Myers 1964, Jordon 1986). However, it is much more common for male Indiana bats to roost in trees with sloughing bark and cavities (Hobson and Holland 1995, Stihler 1996). Indiana bat males may switch roost trees from day to day, often roosting in trees near ridge tops (Kiser and Elliott 1996). In Kentucky, Kiser and Elliott (1996) found Indiana bat males roosting primarily in dead trees on upper slopes and ridge tops within 1.5 miles of the hibernaculum.

One of the earliest reported Indiana bat maternity roosts was a primary roost in a bitternut hickory snag and an alternate roost in a live shagbark hickory (Humphrey et al. 1977). The most common living tree species used is shagbark hickory (Gardner et al. 1991). Indiana bats have been documented using a variety of tree species including red, silver (*A. saccharinum*), and sugar maple, bitternut, shagbark, and pignut (*C. glabra*) hickory, cottonwood (*Populus deltoides*), white (*Fraxinus americana*), black (*F. nigra*), and green (*F. pennsylvanica*) ash, American sycamore (*Platanus occidentalis*), white (*Q. alba*), scarlet (*Q. coccinea*), shingle (*Q. imbricaria*), northern red, and post (*Q. stellata*) oak, sassafras (*Sassafras albidum*), American (*Ulmus americana*), and slippery (*U. rubra*) elm (Brack 1983, Gardner et al. 1991, King 1992, Kurta et al. 1993, Kurta et al. 1993a, Caryl and Kurta 1996, Kurta et al. 1996, Salyers et al. 1996, Callahan et al. 1997). Maternity roosts in eastern Tennessee and western North Carolina were located in conifer snags (Britzke et al. 2003). Autumn and early spring roosting studies in Kentucky also have documented conifer use such as Indiana bats roosting in Virginia pine (*P. virginiana*) and shortleaf pine (*P. echinata*), and females also using sourwood (*Oxydendrum arboreum*) (Kiser and Elliott 1996, MacGregor et al. 1999). In addition, male Indiana bats have also used artificial structures such as bat boxes, bridges, and abandoned mines.

Tree species does not appear to be an important factor in roost site selection. Tree structure, specifically the availability of exfoliating bark with roost space underneath, is a critical characteristic for roost trees. A majority of bat roosts have been located in dead or dying trees, although some alternate roost sites have been in living trees. Indiana bat use of snags appears to be influenced by bark characteristics. The ability of a tree species to produce exfoliating bark probably influences Indiana bat use of that tree (Britzke et al. 2003, Callahan et al. 1997). Maternity colonies are rarely found in tree cavities, and most primary maternity roosts have been located under exfoliating bark. However, studies from Michigan and Missouri that have compared the amount of exfoliating bark and Indiana bat use, and found snags with more exfoliating bark may not be used more than snags with little exfoliating bark (Kurta et al. 1996, Callahan et al. 1997).

Indiana bats may pick maternity roosts with high solar exposure to increase the roost temperature, which may decrease the fetal development time and speed juvenile growth (Callahan et al. 1997). However, because males are not associated with maternity colonies and the need for high roosting temperatures (Callahan et al. 1997), they may seek cooler roosts to reduce their physiological expenditures. Callahan et al. (1997) considered roosts to be either open (exposed to solar radiation) or interior (>50% canopy cover) and found that all primary roosts were in open snags. Roost height may vary with canopy cover in order to maintain a relatively constant level of solar exposure (Gardner et al. 1991).

Stand structure does not appear to determine roost tree location. Generally, primary roosts are located in openings or at the edge of forest stands, while alternate roosts can be either in the open or in the forest interior (USDI Fish and Wildlife Service 1996). Gardner et al. (1991) found a majority of roosts in grazed uplands, with other roosts found in nongrazed uplands, nongrazed floodplains, a clearcut, a hoglot, and a pasture. Kurta et al. (1993) also reported a roost tree from "the middle of a heavily grazed pasture." Several studies suggest that Indiana bats may be more tolerant of limited roosting area disturbance than previously thought. Callahan et al. (1997) suggested that management practices, such as even-aged and uneven-aged management, that include provisions for snag retention and promotion of oak and shagbark hickories may not be detrimental to Indiana bat habitat.

Food Habits

Fecal material analysis shows Indiana bat diets to consist of Lepidoptera (moths), Coleoptera (beetles), Dipterans (true flies), Trichoptera (caddisflies), Plecoptera (stoneflies) Neuroptera (lacewings), Hymenoptera (ants), and Homopterans (Leafhoppers), with moths and beetles making up the majority of the diet (LaVal and LaVal 1980, Brack 1983, Kiser and Elliott 1996, Whitaker 2004). Prey selection often reflects the foraging environment (Romme et al. 1995).

Indiana bats forage nightly for terrestrial moths and aquatic insects, primarily in upland forests and riparian woodlands (Romme et al. 1995). Female Indiana bats seem to prefer to forage over wooded rivers, bottomland areas, riparian pastures with scattered trees, and upland forested areas (Easterla and Watkins 1969, Humphrey et al. 1977, LaVal et al. 1977, Cope et al. 1978, LaVal and LaVal 1980, Brack 1988). Most foraging appears to occur along habitat edges (Brack 1983). There is some evidence that male Indiana bats do not forage over water in riparian areas (LaVal and LaVal 1980). In forested areas, Indiana bats prefer to forage within or just below upper forest canopy layers at a height of 2-30 m (Humphrey et al. 1977, LaVal and LaVal 1980, Romme et al. 1995).

Most studies have shown preferred foraging habitat for Indiana bats is close to a water source and has canopy cover ranging from 50-70%. When canopy closure exceeds 70% or is less than 50% foraging habitat suitability declines (Romme et al. 1995). However, Clark et al. (1987) captured Indiana bats in a wide variety of forested and riparian areas, signifying they may use fragmented and younger forest types. Large open pastures or croplands, stands with large unbroken expanses of young (2-5" dbh.),

even-aged forests are avoided or rarely used for Indiana bat foraging (Brack 1988, Romme et al. 1995). Additionally, Indiana bats routinely will fly a longer commuting distance to foraging areas by utilizing wooded corridors rather then flying across open fields (Murray and Kurta 2004).

During the fall swarming period in Kentucky, Indiana bats foraged more on upper slopes and dry ridgelines with second-growth chestnut oak (*Q. prinus*)-pine and oak-hickory forests than in riparian areas or moist slope-cove forests (Kiser and Elliot 1996). Cooler autumn temperatures and cold-air drainage in hilly or mountainous locations may limit insect abundance and activity in riparian areas and sheltered cove forests, whereas upper slopes and ridgelines have favorable "warm" exposures (Kiser and Elliot 1996).

Reproduction

Young female Indiana bats can mate their first autumn and have offspring the following year. Males reach sexual maturity their second year. Mating takes place from September through October. Female Indiana bats store sperm through the winter and become pregnant via delayed fertilization soon after hibernacula emergence, generally late March or early April (Thomson 1982). Each female gives birth to a single pup in late June or early July. Lactating females may return to the day roost 2-4 times per night for approximately 30 minutes per visit to feed young (Murray and Kurta 2004). Young become volant in approximately 1 month (Jordon 1986), and are weaned soon after (Brack 1988). By late August, maternity colonies begin to disperse.

Causes of Past/ Current Declines

Disturbance to the hibernacula is one of the major factors leading to the decline of this species. Arousal following disturbance (e.g., spelunkers, scientists, predators) can be detrimental (Hall 1962, Myers 1964, LaVal et al. 1976, Humphrey 1978, LaVal and LaVal 1980, Clawson 1984). Exposure to mild sound and light can initiate arousal (Humphrey 1978), as can a drop in cave humidity below 85% (Tuttle and Kennedy 1999). Sudden arousal accompanied by excessive agitation, movement and in-cave flight that can expend 20-30 days of stored energy reserves (Daan 1973). Sudden arousal events cause accelerated fat depletion, premature emergence from hibernacula, lowered spring body condition, and lowered survival (Clawson 1984, Tuttle and Kennedy 1999).

Indiana bats are particularly vulnerable to vandalism during hibernation (Dunn and Hall 1989), and many instances of thoughtless bat colony destruction have been documented (Hall 1962, Myers 1964, LaVal et al. 1976, Humphrey 1978, LaVal and LaVal 1980, Brack et al. 1984, Clawson 1984). Potential or historic hibernacula that are regularly disturbed will not support wintering Indiana bats, and in most instances, Indiana bats fail to recolonization hibernaculum following cave protection (Harvey and McDaniel 1986). Entry into Indiana bat hibernacula should be prohibited from September through May (Humphrey 1978, LaVal and LaVal 1980, Clawson 1984, USDI Fish and Wildlife Service 1996). Improperly designed cave gates that alter cave airflow patterns (particularly trapping warm air) may reduce, and in some instances destroy, hibernacula suitability (Tuttle 1977, Humphrey 1978, Richter et al. 1993, Tuttle and Kennedy 1999).

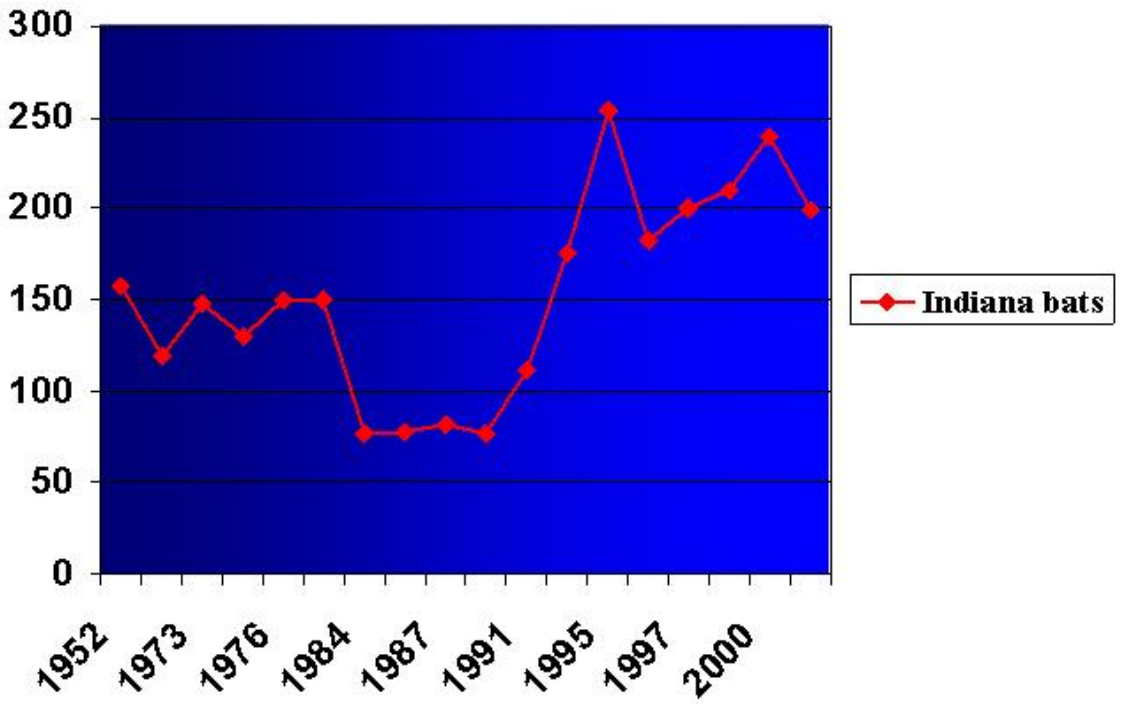
In addition to population threats from human disturbance, hibernating Indiana bats are also vulnerable to natural disturbances, and destruction of any hibernacula can have a tremendous impact on the population because of the limited number of hibernacula (Hall 1962). Mid-winter cave flooding can cause significant mortality by drowning trapped bats or by inducing arousal (Cope and Ward 1965). Some hibernacula occur in caves that excessively trap and hold cold air during unseasonable frigid temperatures, freezing hibernating bats (Humphrey 1978, Richter et al. 1993). Hibernacula ceiling collapse can kill Indiana bats outright or block passageways in mine sites (Hall 1962, Humphrey 1978), and could potentially occur in caves as well (USDI Fish and Wildlife Service 1996).

Exposure to and accumulation of environmental contaminants may potentially occur during the fall swarming period when bats are intensively foraging and gaining weight prior to entering hibernation (Reidinger 1972), a factor that has been directly implicated in local extirpations of bat populations and suspected to be a factor in the decline of insectivorous bat species in North America (Clark 1981).

Habitat on the FEF

Big Springs Cave on the FEF is a winter hibernacula for the Indiana Bat. Winter bat surveys of Big Springs Cave have been conducted periodically since 1952 (Appendix 2). To reduce the possibility of disrupting the hibernating bats, the USFS gated the cave in 1973. Despite the cave gate, the population of Indiana bats at Big Springs Cave started to decline in 1977. Continued human disturbance during the winter hibernation period attributed to this decline. The 1973 gate was a flat bar design, and the bars were readily bent, enabling human access. In the summer of 1986, a new cave gate with a round bar design was installed. Since the installation of the new gate, the Indiana bat population at Big Springs Cave has increased and remained relatively stable since 1993 (Figure 1).

Figure 1. Winter surveys of Indiana bats at Big Springs Cave.



Indiana bats hibernate in caves on and near the FEF, and recent data shows some of their summer habitat is concentrated around hibernacula. Male Indiana bats were found using habitat around Big Springs Cave in summer and fall (Stihler 1996), although no females have been captured on the FEF during the summer months. In the summer of 2004, 2 Indiana bat maternity colonies were documented in WV. One was found in Boone County, located in southern WV. Another colony was discovered July 2004 in Lower Glady west of Gladwin, approximately six miles from the FEF (D. Arling, pers. comm.). This

particular female may have been associated with another cave system than Big Springs, the Cave Hollow/Arbogast cave. Regardless, the discoveries of these maternity colonies, coupled with the capture of a post-lactating female on the Meade-Westvaco Ecosystem Research Forest near Adolph, WV (approximately 30 miles away from the proposed project site) in July, 1999 (Owen et al. 2001) provide the first evidence of Indiana bat maternity colony presence in WV.

During the summer and fall of 1995, the WVDNR conducted a survey on the FEF to determine presence or absence of Indiana bats. The FEF was selected because it contains a known hibernaculum (Big Springs Cave), and potential summer habitat (roost trees, upland forest, and riparian forest). Mist nets were used to capture bats moving along travel corridors and a harp trap was placed at the entrance to Big Springs Cave. One thousand fifty-four bats of nine species were captured during 11 trapping sessions (Appendix 4). The first summer record of the Indiana bat in WV was documented with the capture of one male in June and five males in July. No females were captured until August. Sixty-nine Indiana bats were captured during the study, of which five were females. The majority of the Indiana bats (64 of 69) were captured at the cave entrance, and only a few of these appear to have been trapped as they exited the cave in the evening. Therefore, it was assumed the bats were apparently using the cave as a night roost. The locations of the bats' day roosts were not known at that time (Stihler 1996). This study indicates that some male Indiana bats stay near their winter hibernaculum through the summer months.

The WVDNR conducted a study of male Indiana bat roost selection on the FEF in September 1997 by attaching transmitters to four male Indiana bats. Additionally, in June 2000, scientists at the Northeastern Research Station and West Virginia University attached a radio transmitter to a single, adult male Indiana bat (Ford et al. 2002). Descriptions of the roost sites used by Indiana bats during these two studies are presented in Table 1.

Table 1. Roost trees used by three male Indiana bats on the FEF, September 1997.

Roost Tree	Bat/Year	Tree Species	Condition	dbh (inches)
1	053/1997	Northern Red Oak	living	18.5
2	053/1997	Red Maple	living	5.4
3*	053/1997	Black Cherry	unknown	unknown
4	053/1997	Yellow Poplar	dead	18.7
5	053/1997	Yellow Poplar	dead	10.5
6	094/1997	Shagbark Hickory	living	23.3
7	053/1997	Yellow Poplar	living	9.0
8	112/1997	Slippery Elm	living	18.7
9	094/1997	White Ash	living	14.2
10	094/1997	Shagbark Hickory	living	12.8
11	1/2000	Shagbark Hickory	living	17.9
12	1/2000	Shagbark Hickory	living	26.8
13	1/2000	Sugar Maple	living	27.2

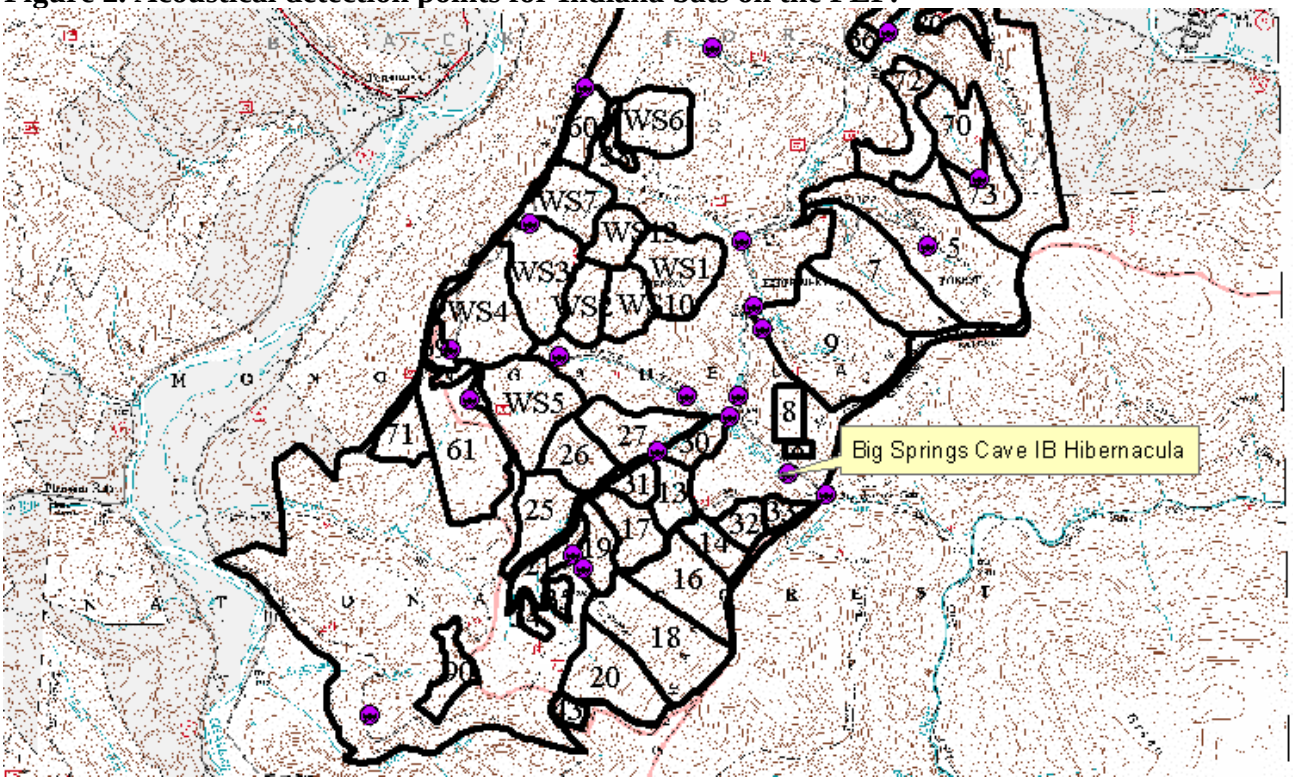
*Roost tree no. 3 was one of three possible black cherry trees. Two were living with a dbh of 16.8 and 14.4 inches. The third tree was dead with a dbh of 10.7 inches.

Results of these studies indicate that Indiana bats appeared to select living trees in pole to sawtimber size classes. Shagbark hickory, sugar maple, slippery elm, and white ash are already documented as preferred roost tree species for Indiana bats. Northern red oak, black cherry and yellow poplar (especially standing dead) display the roost tree characteristics described within the recovery plan. However, stand structure data demonstrate that these preferred tree species are not regenerating on the sites currently used by roosting Indiana bats. Even though the FEF currently contains the tree species

preferred by Indiana bats for roosting, much of the regeneration (sapling and pole-size trees) is in red maple, sugar maple, and American beech. Indiana bats used these species less than expected based upon their availability in the forest. Forest management practices that tend to favor shade tolerant species will result in the regeneration of trees not preferred as roost trees by Indiana bats. Indiana bat roosts are ephemeral (USDI Fish and Wildlife Service 1996), therefore, unless active management to promote preferred tree species is encouraged, roost tress may become a limiting factor for Indiana bats. To promote the presence of black cherry and yellow poplar, it is necessary to utilize even-aged types of silviculture. Such activities are part of the existing Timber and Watershed Laboratory project plans and should be sufficient to maintain a portion of the FEF in this cover type.

During the summers of 2001-2003, researchers at the Northeastern Research Station, in conjunction with other cooperators, used Anabat acoustical equipment to relate bat species presence to habitat conditions and structure (Ford et al. 2004). The study found that foraging and traveling Indiana bats were often associated with more riparian then upland areas (Figure 2). Additionally, the probability of Indiana bat presence increased with the percent forest canopy cover along those riparian areas (Figure 3) (Ford et al. 2004).

Figure 2. Acoustical detection points for Indiana bats on the FEF.



Of the 4700 acres composing the FEF, approximately 845 acres are under even-aged management, 1120 acres are under uneven-aged management, 355 acres are biological controls (monitored but not manipulated), and the remaining 2380 acres are neither manipulated nor within an existing study. The majority of the FEF is in a closed canopy condition. Most of the forest is in uneven-aged management, control, or unmanaged which results in closed overstory canopies. There are currently fewer than 120 acres in open condition (i.e. less than 70% overstory closure). The FEF has approximately 35 miles of streams, nine artificial ponds (8 of which are weir ponds), and a reservoir. Streamside Management Zones (SMZ) are established along perennial and intermittent streams. Perennial streams, such as Elklick Run, will maintain a buffer strip 100 ft. wide along each side of the stream. No timber

harvesting can take place along stream banks, and 75% canopy cover must be maintained in the SMZs. Intermittent streams will have a 50 ft. buffer zone along each side of the stream. No timber harvesting can take place along stream banks, and 50% canopy cover must be maintained in the SMZs. These habitat conditions provide excellent foraging habitat for Indiana bats.

Figure 3. Foraging and traveling Indiana bat habitat use on the FEF.

Because there is evidence that most Indiana bat males are foraging around the hibernacula in summer, all areas within 5 miles of hibernacula are considered summer use areas use for Indiana bats. In addition, these areas are where fall swarming occurs. Tree felling projects in this 5-mile radius occur only from October 1 through April 30, to reduce the possibility of potential take of Indiana bat individuals. These dates afford some protection if Indiana bats are roosting on the FEF during the summer months, when young bats are not volant, while ensuring the integrity of long-term research projects and allowing Northeastern Research Station Timber and Watershed Laboratory research scientists to meet their research mission and mandate.

The proposed new study on the FEF would involve improving roosting/maternity colony habitat on the FEF, as well as plans to track Indiana bats as they emerge from the cave in the spring to determine where and what habitat these bats choose during the summer months. The availability of roost/maternity trees may govern the presence or absence of Indiana bats in an area. The FEF contains a number of tree species preferred by the Indiana bat as roost trees, such as shagbark and bitternut hickory, red and white oak, sugar maple, white ash, sassafras, and black locust (*Robinia pseudoacacia*). Individual trees exhibiting roosting characteristics are scattered throughout the FEF, however, the proposed study would attempt to replicate conditions found at the known maternity colony in Lower Glady, where a wildfire opened the over- and mid-story, and created a large number of snags. This habitat type provided suitable maternity colony site for Indiana bats, and perhaps similar conditions could be replicated on the FEF.

Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

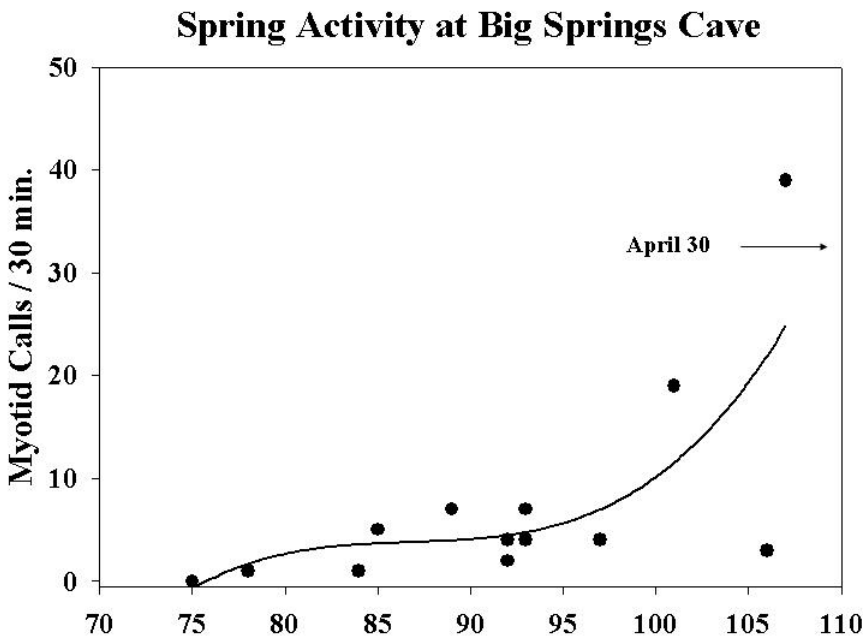
This Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the Indiana bat would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no effect** is made for the Indiana bat on the FEF as a result of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

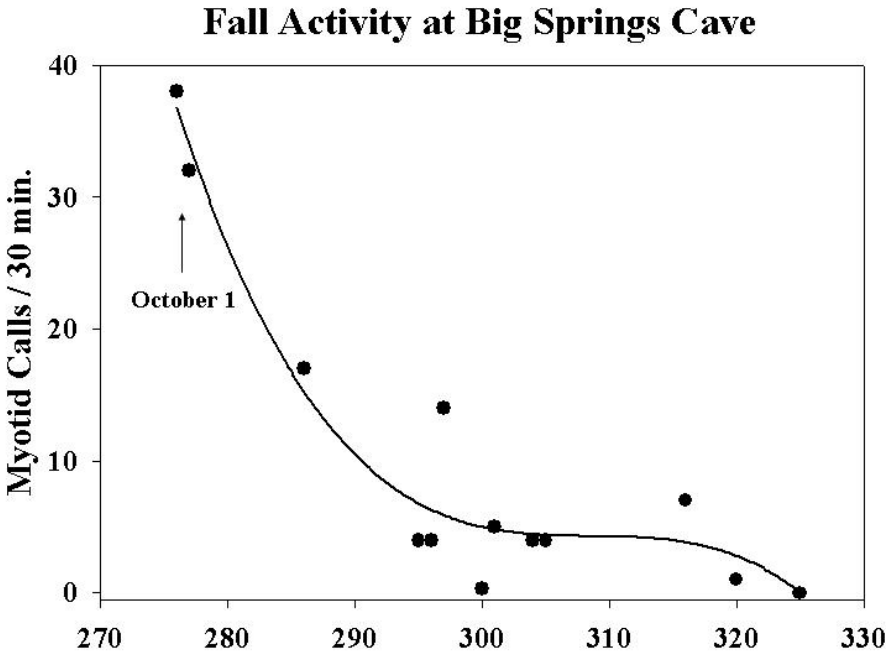
Dr. Mark Ford, Northeastern Research Station Wildlife Research Scientist, has monitored spring emergence dates and fall entrance dates for bats at Big Springs Cave during 2001-2004 in order to gather data as to when Indiana bats are post-hibernation. A summary of these data is presented in Figure 4 and Figure 5.

Figure 4. Spring emergence dates for bats at Big Springs Cave (Julian dates).



Currently, the FEF only cuts trees between the dates of October 1 – April 30 in an effort to reduce the direct impacts of timber harvesting on Indiana bats. The monitoring data from Big Springs Cave reveals that bats are entering the cave later then October 1 in the fall, and emerging from the cave earlier then April 30 in the spring. Although the possibility of negative direct impacts would be minimal due to the relatively low Indiana bat density on the FEF, the abundance of roost trees scattered throughout the FEF, and the small acreage to be cleared on the landscape, the proposed study sites are within a 2 mile radius of Big Springs cave which is a known Indiana bat hibernacula so direct impacts may occur. Tree removal during study treatments could have negative direct effects on the Indiana bat by harming individual bats that may be utilizing trees located in the treatment areas.

Figure 5. Fall entrance dates for bats at Big Springs Cave (Julian dates).



Approximately 10% of the 4615 acres on the FEF would be affected by one of these silvicultural treatments; however, less then 1% would involve complete overstory removal. Since it appears that Indiana bats are generalists when selecting foraging habitat and utilize many different habitat types when foraging, the opening of the overstory in because of these treatments would not change the abundance of foraging habitat on the landscape. Additionally, Callahan et al. (1997) stated that even-aged and uneven-aged management could be used in conjunction with Indiana bat management when snags and shagbark hickories are retained, and management favors oak species. Shagbark hickory is a protected tree species on the FEF, and several proposed research studies state oak restoration and regeneration as one of their objectives. Although some potential Indiana bat roost trees may be removed during harvest, additional roost trees may be created due to some overstory removal. Therefore, there would be no indirect or cumulative effects due to the proposed silvicultural practices for these research studies.

Prescribed burning

Few studies have been done documenting the effect of prescribed fire on Indiana bats, and no studies have documented the potential direct effects of prescribed fire on this species. In Tucker County, WV on MNF land, a myotid bat flew out of a burning snag during a prescribed fire and into an unburned forested area during the spring 2001. Additionally, two red bats (*Lasiurus borealis*) were observed flying from another prescribed burn unit into an unburned area during another prescribed fire (Rodrigue et al. 2001). This behavior would indicate that Indiana bats might be capable of escaping burning roost trees when necessary and if volant. The propensity of this species to utilize multiple roost trees when out of the hibernacula ensure that other roost trees are available when one is destroyed. Prescribed burns would occur in the early spring before the young are born, and in the fall when the young of that year are volant. Therefore, there would be no direct effects to Indiana bats due to prescribed burning.

Carter et al. (2000) state that additional potential roost cavities and snags can be created in forested stands by utilizing prescribed fire, depending on fire intensity. Alternatively, snags subjected to fire can be highly combustible, and some roost trees may be destroyed by fire, depending on their age and condition. The Indiana bat maternity colony discovered in the summer of 2004 in Lower Glady was

located in an area subjected to a wildfire during the spring of 2002 (D. Arling pers. comm.). Therefore, there could be both positive and negative indirect and cumulative effects to Indiana bats due to prescribed fire. There would be no cumulative effects to this species as there would be no change to foraging and roosting habitat on the landscape scale.

Ammonium nitrate fertilization

Fertilization of this watershed would have no direct effect on Indiana bats as the fertilizer pellets would not be applied in high enough density and are not toxic to this species at this concentration. Additionally, preliminary study results have not revealed any effects on the diversity and abundance of herbaceous plants, salamanders, or insects in the artificially acidified watershed (M.B. Adams, pers. comm.). Therefore, it is unlikely that this study would have any negative effects on Indiana bats.

Determination

Due to the possibility of negative direct effects during timber removal, a determination of **may affect, likely to adversely effect** is made for the Indiana bat on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the Indiana bat are discussed below.

Herbicide Application

Herbicide application would be species-specific, targeting exotic plant species that threaten to form exotic invasive monoculture on the FEF. There would be no direct effects to Indiana bats because of herbicide application due to that fact that application would be directly on targeted plants, and no Indiana bats would be present on targeted plant species. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Herbicide application would be species-specific, and there would be no indirect or cumulative effects to Indiana bats as overall habitat would remain the same.

Determination

Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may affect, likely to adversely effect** is made for the Indiana bat on the FEF under the Preferred Alternative.

Virginia big-eared bat

The Virginia big-eared bat was listed as endangered under provisions of the Endangered Species Act on December 31, 1979. The USFWS developed the Virginia big-eared bat Recovery Plan, and the plan was signed on May 8, 1984.

T. Carter

Distribution and Habitat

The Virginia big-eared bat is a geographically isolated, sporadically distributed cave obligate subspecies of Townsend's big-eared bat (*C. t. townsendii*). It occurs in karst areas in eastern Kentucky, eastern WV, extreme western Virginia, and North Carolina (Clark and Lee 1987).

Hibernacula
Virginia big-eared bats return to hibernacula in September, and continue feeding during warm evenings. Throughout their range, Virginia big-eared bats hibernate in caves and mines, which provide cold to near freezing temperatures (36.5^o to 49.1^o F). In Kentucky and WV, Virginia big-eared bats occasionally hibernate in clusters of several hundred to more then a thousand, occupying the same spot within the cave year after year. Ages and sexes of bats hibernating in small clusters appear to be random, but large clusters usually consists of nearly equal numbers of both sexes. Winter clusters stabilize body temperatures against external changes. Handley (1959) stated that winter clusters protect the bats from the heat rather then the cold, but they likely minimize changes in both directions (Barbour and Davis 1969).

Summer/maternity roosting habitat
In Oregon, female Townsend's big-eared bats do not move directly from their winter hibernacula to maternity sites, but utilize a series of interim roost sites for a period of up to 2 months before reaching maternity roosts (Dobkin et al. 1995). Virginia big-eared bats generally reach maternity roost sites by early May (Lacki et al. 1994). Females return to the same maternity roost site year after year (Clark et al. 1997), although maternity colonies may split into smaller groups in a cave, thereby reducing competition for resources during the latter stages of pregnancy and during lactation. These divisions also may reduce competition with juvenile bats when they first become volant (Clark et al. 1997)

Female Virginia big-eared bats form maternity roosts in limestone caves and sandstone rock shelters (Adams et al. 1994, Lacki et al. 1994), and may use rock shelters as summer feeding roosts (Lacki et al. 1993). Maternity roosts utilize warm caves, with temperatures ranging from 59° to 64° F (Clark 1991). Male Virginia big-eared bats form bachelor colonies that also are dependent on caves and rock shelters in the summer, although they inhabit different areas of the roost site then females. Vegetative and other surface habitat characteristics do not seem to play a role in roost site selection by bats (Wethington et al. 1997). Nursery colonies disperse in August, following weaning. Females that have lost their young leave earlier then lactating females, and young males tend to leave earlier then young females (Barbour and Davis 1969).

Virginia big-eared bats move readily from one roost to another, but they probably do not migrate long distances between summer roosting and winter hibernacula habitat (Barbour and Davis 1969). Barbour and Davis (1969) recorded a migration movement of 38.6 miles in Kentucky. Harvey et al. (1981) reported a 3.9 miles movement between hibernacula and maternity cave in Arkansas.

Food Habits
Most foraging activity occurs on evening with a relative humidity of 64% to 97%, perhaps as a mechanism to avoid substantial water loss. In addition, foraging activity is negatively correlated with wind speed and moon phase, which may be a factor in predator avoidance or a result of availability of insect prey (Adams et al. 1994a).

Conditions outside the cave must be suitably dark for Virginia big-eared bats to begin foraging (Barbour and Davis 1969). The high maneuverability of this bat species allows it to forage both in cluttered and open habitats (Dalton et al. 1989, Adams et al. 1994, Burford and Lacki 1995, Wethington et al. 1996). Townsend's big-eared bats forage in open habitats along forest-shrub ecotones (Dobkin et al. 1995), while in Virginia, Virginia big-eared bats forage over open pastures, corn and alfalfa fields, and around tree crowns (Dalton et al. 1989). Virginia big-eared bats tend to concentrate foraging activity near night roosts. Adams et al. (1994) found Virginia big-eared bats forage along cliff faces and forested habitat in

close proximity to their rock shelter night roosts. Clifftops and faces generally are open habitat, and provide the bats an uncluttered foraging environment.

In general, foraging area size does not differ between males and females (Adams et al. 1994), thought foraging area may increase during the summer for females. Forage areas for females are the smallest in May, due to recurrent visitations to maternity roosts to nurse their young (Adams et al. 1994). The largest foraging areas for female Virginia big-eared bats occur in August, likely a result of competition with newly foraging young and accommodation of the larger bat population (Adams et al. 1994). However, Wethington et al. (1996) found female bats traveled shorter distances in the autumn compared to summer, perhaps a factor of decreased energy requirements.

In WV, moths comprise more then 90% of Virginia big-eared bat diet (Dalton et al. 1986, Sample and Whitmore 1993). Virginia big-eared bats are highly maneuverable, and may be moth specialists (Dalton et al. 1986, Wethington et al. 1996). The great abundance, ease of capture, and active period of moths makes these insects desirable prey species (Dalton et al. 1986). Coleoptera (beetles) are of secondary dietary importance, with bats from caves adjacent to open fields consuming the greatest number of these insects (Sample and Whitmore 1993). Diptera (true flies and mosquitoes), and Hymenoptera (bees, wasps, and ants) are important components of the Virginia big-eared bat diet (Sample and Whitmore 1993).

Reproduction

Females mate in their first autumn; however, males do not reach sexual maturity until their second year. Mating usually occurs during the first 3 weeks of October, but fertilization is delayed until spring when ovulation takes place. Female bats store sperm over winter and fertilization occurs in the spring. Gestation ranges from 56-100 days, depending on spring temperatures and the degree of torpor in the female bats (Whitaker and Hamilton 1998).

In WV, female bats give birth to a single offspring in June. The young bats are naked in non-volant for their first few days. If disturbed, female Virginia big-eared bats can carry their young to other parts of the cave, or to other caves. Young bats grow rapidly, and at 3 weeks old, although still dependent upon their mothers, they are capable of flight. At 1 month, they have developed adult-length forearms, and by 6 weeks, young are weaned (Whitaker and Hamilton 1998, Wilson and Ruff 1999).

Causes of Past/ Current Declines

The greatest threats to Virginia big-eared bat populations are human disturbance and vandalism at maternity and hibernating sites. During hibernation, bats depend on stored body fat. When disturbed during winter, they emerge from hibernation and move to a safer roosting area in the cave, requiring the bat to raise its body temperature by burning stored fat. As few as two disturbances can cause a cave-dwelling bat to expend all its winter fat reserves, leading to starvation (Harvey et al. 1999). If maternity colonies are disturbed, females may abandon their flightless newborns, move their pups to locations less suitable for newborn survival (Harvey et al. 1999), or drop their pups in transit if sufficiently panicked. Bats have very low reproductive rates – a female bat will give birth to a single young every 1 or 2 years. Therefore, even seemingly small reductions in bat populations could devastate populations (Harvey et al. 1999).

Vandalism has resulted in destruction of many bat colonies simply because bats often are viewed as nuisances or threats to human health (USDI Fish and Wildlife Service 1996). Cave gating appears to be the most effective way to protect Virginia big-eared bat populations at high risk of disturbance. However, poorly designed and installed cave gates restrict bat movement and alter airflow into caves. Airflow alterations may changes the microclimate, rendering the cave unsuitable for hibernation and

roosting. Microclimate changes caused by increased or decreased airflow are probably major contributors to roost and hibernaculum degradation. Even small entry point blockages can be extremely important in hibernacula that require chimney-effect airflow to function. Airflow changes can elevate temperatures (Richter et al. 1993) in caves and cause bats' metabolic rate to increase, resulting in premature exhaustion of fat reserves (USDI Fish and Wildlife Service 1999).

Other possible causes of bat population declines include natural disasters (flooding, cave subsidence), loss of roosting sites due to sealing mine entrances, cave commercialism, chemical contamination, and loss of foraging habitat. Stream impoundment can create permanent or seasonal cave flooding, and cave commercialization may disturb roosting and hibernating bat colonies (USDI Fish and Wildlife Service 1983). Timber harvesting, water quality degradation, stream channelization, and other actions potentially could alter foraging habitat in some cases (Grindal 1996).

Insecticides, particularly those used for gypsy moth (*Lymantria dispar*) control, may adversely affect the food supply (Sample and Whitmore 1993). Bats have many potential predators, including house cats, owls, hawks, raccoons (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and snakes.

Habitat on the FEF

Mist net surveys on the FEF have captured a single Virginia big-eared bat during the late summer 1995. Additionally, a winter bat survey of Big Springs cave in January 2003 documented the presence of two Virginia big-eared bats utilizing the cave as a hibernacula. Although these surveys document the presence of Virginia big-eared bats on the FEF, the low capture rate suggests that the FEF has minimal Virginia big-eared bats roosting and hibernacula use. Virginia big-eared bats forage and night roost in a wide variety of habitats, including open pastures, riparian areas, upland forests, and fields. Both male and female Virginia big-eared bats are known to roost close to the hibernacula during the spring and summer. Therefore, the proposed project area may provide suitable foraging and night roosting habitat for Virginia big-eared bats.

Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the Virginia big-eared bat would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no effect** is made for the Virginia big-eared bat on the FEF as a result of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

No direct effects to Virginia big-eared bats would occur as this species day roosts in caves and cliff faces and hibernates in caves. Since tree removal would not occur at these sites, direct effects would be avoided. These bats forage in a wide variety of environment, in both open and cluttered areas. Additionally, the amount of disturbance occurring on a landscape scale would be small. Therefore, there would be no indirect or cumulative effects to the Virginia big-eared bat due to these silvicultural treatments.

Prescribed burning

All prescribed burns would occur over ¼ mile from Big Springs Cave, so there would be no negative effects from smoke or fire. Additionally, prescribed fire would create a mosaic of habitat for foraging

by opening the mid- and under-story in burned areas. This could provide more diverse foraging habitat for the Virginia big-eared bat on the FEF.

Ammonium nitrate fertilization
Fertilization of this watershed would have no direct effect on Virginia big-eared bats as the fertilizer pellets would not be applied in high enough density and are not toxic to species at this concentration. Additionally, preliminary study results have not revealed any effects on the diversity and abundance of herbaceous plants, salamanders, or insects in the artificially acidified watershed (M.B. Adams, pers. comm.). Therefore, it is unlikely that this study would have any negative effects on Virginia big-eared bats.

Determination
Due to the lack of adverse effects, a determination of **no effect** is made for the Virginia big-eared bat on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the Virginia big-eared bat are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to Virginia big-eared bats due to herbicide application because application would be directly on targeted plants, and no Virginia big-eared bats would be present on targeted species (Japanese stiltgrass and tree-of-heaven). Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be species-specific, there would be no indirect or cumulative effects to Virginia big-eared bats, as overall habitat would remain the same.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **no effect** is made for the Virginia big-eared bat on the FEF under the Preferred Alternative.

Virginia northern flying squirrel
On July 31, 1985, USFWS listed Virginia northern flying squirrel, (*Glaucomys sabrinus fuscus*), as endangered (50 CFR Part 17). The USFWS released the *Appalachian northern flying squirrel (Glaucomys sabrinus fuscus) (Glaucomys sabrinus coloratus) Recovery Plan* on September 24, 1990 (USFWS 1990). In September 2002, the USFWS released the Appalachian northern flying squirrel (*Glaucomys sabrinus fuscus) (Glaucomys sabrinus coloratus)* Recovery Plan (Updated).

Distribution and Habitat
Northern flying squirrels occur in forested areas throughout the northern U.S. and Canada. The southern and central Appalachian Mountains, the Black Hills, the southern Rocky Mountains, and the Sierra Nevada contain disjunct populations (Wells-Gosling and Heaney 1984). Two Appalachian northern flying squirrel species appear on the USFWS list of endangered species. The Virginia northern flying squirrel is the northernmost of the two (USDI Fish and Wildlife Service 1990) and is the subspecies that

occurs on the MNF. In WV, the range of the Virginia northern flying squirrel extends southward from the Mount Storm Reservoir (Tucker county), to Briery Knob (Pocahontas county) and Rabbit Run (Greenbrier county) (Stihler et al. 1995, C. Stihler pers. comm.. 2004). Currently, over 1200 Virginia northern flying squirrels were captured during nest box surveys and live trapping efforts in WV from 1985- present.

In the central Appalachians, Virginia northern flying squirrels occur primarily at elevations above 3000 ft. in red spruce and red spruce/northern hardwood forests, but some individuals have been captured at elevations as low as 2200 ft. Additionally, they appear to prefer areas with northerly aspects in close proximity to water (Menzel 2003). They also live in forests dominated by red spruce with hemlock (*Tsuga canadensis*), American beech, yellow birch (*Betula allegheniensis*), sugar maple, red maple, and black cherry associates or in pure northern hardwood stands (Wells-Gosling and Heaney 1984, Payne et al. 1989, Weigl et al. 1999). In general, Virginia northern flying squirrel captures in WV are associated with red spruce and mixed red spruce/northern hardwood forests. State-wide capture percentages from 1985-1996 were 30.1% in stands with $\geq$50% red spruce, 32.1% in stands containing 25-50% red spruce, 36.6% in stands with 0-25% red spruce, and 1.2% in Norway spruce (*P. abies*) plantations (Menzel et al. 2001). Ford et al. (2004a) found this species generally occupied sites with 35% montane conifers in the over-story. The occurrence of Virginia northern flying squirrels is closely linked to overstory conditions where montane conifers comprise >35% of the stand. Capture areas with no over story red spruce contained eastern hemlock or balsam fir (*Abies balsamea*), with red spruce usually present in the understory (Stihler et al. 1995). Understory components do not appear to be significant indicators of northern flying squirrel habitat (Payne et al. 1989), nor are old-growth stands essential habitat to northern flying squirrel populations. Rosenberg and Anthony (1992) found no difference in northern flying squirrel abundance in second growth (30-60 years old) and old growth (>400 years old) in Oregon. However, coarse woody debris is an important component of Virginia northern flying squirrel habitat, as this provides a medium for the growth of important food items such as fungi, lichens, and ferns (Carey et al. 1999, Weigl et al. 1999). Ultimately, food availability, predation rate, and competition from other species may determine Virginia northern flying squirrel abundance in suitable habitat. Northern flying squirrel populations in British Columbia appear to be limited by food abundance rather then den site abundance (Ransome and Sullivan 2004). Home ranges in WV may range from seven to 294 ha (Menzel 2003).

Virginia northern flying squirrels utilize two types of nests, cavity nests (abandoned woodpecker holes and nest boxes), and nests built in tree limbs (drey nests). Generally, drey nests are unsuitable for winter use, due to their exposed nature (Wells-Gosling and Heaney 1984, Whitaker and Hamilton 1998). However, northern flying squirrels in North Carolina and WV regularly use drey nests, and may use cavity nests only during severe weather and for raising young (Urban 1988, Weigl et al. 1999). In WV, cavity nests were utilized 69% of the time, while drey nests were utilized 31%, and drey nests are commonly located in red spruce trees (Menzel 2003). Virginia northern flying squirrels in WV chose yellow birch and Fraser magnolia (*Magnolia fraseri*) as nest trees more then expected based on availability. The outside shell of nests consists of tightly matted spruce twigs, shredded birch bark, moss, and lichens, and an inner lining of shredded birch bark (Weigl et al. 1999). Virginia northern

flying squirrels line cavity nests with shredded bark, and may place large amounts of lichens in the nest that may insulate the nest and provide a food source during the winter (Hayward and Rosentreter 1994). In WV, Virginia northern flying squirrels used an average of 3.6 nest trees/month, and changed nest trees frequently (Menzel 2003). These squirrels will nest in cavities in large and small trees or snags; therefore, nest site availability may not be a limiting factor (Rosenberg and Anthony 1992). Cavity trees in WV are generally taller than the surrounding trees, and are often located near trails or old skidder trails (Menzel 2003).

Food Habits

The diet of the Virginia northern flying includes acorns, hazelnuts, beechnuts, and other nuts, conifer and hardwood seeds, buds, staminate cones, catkins, wild fruits, insects, tree sap, fern sporangia, fungi (both hypogeous and epigeous), and lichens (Wells-Gosling and Heaney 1984, Weigl et al. 1999). Fecal samples of VNFS captured in WV indicate the most common foods eaten in the spring were tree buds, lichens, and hypogeous fungi, while hypogeous and epigeous fungi dominated the diet in the fall (Mitchell 2001). Additionally, other studies have shown fungi and lichens to be the predominant or only foods eaten at certain times of the year (Wells-Gosling and Heaney 1984).

Reproduction

In Virginia, male Virginia northern flying squirrels become reproductively active in December and remain active through the winter and spring months, and reproductively active females were first recorded in March (Reynolds et al. 1999). The gestation period is 37 to 42 days, and the young are born from late May through June (Wells-Gosling and Heaney 1984); however, nestlings have been found in WV in late April (Stihler et al. 1987). In the southern Appalachians, Carolina northern flying squirrels may produce litters through August and into September (Weigl et al. 1999). Typically, females give birth to one litter of 2-4 young annually (Wells-Gosling and Heaney 1984). The young are born naked and helpless, and do not emerge from the nest until 40 days of age. Weaning occurs at 60 days; however, they may remain with their mother for some time (Wells-Gosling and Heaney 1984).

Causes of Past/Current Decline

Habitat destruction by widespread timber harvesting in the 1880's-1920's most likely contributed to the decline of the Virginia northern flying squirrel. All but approximately 200,000 acres of WV original 500,000 red spruce acres were impacted by exploitative timber harvesting practices and repeated burning for livestock range at the turn of the century (Schuler et al. 2002). The greatest immediate threats to Virginia northern flying squirrel are habitat destruction, fragmentation, or habitat alteration associated with forest clearing, mineral extraction, recreational and housing development, and excessive white-tailed deer (*Odocoileus virginianus*) (Schuler et al. 2002). Introduced pests, such as balsam wooly adelgid, (*Adelges piceae*) and red spruce-fir declines from acid precipitation and heavy metal pollution further threaten to reduce the range and quality of remaining conifer-hardwood habitats (Weigl et al. 1999).

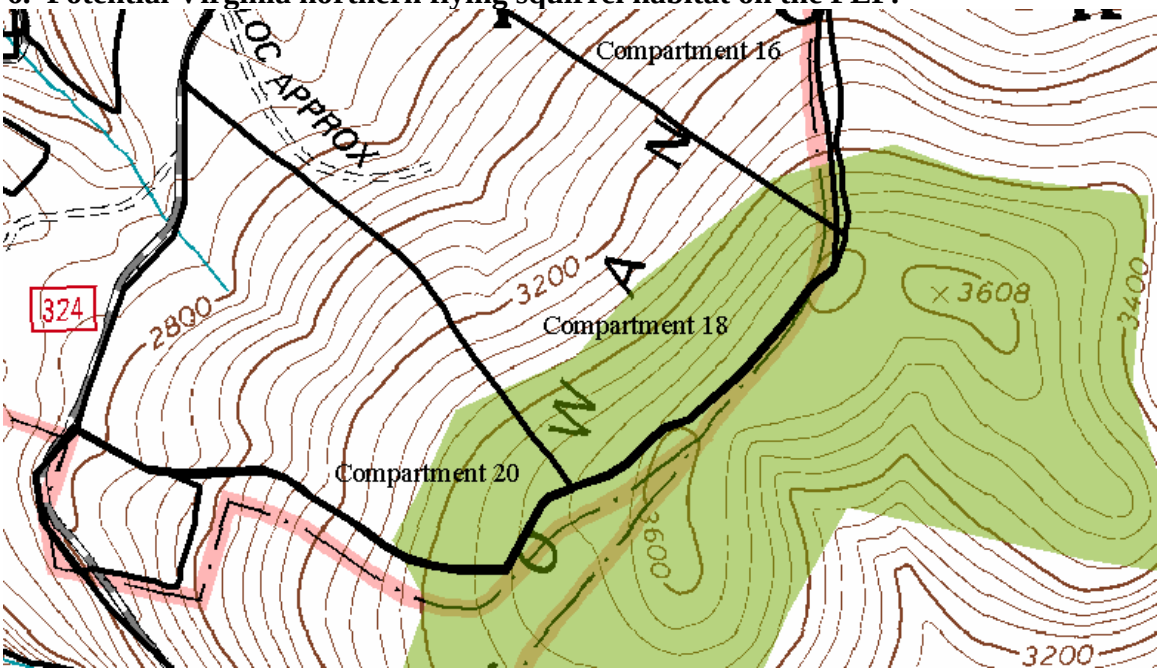
The more aggressive southern flying squirrel (*G. volans*) may displace the Virginia northern flying squirrel in certain overlapping hardwood habitats, although little evidence shows this to be true in WV (Stihler et al. 1987). Southern flying squirrels also may transmit the parasite *Strongyloides robustus*, which can be fatal to Virginia northern flying squirrel (Weigl et al. 1999). Predators of the flying squirrel include owls, domestic cats (*F. domesticus*), bobcats (*Lynx rufus*), weasels (*Mustela* spp.), and foxes (Wells-Gosling and Heaney 1984).

Habitat on the FEF

Live trapping sessions in the summers of 2001, 2002, 2003, and 2004 have not captured any Virginia northern flying squirrels. Due to the lack of trapping success, the Virginia northern flying squirrel

predictive model developed by Dr. Jennifer Menzel was utilized to determine the FEF suitability for this species (Menzel 2003). Using this model, the area identified below (Figure 6) on the FEF has a "50-75%" probability of being occupied by Virginia northern flying squirrels. Additionally, the nearest capture record for this species is just a little over two miles from the FEF boundary on McGowan Mountain. Currently, only a small portion of the FEF is considered potentially suitable habitat for the Virginia northern flying squirrel, and no Virginia northern flying squirrels have been captured on the FEF.

Figure 6. Potential Virginia northern flying squirrel habitat on the FEF.



Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the Virginia northern flying squirrel would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no effect** is made for the Virginia northern flying squirrel on the FEF as a result of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

Surveys efforts conducted during 2000-2004 have failed to document the presence of the Virginia northern flying squirrel on the FEF; therefore, direct effects to this species due to timber harvesting are unlikely. The lack of red spruce in the over- and mid-story coupled with the abundance of beech currently do not provide good habitat for the Virginia northern flying squirrel on the FEF. Additionally, portions of National Forest land adjacent to the FEF were harvested approximately 30 years ago, and the small diameter trees comprising the stand do not provide suitable habitat for denning. However, Dr. Menzel's Virginia northern flying squirrel model suggests that this portion of the FEF may eventually provide habitat for this species. There is some small, scattered red spruce in these compartments on the FEF. Current silvicultural practices for the ongoing research studies (single-tree selection and 0.4 acre patch cutting) may improve Virginia northern flying squirrel habitat by releasing understory red spruce

and removing competing vegetation. Red spruce will not be removed during timber harvesting. Long-term indirect and cumulative effects to this species would be beneficial by improving and extending the range of suitable habitat. Annual surveys for this species utilizing nest boxes and live-trapping will continue to document when, or if, the Virginia northern flying squirrel utilizes the FEF. If this species is captured, the USFWS will be contacted and consultation will continue if needed.

Prescribed burning
Prescribed burning would not occur in potentially suitable habitat for the Virginia northern flying squirrel. Therefore, there would be no direct, indirect, or cumulative effects as a result of prescribed burning.

Ammonium nitrate fertilization
Fertilization would not occur in potentially suitable habitat for the Virginia northern flying squirrel, and the affected watershed is not adjacent to any potentially suitable habitat. Therefore, there would be no direct, indirect, or cumulative effects to the Virginia northern flying squirrel due to ammonium nitrate fertilization.

Determination
Due to the lack of occurrence records for the Virginia northern flying squirrel on the FEF and the potential beneficial indirect and cumulative effects on habitat for this species, a determination of **may affect, not likely to adversely effect** is made for the Virginia northern flying squirrel on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the Virginia northern flying squirrel are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monocultures on the FEF. There would be no direct effects to Virginia northern flying squirrels because of herbicide application due to that fact that application would be directly on targeted plants, and no Virginia northern flying squirrels would be present on targeted species. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Due to the fact that herbicide application would be species-specific, there would be no indirect or cumulative effects to Virginia northern flying squirrels, as overall habitat would remain the same.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may affect, not likely to adversely effect** is made for the Virginia northern flying squirrel on the FEF under the Preferred Alternative.

Cheat Mountain Salamander

On September 28, 1989, the USFWS determined that the Cheat Mountain salamander, *Plethodon nettingi*, was in threatened status (Federal Register, Vol. 53, No. 188:37814-37818). The USFWS released a Cheat Mountain salamander Recovery Plan on July 25, 1991.

Distribution and Habitat

The Cheat Mountain salamander is a relict species of approximately 70 known populations that are geographically isolated from one another (Petranka 1998). Seventy-five percent of the known populations have less then 10 individuals (USDI Fish and Wildlife Service 1991). The range is a 700 square mile area exclusively within WV (USDI Fish and Wildlife Service 1991). Distributions of Cheat Mountain salamander populations occur in Tucker, Randolph, Pocahontas, Grant, and Pendleton counties (Pauley and Pauley 1997), extending from Backbone Mountain in the north to Back Allegheny Mountain in the south.

Historically, the range of the Cheat Mountain salamander was more extensive then it is today. However, by 1920, natural events and extensive logging eliminated 93% of the original spruce acreage preferred by the Cheat Mountain salamander (Clarkson 1964). The Cheat Mountain salamander is found in high elevation stands of red spruce, red spruce-yellow birch, or deciduous forests with a *Bizzania*-domintated forest floor (Brooks 1948, Highton 1971, Green and Pauley 1987, Pauley and Pauley 1997). Brooks (1948) collected numerous Cheat Mountain salamanders in dense stands of sapling or pole-sized spruce and spruce-birch stands, and noted that these salamanders were not numerous in mature stands. This species commonly occurs from elevations of 2900 ft. to 4799 ft. (Petranka 1998), with most colonies occurring at elevations greater than 3500 ft. (Pauley 1991).

Salamanders have preferred temperature ranges that minimize dehydration (Spotila 1972). Because of these physiological requirements, Cheat Mountain salamander survival requires microhabitats with high relative humidity or micro-site moisture (Feder 1983) and acceptable temperatures. Pauley (1980) found that Cheat Mountain salamanders inhabit microhabitats that have higher relative humidity and lower temperatures then other sympatric species. Brooks (1948) found this species preferred rock crevices and decaying spruce logs covered with mosses and lichens, usually in rock or boulder fields. Roads, and possibly even trails, may serve as territory barriers to Cheat Mountain salamanders (T. Pauley unpubl. data).

Food Habits

Cheat Mountain salamanders forage at dusk along the forest floor, and occasionally on tree trunks, when the relative humidity is high (Brooks 1948, Spotila 1972, Green and Pauley 1987). On dry nights, they do not leave their moist retreats to forage (Spotila 1972). The Cheat Mountain salamander diet includes mites (42.1%), springtails (17.8%), beetles (16.4%), flies (9.3%), ants (4.3%), and various other insects (10.0%) (Pauley 1980, Green and Pauley 1987).

Reproduction

Once females become sexually mature, they deposit egg clusters containing 4 to 17 eggs (Green and Pauley 1987) every other year (Pauley 1991) from late April to late August (Brooks 1948, Petranka 1998). Female Cheat Mountain salamanders suspend egg masses by a short pedicel in damp crevices in rocks and decaying spruce logs (Brooks 1948, Green and Pauley 1987). One or two adults guard the eggs (Brooks 1948, Petranka 1998).

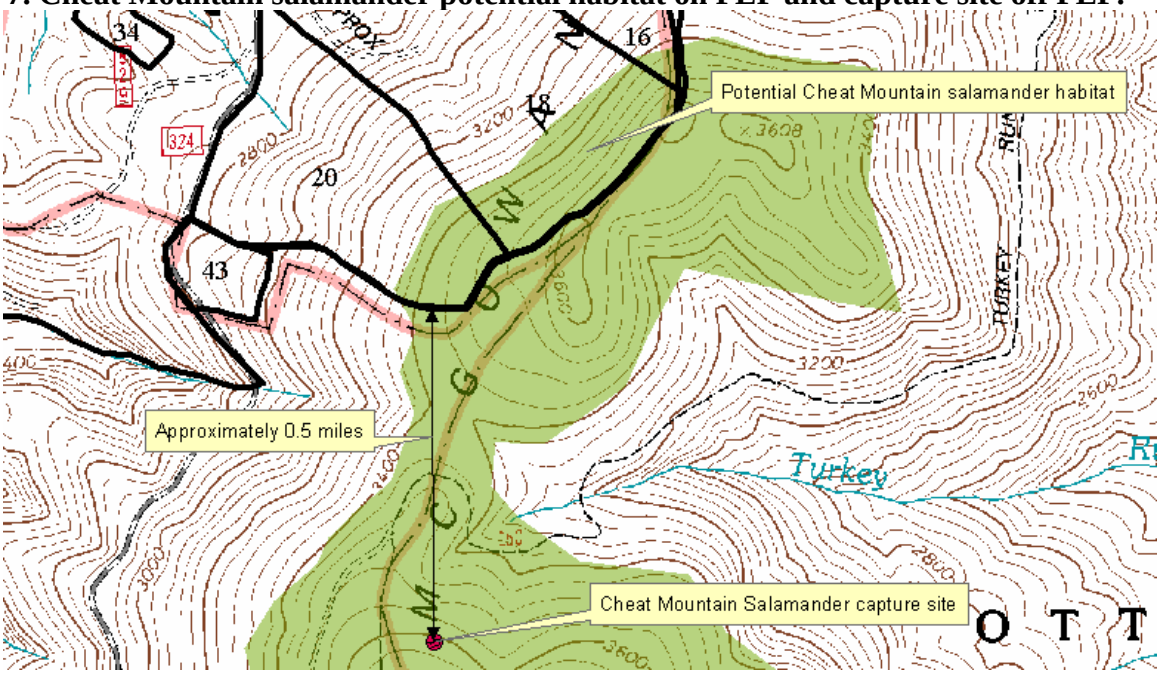
Causes of Past/ Current Declines

Competitions from other similar Plethodontids, genetic isolation of populations by habitat fragmentation, removal of forest canopy, wildfires, and roads and trails that remove forest floor litter contribute to the limited occurrence of the Cheat Mountain salamander (Pauley 1980, Pauley 1991). Reductions in canopy cover during timber harvesting decrease forest floor moisture and increase the ambient temperature. These types of habitat changes have a negative impact on Plethodontid salamanders as Plethodontids rely heavily on cutaneous respiration, which requires moist skin and cool ambient temperatures to be effective (Demaynadier and Hunter 1998).

Habitat on the FEF

Spring ground searches in the spring of 2001, 2002, 2003, and 2004 for the Cheat Mountain salamander failed to document any individuals of this species. However, this species often occurs in habitats similar to the Virginia Northern flying squirrel, and there is an occurrence record for the Cheat Mountain salamander approximately 0.5 miles from the FEF border. Because there is a high degree of congruity between Virginia northern flying squirrel and Cheat Mountain salamander distribution, using the Virginia northern flying squirrel predictive developed by Dr. Jennifer Menzel (Menzel 2003) identified areas on the FEF as potential habitat for the Cheat Mountain salamander (Figure 7). Currently, a small portion of the FEF could contain habitat for the Cheat Mountain salamander, although no Cheat Mountain salamanders have been captured on the FEF.

Figure 7. Cheat Mountain salamander potential habitat on FEF and capture site off FEF.



Effects of Proposed Project Implementation

<u>Alternative A: No-Action Alternative</u>

This Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the Cheat Mountain salamander would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no effect** is made for the Cheat Mountain salamander on the FEF because of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

There are no previous documented occurrences of the Cheat Mountain salamander on the FEF, and surveys efforts conducted during 2000-2004 failed to document this species presence. Additionally, tree removal would occur while these salamanders are in their winter refugia underground, so no direct effects would occur due to timber harvesting. These facts, coupled with the absence of this species on the FEF make the possibility of direct adverse effects on this species negligible.

Salamander surveys conducted from 2000-2004 recorded an abundance of redback salamanders, a known competitor with the Cheat Mountain salamander (USDI Fish and Wildlife Service 1991). The current forest tree species composition and structure may favor this species. Removing some overstory hardwood trees would release understory red spruce, and timber harvesting practices in these compartments provide abundant coarse woody debris post-harvest, therefore habitat for the Cheat Mountain salamander should improve over time. Long-term indirect and cumulative effects to this species would be beneficial by improving and extending suitable habitat. Annual surveys for this species will continue to document when, or if, the Cheat Mountain salamander utilizes the FEF. If this species is captured, the USFWS will be contacted and consultation will continue if needed.

Prescribed burning

No prescribed burns would occur in habitats with suitable potential Cheat Mountain salamander habitat. Therefore, there would be no negative direct, indirect, or cumulative effects as a result of prescribed burning.

Ammonium nitrate fertilization

Fertilization would not occur in potentially suitable habitat for the Cheat Mountain salamander, and the affected watershed is not adjacent to any potentially suitable habitat. Therefore, there would be no direct, indirect, or cumulative effects to the Cheat Mountain salamander due to ammonium nitrate fertilization.

Determination

Due to the lack of occurrence records for the Cheat Mountain salamander on the FEF and the potential beneficial indirect and cumulative effects on habitat for this species, a determination of **may affect, not likely to adversely effect** is made for the Cheat Mountain salamander the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the Cheat Mountain salamander are discussed below.

Herbicide Application

Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to Cheat Mountain salamanders as a result of herbicide application due to that fact that application would be directly on targeted plants, and application would occur while Cheat Mountain salamanders have sought their day refugia (under leaf litter, logs, rocks, etc.). Tatum (2003) stated that most commonly used herbicides degrade quickly once

they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be plant species-specific, there would be no indirect or cumulative effects to Cheat Mountain salamanders, as overall habitat would remain the same.

Determination

Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may affect, not likely to adversely effect** is made for the Cheat Mountain salamanders on the FEF under the Preferred Alternative.

<u>Running Buffalo Clover</u>

The USFWS listed the Running buffalo clover as endangered on July 6, 1987, and completed a recovery plan in June 1989 (USDI Fish and Wildlife Service 1989).

Distribution and Habitat

Running buffalo clover formerly grew over a broad area from the western Allegheny Mountains across the Upper Ohio Valley westward to Missouri and Kansas (Cusick 1989). Once widespread the species range is now restricted to WV, Kentucky, Indiana, and Ohio. Populations of running buffalo clover range from just a few to 100,000 individuals.

Many botanists believe running buffalo clover is an open woodland-savanna species dependent on disturbance for survival. The original habitat appears to have been the rich ecotone soils found between open forest and prairie. Habitat may have been maintained by a disturbance regime that promoted grassland or savannah conditions. Periodic fires and grazing by large ungulates probably contributed to maintaining open conditions. Running buffalo clover was closely associated with distributional records of bison (*Bison bison*), and often was found near buffalo trails in the Ohio Valley (Bartgis 1985).

Existing running buffalo clover populations occur in disturbed habitats along floodplain forests, stream banks, deer trails, grazed woodlots, field edges, old skidroads and logging roads, ungravelled truck roads, cemeteries, open woodlands, mowed parks, jeep trails, and hawthorn (*Crataegus* spp.) thickets. This species does not appear to grow in full sun. Running buffalo clover frequently occurs in disturbed habitats, including stream banks, deer trails, grazed woodlots, mowed paths, old logging roads, and skidder trails (Bartgis 1985, Homoya et al. 1989, Harmon 1996, Madarish and Schuler 2002).

Reproduction

Running buffalo clover is a stoloniferous perennial, which spreads by seed and stolon. It is the only *Trifolium* not known to have a rhizobial associate. Running buffalo clover is believed to be self-fertile, capable of self-pollination. Bees have been suggested as the insect pollinators for running buffalo clover.

Flowers are produced from April-June and seeds are set from May-July. Seed scarification is essential for germination. Historically, large herbivores scarified seeds digestively, and these seeds may have had enhanced germination rates (Ford et al. 2003). On the FEF, this species is most often found on logging trails that are disturbed approximately once every 10 years during timber removal. These types of areas are heavily utilized by white-tailed deer in the Appalachians (Wentworth et al. 1990), which supported the hypothesis that white-tailed deer might be capable vectors of running buffalo clover seed (Cusick

1989). However, Ford et al. (2003) found that although white-tailed deer are potential viable vectors for running buffalo clover seed, germination and survival of clover seed is low. Morris et al. (2002) state that as viable seeds were excreted in the manure of ungulates, there was a high enough nitrogen level to support running buffalo clover to complete its life cycle before another ruminant came along and consumed new seed. Occasionally, unscarified seed germination occurs in spring when daytime temperatures are 15-20°C and nighttime temperatures are 5-10°C.

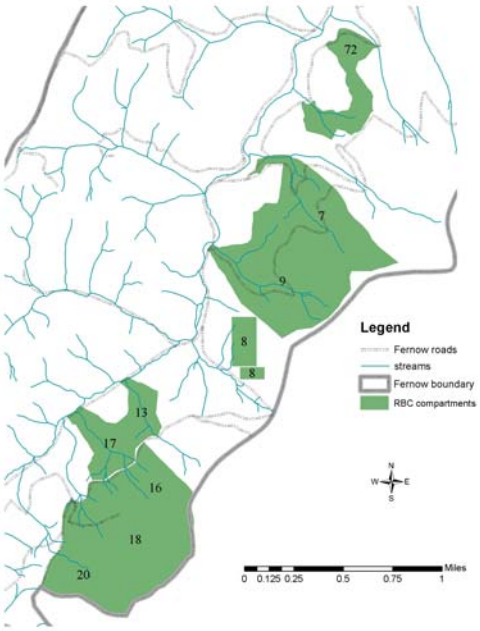
Causes of Past/Current Declines

Past running buffalo clover declines have been attributed to habitat loss from forest canopy closure, buffalo herd extirpation, habitat clearing, disease from other clovers, pollinator loss, and fire regime changes. Other limiting factors may include: poor dispersal characteristics, possible loss of rhizobial associates (Morris et al. 2002), increased herbivory from white-tailed deer and eastern cottontail rabbits (*Sylvilagus floridana*) (Ford et al. 2003), competition from other exotic plants (Campbell et al. 1988) and restricted gene flow (Hickey and Vincent 1991, Crawford 1995). Repeated consumption of plants prior to seed production or seed viability would have negative effects on both individual plants and populations as a whole (Ford et al. 2003). However, all these mechanisms are speculative, and more research is needed to learn about the reproductive and survival requirements of running buffalo clover.

Habitat on the FEF

Running buffalo clover has a high affinity for calcium-rich soil, which is abundant in the eastern portion of the FEF where the Greenbrier Limestone formation is exposed. It is most often found in locations underlain by limestone or other calcareous bedrock. This species persists in mesic woodlands with partial sunlight and periodic disturbance, and is scattered throughout compartments with limestone soils along old logging roads, skid roads, deer trails, and other partially disturbed areas (Figure 8).

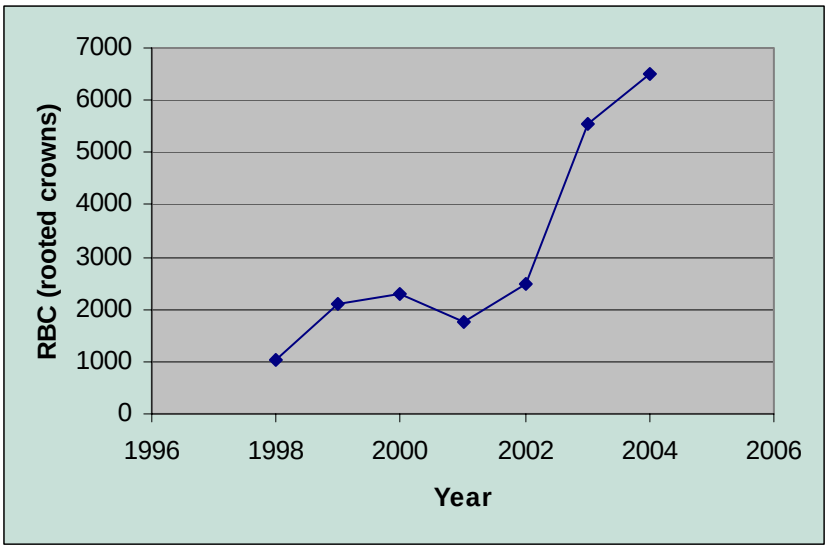
Figure 8. Compartments containing running buffalo clover on the FEF.



In 1994, the FEF initiated a study on running buffalo clover that is important on the regional scale. Clover in areas with no ground disturbance increased in density the second growing season, but began to

decline by the third season. In disturbed areas, results after 10 years of monitoring indicate that 2 years following timber removal, previously declining running buffalo clover populations began to increase in density. Data from this study appears to illustrate disturbance-dependent population dynamics for running buffalo clover. Several years after disturbance, population density peaks and then begins a decline. Following a subsequent disturbance, population density declines initially but then rebounds within one or two growing seasons. It appears no action associated with existing populations of running buffalo clover is equivalent to allowing local populations to decline (Madarish et al. 1999). The results of this study suggest that controlling the intensity of ground disturbance combined with a reduction in canopy density, such as that associated with uneven-aged harvests, may help sustain populations of running buffalo clover (Madarish and Schuler 2002). Monitoring efforts in running buffalo clover compartments on the FEF document an increasing population of this species, especially in lightly disturbed areas (Figure 9). Analysis of FEF data by Dr. Schuler concluded that using count based data and the diffusion approximation approach, population viability analysis of the FEF running buffalo clover population has a very low probability of extinction (POE) (POE = 0.005) during the next 20 years.

Figure 9. Number of running buffalo clover stems on the FEF.



Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

The No-Action Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Studies have shown that without the light disturbance, habitat for the running buffalo clover would diminish. Therefore, a determination of **may effect, likely to adversely effect** is made for the running buffalo clover on the FEF because of the No-Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

Under this alternative, timber harvesting would proceed as scheduled in these compartments. The direct effects of timber harvesting may include harming individual plants with timber harvesting equipment. However, indirect and cumulative effects of timber harvesting should benefit running buffalo clover. Several years after disturbance, population density peaks and then begins a decline. Following a subsequent disturbance, population density declines initially but then rebounds within one or two

growing seasons. Some ground disturbing activities, such as skid roads and logging decks, provide mechanical seed scarification and provide an area for species dispersal. The cumulative effect of repeated disturbances over the past 50 years on FEF has apparently maintained a refugium for running buffalo clover, and running buffalo clover has responded positively to silvicultural practices occurring on the FEF since 2000 as the overall population has continued to increase. The Running Buffalo Clover Recovery Plan states that appropriate habitat management techniques are needed and should be evaluated experimentally. Additionally, to achieve the desired number of self-sustaining populations, it will be necessary to define limiting factors that regulate wild populations. The running buffalo clover study taking place on FEF should help to determine some of these factors. The preliminary results of this study suggest that controlling the intensity of ground disturbance combined with a reduction in canopy density, such as that associated with uneven-aged harvests, may help sustain populations of running buffalo clover.

Prescribed burning

The effects of prescribed fire on running buffalo clover are unknown. A very small portion of the running buffalo population (>0.1%) on the FEF occurs on proposed prescribed burn sites (Compartment 13). While the aboveground stems may be destroyed during the burn, this type of disturbance may release the understory and improve habitat for running buffalo clover in this compartment. Subjecting a small population of running buffalo clover to prescribed fire provides researchers at the FEF an important opportunity to study the effects of fire on this species, beneficial or adverse indirect effects may occur. There would be no cumulative effects to this species, as such a small portion of the population and habitat would be involved. Additionally, the population of running buffalo clover has increased dramatically since 2002.

Ammonium nitrate fertilization

Fertilization would not occur in suitable habitat for the running buffalo clover, and the affected watershed is not adjacent to any potentially suitable habitat. Therefore, there would be no direct, indirect, or cumulative effects to running buffalo clover due to ammonium nitrate fertilization.

Determination

Due to the possibility of negative direct effects as a result of silvicultural practices and prescribed burning, a determination of **may affect, likely to adversely effect** is made for the running buffalo clover on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the running buffalo clover are discussed below.

Herbicide Application

Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF; however no herbicides would be applied in areas where running buffalo clover is present. Some beneficial indirect or cumulative effects may occur by removing competing exotic plants in areas suitable for running buffalo clover, thus providing more habitat for this species.

Determination

Taking into account the negative direct effects as a result of silvicultural practices and prescribed burning under the Proposed Action Alternative, a determination of **may affect, likely to adversely effect** is made for running buffalo clover on the FEF under the Preferred Alternative.

USFS Regionally Sensitive Species

The following is a discussion of regionally sensitive species with documented occurrences or habitat within 100 meters of the proposed project area. Any sensitive species determined "absent', or "unlikely to occur" in the project area are not carried forward in this biological assessment. Sensitive species are not afforded Federal protection by law; however, the USFS considers sensitive species in their management and research activities. The USFS identifies potential risks to sensitive species, and efforts are made through project amendment to reduce risk to the species population. The discussion includes: 1) species population distribution and habitat descriptions 2) discussion of food habits and diet, when applicable 3) reproduction information for each species 4) causes of past and current population declines 5) habitat availability and use on the project area 6) effects of implementation of the proposed actions on each species.

Southern Water Shrew

Distribution and Habitat

The Southern water shrew, (*Sorex palustris punctulatus)*, is found from southwestern Pennsylvania to northern Georgia, and is uncommon throughout its range (Pagels et al. 1998, Whitaker and Hamilton 1998).

Southern water shrews most commonly occur along the edge of slow- or swift-flowing streams with rocks, crevices, and over-hanging banks, with boulders, rocks, and woody debris present in the stream and streambed. This species inhabits both perennial and ephemeral streams (Beneski and Stinson 1987, Merritt 1987, Pagels et al. 1998). Southern water shrews also occupy sphagnum swamps, beaver pond meadows, and grass/sedge marshes, and shrub zones along ponds and streams in coniferous forests (Wrigley et al. 1979, Merritt 1987, Whitaker and Hamilton 1998). Riparian areas with suitable Southern water shrew habitat typically are undisturbed, with overstory canopy trees and an undeveloped understory. The closed canopy probably maintains the cool, moist conditions required by this species (Pagels et al. 1998, Wilson and Ruff 1999). The most abundant canopy trees are yellow birch, black birch (*B. lenta*), sugar maple, basswood (*Tilia americana*), black cherry, red maple, American beech, spruce, eastern hemlock, and rhododendron (*Rhododendron* spp.) (Merritt 1987, Pagels et al. 1998).

The Southern water shrew makes small nests of dried moss in bankside burrows, under boulders, or in root mounds (Merritt 1987). This species may travel along the waters edge and hide from predators among rocks, root wads, and logs. Southern water shrews actually dive into the water and forage on benthic invertebrates. Maintaining water quality is important to southern water shrews, but perhaps the most important factor of Southern water shrew habitat is the abundance of invertebrates and plant species as food resources in the area (Beneski and Stinson 1987).

Southern water shrews captured in WV and PA were collected in montane areas near high gradient rock-bedded creeks with the surrounding forest consisting of heavy stands of eastern hemlock, red spruce and rhododendron (Merritt 1987, WVDNR Natural Heritage Records).

Food Habits

The diet of the Southern water shrew includes Gastropoda (snail and slugs), Annelida (earthworms), Plecoptera (stoneflies), Ephmeroptera (mayflies), Tricoptera (caddis flies), Dipterans (tipulids), plant material, small fish and their eggs, and salamanders (Beneski and Stinson 1987, Merritt 1987).

Reproduction

The breeding season for this shrew in the Mid-Atlantic States extends from late March through September (Merritt 1987). Gestation period for the Southern water shrew is approximately 21 days. Southern water shrews produce two or three litters each year, with litter sizes ranging from 3-10 young (Merritt 1987, Whitaker and Hamilton 1998, Wilson and Ruff 1999).

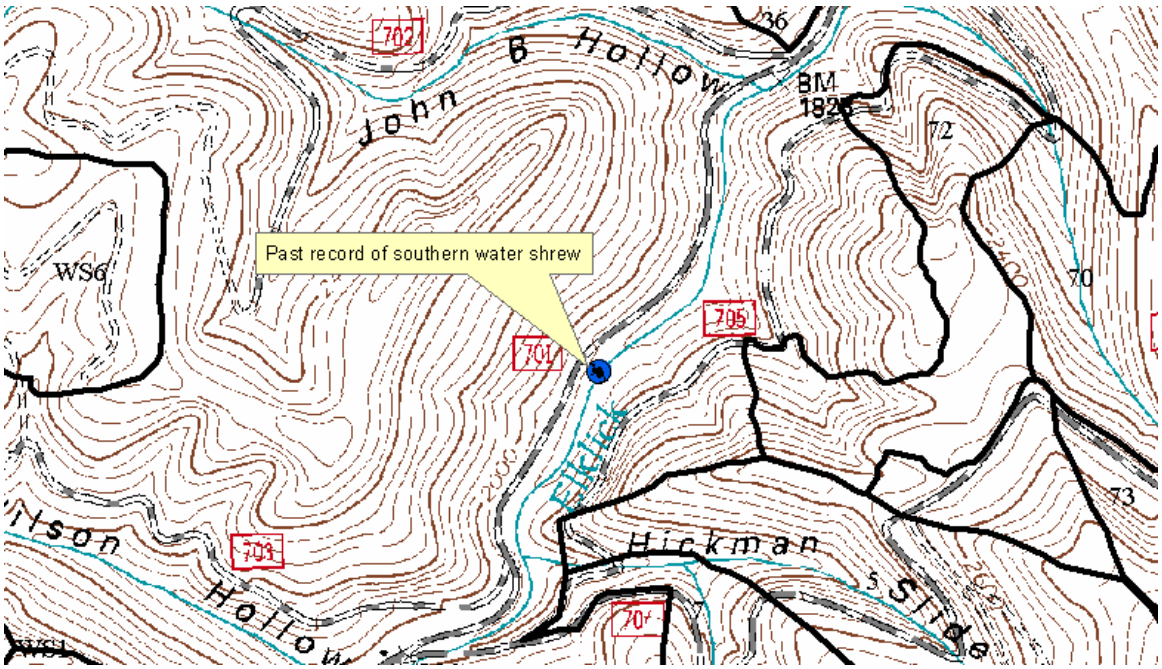
Causes of Past/Current Decline

The difficulty in capturing Southern water shrews has made this a difficult species to monitor. It may be more abundant in its home range than records indicate (Whitaker and Hamilton 1998). The effects of various silvicultural practices on Southern water shrews are unknown (Pagels et al. 1998). Natural predators of these shrews include snakes, mink (*M. vison*), and larger species of fish (Beneski and Stinson 1987).

Habitat on the FEF

The Elklick drainage on the FEF provides some suitable habitat for the southern water shrew, in addition to various seeps on the forest. A single specimen was captured along Elklick Run in 1975 (Figure 10), although live-trapping efforts along Elklick Creek during the summers of 2000, 2001, and 2003 failed to capture a southern water shrew. Surveys to monitor this species will continue on the FEF; however, this species is notoriously difficult to trap.

Figure 10. Occurrence record for the southern water shrew on the FEF.



Effects of Proposed Project Implementation

<u>Alternative A: No-Action Alternative</u>

The No-Action Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Studies have shown that without the light

disturbance, habitat for the southern water shrew. Therefore, a determination of **no impacts** is made for the southern water shrew on the FEF because of the No-Action alternative.

<u>Alternative B: Proposed Action Alternative</u>

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

No southern water shrews have been captured on the FEF in 29 years, despite repeated surveys. Therefore, this species occurs in very low densities on the FEF. SMZs are established along all perennial and non-perennial streams during timber harvesting and road reconstruction. Under this alternative, timber harvesting would take place utilizing BMPs and standard SMZs will be established. Because southern water shrews inhabit streamside areas and occur in such low numbers, there would be no direct impacts from these silvicultural practices.

Adverse indirect effects may result from timber harvesting. A temporary, slight increase in stream siltation may occur, which may temporarily reduce habitat quality for individual southern water shrews and their prey in a particular area. However, if stream siltation occurred, the amount would be negligible and the stream would return to its original condition quickly. Cumulative effects on this species would be negligible as such a small population would be impacted, and effects would only occur in the short-term, usually a few days.

Prescribed burning

There would be no direct effects to the southern water shrew due to prescribed burning, as this species would not occur in areas suitable for burning. A portion of Elklick Run is located adjacent to a proposed prescribed burn area. Some adverse indirect effects may result from prescribed burning. A temporary, slight increase in stream siltation may occur, which may temporarily reduce habitat quality for individual southern water shrews and their prey in a particular area. However, if stream siltation occurred, the amount would be negligible and the stream would return to its original condition quickly. Ford et al. (1999) found that prescribed burning in the southern Appalachians had no effect on water shrew populations. Cumulative effects on this species would be negligible as such a small population would be impacted, and effects would only occur in the short-term, usually a few days.

Ammonium nitrate fertilization

Direct effects to southern water shrews would be negligible due to this species low population density on the FEF, coupled with the low toxicity of ammonium nitrate and the speed with which it dissolves on the landscape. Additionally, the proposed site for ammonium nitrate fertilization occurs approximately 1.5 miles upstream from the capture site for the southern water shrew. Effects of fertilization are not detectable ¼ mile downstream (M.B. Adams, pers. comm. 2004), so while habitat for prey items may be affected in the treated watershed, indirect effects would not occur over other portions of the FEF. Cumulative effects would also be miniscule due to the small portion of southern water shrew population and habitat affected by the proposed study.

Determination

Due to the possibility of indirect effects as a result of silvicultural practices and ammonium nitrate fertilization, a determination of may **impact individual but not likely to cause a trend to federal listing or loss of viability** is made for the southern water shrew on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the southern water shrew are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to southern water shrews because of herbicide application due to that fact that application would be directly on targeted plants, and application would not occur directly along streams. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be plant species-specific, there would be no indirect or cumulative effects to southern water shrews, as overall habitat would remain the same.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may impact individual but not likely to cause a trend to federal listing or loss of viability** is made for the southern water shrew on the FEF under the Preferred Alternative.

Eastern Small-Footed Myotis

Distribution and habitat
The range of the eastern small-footed myotis, (*M. leibii*), ranges from eastern Canada south to Alabama and Georgia, and west to southeastern Oklahoma (Whitaker and Hamilton 1998, Harvey et al. 1999).

Hibernacula
Eastern small-footed myotis may hibernate close to summer roosting and maternity habitat (Whitaker and Hamilton 1998). These bats are some of the last bats to enter winter hibernacula, arriving after October (Dalton 1987, Harvey et al. 1999). Eastern small-footed myotis hibernate in caves with relatively low temperatures and humidity, and are often found near cave entrances. They may hibernate in cracks or crevices along the cave floor, walls, and ceiling (Dalton 1987, Whitaker and Hamilton 1998, Harvey et al. 1999, Wilson and Ruff 1999). The peculiar hibernation requirements may make this species difficult to locate in winter hibernacula (Dalton 1987, Harvey et al. 1999). It is common to find concentrations of over 1000 eastern small-footed in a hibernacula (Dunn and Hall 1989). Eastern small-footed myotis depart the winter hibernacula in March (Dalton 1987).

Summer Maternity And Roosting Habitat
Summer roosts and maternity colonies have been found in caves, buildings, bridges, rock wall crevices, and under rocks. Maternity colonies consist of 20 or more bats (Whitaker and Hamilton 1998, Harvey et al. 1999, Wilson and Ruff 1999). The preferred temperature for summer roosts and maternity colonies ranges from 80°-92° F (Whitaker and Hamilton 1998).

Food Habits
Eastern small-footed myotis forage over land and bodies of water (Wilson and Ruff 1999). These bats emerge shortly after sunset and fly low over the ground, usually 3-10 ft (Harvey et al. 1999).

The diet of the eastern small-footed myotis includes Diptera (true flies and mosquitoes), Hemiptera (true bugs), Coleoptera (beetles), Hymenoptera (bees, wasps and ants), and other insects (Harvey et al. 1999).

Reproduction

Eastern small-footed myotis mate in the autumn before hibernation. Females store sperm until fertilization in the spring (Wilson and Ruff 1999). Female eastern small-footed myotis give birth to a single young between late May and July (Whitaker and Hamilton 1998, Harvey et al. 1999, Wilson and Ruff 1999).

Causes of Past and Current Declines

The greatest threats to eastern small-footed myotis populations are human disturbance and vandalism at maternity and hibernating sites. During hibernation, bats depend on stored body fat. When disturbed during winter, they emerge from hibernation and move to a safer roosting area in the cave, requiring the bat to raise its body temperature by burning stored fat. As few as two disturbances can cause a cave-dwelling bat to expend all its winter fat reserves, leading to starvation (Harvey et al. 1999). If maternity colonies are disturbed, females may abandon their flightless newborns, move their pups to locations less suitable for newborn survival (Harvey et al. 1999), or drop their pups in transit if sufficiently panicked. Bats have very low reproductive rates - a female bat will give birth to a single young every one or two years. Therefore, even seemingly small reductions in bat populations could devastate populations (Harvey et al. 1999).

Vandalism has resulted in destruction of many bat colonies simply because bats often are viewed as nuisances or threats to human health (USDI Fish and Wildlife Service 1996). Cave gating appears to be the most effective way to protect eastern small-footed myotis populations at high risk of disturbance. However, poorly designed and installed cave gates restrict bat movement and alter airflow into caves. Airflow alterations may change the microclimate, rendering the cave unsuitable for hibernation or roosting. Microclimate changes caused by increased or decreased airflow are probably major contributors to roost and hibernaculum degradation. Even small entry point blockages can be extremely important in hibernacula that require chimney-effect airflow to function. Airflow changes can elevate temperatures (Richter et al. 1993) in the caves and cause the bats' metabolic rate to increase, resulting in premature exhaustion of fat reserves (USDI Fish and Wildlife Service 1999).

Other possible causes of bat population declines include natural disasters (flooding, cave subsidence), loss of roosting sites due to sealing mine entrances, cave commercialism, chemical contamination, and loss of foraging habitat. Stream impoundment can create permanent or seasonal cave flooding, and cave commercialization may disturb roosting and hibernating bat colonies (USDI Fish and Wildlife Service 1983). Timber harvesting, water quality degradation, stream channelization, and other actions potentially could alter foraging habitat in some cases (Grindal 1996).

Insecticides, particularly those used for gypsy moth (*Lymantria dispar*) control, may adversely affect the food supply (Sample and Whitmore 1993). Bats have many potential predators, including house cats, owls, hawks, raccoons, striped skunks, and snakes.

Habitat on the FEF

Mist-net and Anabat II acoustical surveys on the FEF and in the summers of 2001, 2002, 2003, and 2004 failed to document an eastern small-footed myotis. Additionally, this bat was not found during on winter cave surveys in 1999 and 2001. However, eastern small-footed myotis utilized Big Springs Cave as a hibernacula during the winter of 1997, and may return to the cave at some point in the future. Therefore, the FEF is still considered suitable habitat for this species, at least during the hibernation period.

Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This Alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the eastern small-footed myotis would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for the eastern small-footed myotis on the FEF due to the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

No direct effects to eastern small-footed myotis would occur as this species day roosts in caves and cliff faces and hibernates in caves. Since tree removal would not occur at these sites, direct effects would be avoided. These bats prefer to forage over open ponds and streams, and these habitat types would be unaltered as a result of these silvicultural practices since they are protected by SMZs. Eastern small-footed myotis will also forage over land, although little is known about upland habitat types this species prefers to utilize during foraging. However, the amount of disturbance occurring on a landscape scale would be small. Therefore, there would be no indirect or cumulative effects to the eastern small-footed myotis due to these silvicultural treatments.

Prescribed burning

All prescribed burns would occur over ¼ mile from Big Springs Cave, so there would be no negative effects from smoke or fire to roosting small-footed myotis. Additionally, prescribed fire would create a mosaic of upland habitat for foraging by opening the mid- and under-story in burned areas. This could provide more diverse foraging habitat for the eastern small-footed myotis on the FEF.

Ammonium nitrate fertilization

Fertilization of this watershed would have no direct effect on the eastern small-footed myotis as the fertilizer pellets would not be applied in high enough density and are not toxic enough to harm this species. Additionally, preliminary study results have not revealed any effects on the diversity and abundance of herbaceous plants, salamanders, or insects in the artificially acidified watershed (M.B. Adams, pers. comm.). Therefore, it is unlikely that this study would have any negative effects on eastern small-footed myotis.

Determination

Due to the lack of adverse effects, a determination of **no impacts** is made for the eastern small-footed myotis on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the eastern small-footed myotis are discussed below.

Herbicide Application

Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to eastern small-footed myotis because of herbicide application due to that fact that application would be directly on targeted plants, and no eastern small-footed myotis would be present on targeted species. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative

nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be species-specific, there would be no indirect or cumulative effects to eastern small-footed myotis, as overall habitat would remain the same.

Determination

Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **no impacts** is made for the eastern small-footed myotis on the FEF under the Preferred Alternative.

Southern Rock Vole

Distribution and habitat

R. Barbour

The range of the southern rock vole, (*Microtus chrotorrhinus carolinensis*), extends from eastern WV and western Virginia southward through the Appalachian Mountains to North Carolina and Tennessee. Southern rock vole populations are scattered, and this species only occurs in the most suitable habitats (Kirkland and Jannett 1982, Whitaker and Hamilton 1998).

Southern rock voles inhabit boulder fields, talus slopes, and other rocky areas in a variety of forest types, including red spruce and deciduous forests. Forest age where southern rock voles live ranges from recent clearcuts to uncut forests (Kirkland and Jannett 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999). Another seemingly important habitat feature is water, as either a surface or subsurface stream. The presence of mosses, forbs, and other ground-cover plants also determines the presence or absence of this species (Kirkland and Jannett 1982).

Food Habits

The diet of the southern rock vole primarily consists of green plant matter, although they also consume lepidopterous larvae, fungi, and various seeds and roots. Voles extensively use bunchberry (*C. canadensis*) (Kirkland and Jannett 1982, Whitaker and Hamilton 1998, Wilson and Ruff 1999).

Reproduction

Young southern rock voles are born from the early spring into the autumn months. Litter sizes range from 2-4 young (Whitaker and Hamilton 1998, Wilson and Ruff 1999). Gestation period for southern rock voles is 19 to 21 days, and the female comes into post-partum estrus within 24 hours after giving birth (Kirkland and Jannett 1982, Wilson and Ruff 1999).

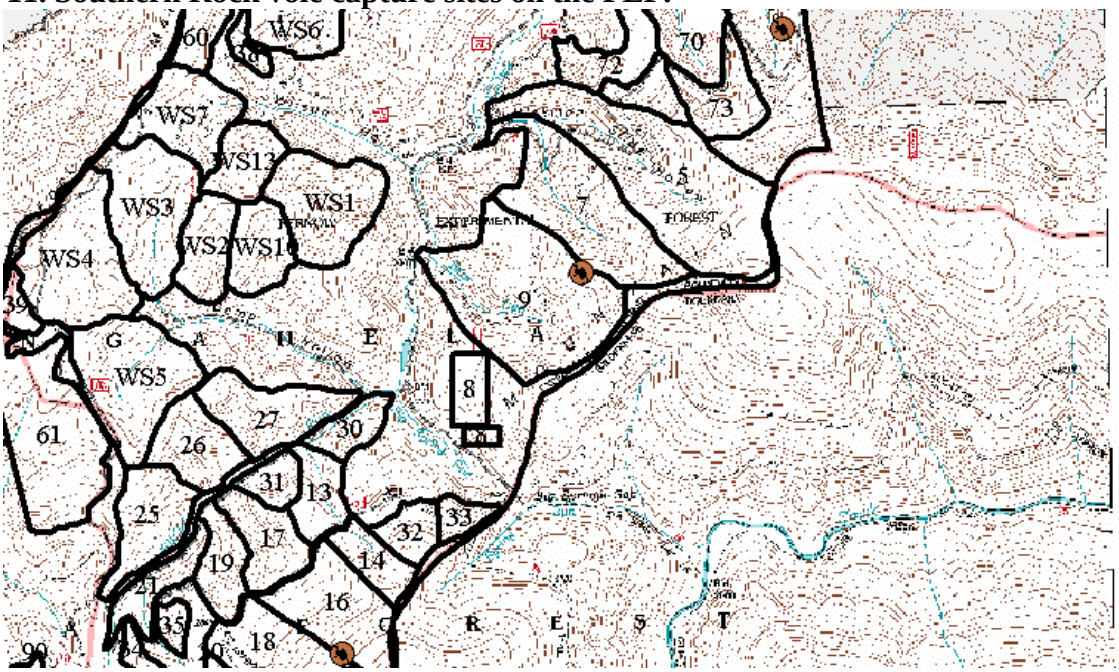
Causes of Past/Current Declines

The unique habitat requirements of the southern rock vole make this an uncommon species. Habitat fragmentation and isolation of colonies may lead to inbreeding depression.

Habitat on the FEF

Summer and fall surveys of 2001 and 2002 captured rock voles on the FEF in boulder and rock fields (Figure 11). Surveys during the fall of 2004 failed to capture any of this species; however, this may have been due to weather conditions rather then the presence of absence of southern rock voles. Additionally, these species has been documented from previous surveys on the FEF. Populations of southern rock voles on the FEF will continue to be monitored.

Figure 11. Southern Rock vole capture sites on the FEF.



Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the southern rock vole would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impact** is made for the southern rock vole on the FEF due to the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

Boulder fields where southern rock voles have been captured are currently protected on the FEF, and no new ground disturbance or tree felling would occur in these areas. There is a slight possibility of an individual, dispersing rock vole being harmed by logging equipment or falling trees, although this adverse direct effect would be small as this species is prone to seek underground refugia to avoid human disturbance. However, there may be undocumented colony sites, and these areas may be indirectly affected by timber harvesting due to habitat alterations, such as overstory canopy reduction, that may occur. Previous logging activity has occurred in these areas over the last 50 years, and there is no evidence of adverse impacts on southern rock vole populations; therefore, the cumulative effects are insignificant.

Prescribed burning

Prescribed burning would not occur in documented or suitable habitat for the southern rock vole. Therefore, there would be no direct, indirect, or cumulative effects due to prescribed burning.

Ammonium nitrate fertilization

Fertilization would not occur in documented or suitable habitat for the southern rock vole, and the affected watershed is not adjacent to any suitable habitat. Therefore, there would be no direct, indirect, or cumulative effects to the southern rock vole due to ammonium nitrate fertilization.

Determination
Due to the small possibility of harming individual southern rock voles, it is determined that the Proposed Action Alternative **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** to this species on the FEF.

<u>Alternative C – Preferred Alternative</u>
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the southern rock vole are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monocultures on the FEF. There would be no direct effects to southern rock voles because of herbicide application due to that fact that application would be directly on targeted plants, and no southern rock voles would be present on targeted species. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be species-specific, there would be no indirect or cumulative effects to southern rock voles, as overall habitat would remain the same.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the southern rock vole on the FEF under the Preferred Alternative.

<u>Timber Rattlesnake</u>
Distribution and Habitat

J. Rodrigue

The range of the timber rattlesnake, (*Crotalus horridus*), extends from southern New Hampshire, south to northern Florida, and west to Texas (Green and Pauley 1987, Wilson 1995).

Timber rattlesnakes occupy a wide variety of habitats, from upland forests to riparian areas. However, in the summer this species most commonly occurs in open woods, grassy fields, and secondary growth (Green and Pauley 1987, Mitchell 1994, DeGraaf and Yamasaki 2001). The preferred habitat for timber rattlesnakes appears to be upland hardwood and mixed oak-pine forests with talus slopes or rocky hillsides that contain an abundance of south-facing ledges, and light ground cover. Forested areas consisting of second-growth deciduous or coniferous forests with high rodent populations provide excellent habitat for this species (DeGraaf and Yamasaki 2001). Rocky areas with southern exposure allow maximum exposure to the sun during the spring and fall (Green and Pauley 1987, Mitchell 1994, Wilson 1995). Timber rattlesnakes utilize valley bottoms by streams in the summer, due to the abundance of prey (Shaffer 1991).

Timber rattlesnakes return to the same den site each year during late September or early October (Mitchell 1994). Den sites occur at elevations ranging from 600 ft. to 3500 ft (Mitchell 1994), and consist of deep fissures in rocks or talus slopes below the frost line, where temperatures remain at approximately 55° F year-round (Green and Pauley 1987, Shaffer 1991). After emergence in the spring, rattlesnakes disperse up to a two-mile radius of the den. In April, snakes move to open, sunny areas

such as rocky talus slopes. Although these spring basking sites should not be confused with winter dens, if many snakes are seen at a rocky basking site, the winter den is usually close by.

Food Habits

The diet of the timber rattlesnake primarily consists of small mammals (87%), rabbits, squirrels, bats, songbirds, frogs, and other snakes (Green and Pauley 1987, Mitchell 1994, DeGraaf and Yamasaki 2001).

Reproduction

Timber rattlesnakes breed after they emerge from the den in the spring (March-April). The gestation period is 5½ to 6 months, and 5 to 17 young are born in late August or September (Green and Pauley 1987, Shaffer 1991, DeGraaf and Yamasaki 2001). Rattlesnakes disperse in the late summer when looking for mates and feeding on prey before winter hibernation.

Causes of Past/Current Decline

The primary causes of timber rattlesnake population decline are the destruction of den sites and removal of timber rattlesnakes from winter dens by humans (Mitchell 1994). Some populations of timber rattlesnakes have declined due to forest loss to commercial and highway development (Green and Pauley 1987). The timber rattlesnake was once widespread, but because of hunting and disturbance of winter dens, remaining populations are restricted primarily to mountainous areas that have suitable denning areas for winter hibernation, and rocky ledges on south facing slopes for basking and nursery areas.

Habitat on the FEF

From 2000-2004, timber rattlesnakes have been sighted regularly on many of the roads, trails, and logging roads on the FEF; however, no den sites have been located in any of the boulder fields scattered across the forest. Monitoring efforts will continue, and if a den site were located, it would be protected from human disturbance. Additionally, efforts have been made to educate FEF personnel on the importance of not harming individual timber rattlesnakes they may encounter.

Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the timber rattlesnake would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for the timber rattlesnake on the FEF due to the No-Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

There would be no direct impacts to timber rattlesnakes because of tree removal, as the snakes will be in their dens while timber harvesting occurs (November 1-April 30). Additionally, indirect effects would be minimal, as the abundance of prey species, such as small mammals would not decline with the scale and type of proposed timber harvest. Previous logging activity has occurred in these areas over the last 50 years, and there is no evidence of adverse impacts on timber rattlesnakes; therefore, it appears that cumulative effects are insignificant.

Prescribed burning
In Florida, of 68 marked eastern diamondback rattlesnakes (*C. adamanteus*), only two snakes were killed by burning. However, both of these snakes were in mid-ecdysis (Means and Campbell 1981). Shedding of the skin may impede a snake's sensory ability, thus making escape from predators or fire more difficult. However, this study suggests that timber rattlesnakes should have no difficulty escaping from prescribed fire when not in ecdysis. There would be no adverse indirect and cumulative effects to timber rattlesnakes as prey species abundance would remain stable, or even increase after prescribed burning (Masters et al. 2000, Vreeland and Tietje 2000), and the opening of the understory would improve habitat for this species.

Ammonium nitrate fertilization
Fertilization of this watershed would have no direct effect on the timber rattlesnake as the fertilizer pellets would not be applied in high enough density and are not toxic enough to harm this species. Additionally, preliminary study results have not revealed any effects on the diversity and abundance of herbaceous plants, salamanders, or insects in the artificially acidified watershed (M.B. Adams, pers. comm.). Therefore, it is unlikely that this study would have any negative effects on the timber rattlesnake.

Determination
Due to slight possibility of harming individual timber rattlesnakes during timber harvesting and prescribed burning, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the timber rattlesnake on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the timber rattlesnake are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to the timber rattlesnake because of herbicide application due to that fact that application would be directly on targeted plants, and no eastern small-footed myotis would be present on targeted species. Tatum (2003) stated that most commonly used herbicides degrade quickly once they enter the environment, and therefore are neither cumulative nor bioaccumulative. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be species-specific, there would be no indirect or cumulative effects to the timber rattlesnake, as overall habitat would remain the same.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the timber rattlesnake on the FEF under the Preferred Alternative.

Greenbrier Cave Amphipod

Distribution and Habitat
Little is known about the Greenbrier cave amphipod, (*Stygobromus emarginatus*). This species has been found in 18 caves in Greenbrier, Monroe, Pocahontas, Randolph, and Tucker counties in WV. It occurs

under gravel in streambeds and occasionally in pools. The Greenbrier cave amphipod is most abundant in smallest trickles of water, primarily in tiny first and second order headwater cave streams.

Habitat on the FEF

This amphipod has been found in Big Springs Cave on the FEF. Big Springs Cave is located in a 77-acre biological control area where no timber management occurs. Therefore, this population of the Greenbrier cave amphipod is protected from disturbance and habitat destruction.

Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for the Greenbrier cave amphipod would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for the Greenbrier cave amphipod on the FEF as a result of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

Big Springs cave is located in a 77-acre biological control area where no timber harvesting will occur; therefore, there would be no direct, indirect, or cumulative effects to this species as a result of these silvicultural practices.

Prescribed burning

Prescribed burning would not occur in the biological control area around Big Springs cave; therefore, there would be no direct, indirect, or cumulative effects to this species due to prescribed burning.

Ammonium nitrate fertilization

Fertilization would not occur in the biological control area, and the affected watershed is downstream from Big Springs cave. Therefore, there would be no direct, indirect, or cumulative effects to the Greenbrier cave amphipod because of ammonium nitrate fertilization.

Determination

Because this species habitat would not be affected by any of the proposed actions, a determination of **no impacts** to the Greenbrier cave amphipod on the FEF due to the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the Greenbrier cave amphipod are discussed below.

Herbicide Application

Herbicide application would not take place in Big Springs cave, habitat for the Greenbrier cave amphipod. Additionally, modern herbicides have been designed to target biochemical processes unique to plants, thus having a low level of direct toxicity to animals. Because herbicide application would be species-specific, there would be no indirect or cumulative effects to the Greenbrier cave amphipod as its habitat would be unaffected.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **no impacts** is made for the Greenbrier cave amphipod on the FEF under the Preferred Alternative.

Butternut

Distribution and Habitat
Butternut, (*Juglans cinerea*), ranges from Quebec and Ontario, west to Minnesota and Arkansas, and south to Mississippi, Alabama, Georgia, and the Carolinas (Crouch 1994).

Butternut occurs in mixed hardwood forests, coves, riparian zones, along ridges, open fields, forest edges, or other sites with good drainage (Strausbaugh and Core 1952, Rink 1990). It commonly grows on rich loamy soils, as well as on dry rocky soils of limestone origin (Rink 1990). This tree never occurs in pure stands, but may be locally abundant in mixed hardwood forests. Butternut is shade intolerant, and is only able to reproduce in stand openings or fields with abundant sunlight.

Butternut begins producing seeds at approximately 20 years, with good hickory nut crops occurring every 2-3 years (Ostry et al. 1994). Stumps of young butternut trees and saplings are capable of sprouting, but tree regeneration can only occur in stand openings or fields where shade cannot impede its development (Rink 1990, Ostry et al. 1994). Young trees may withstand competition from the side, but will not survive shade from above (Ostry et al. 1994).

Causes of Past/ Current Decline
The fungus *Sirococcus clavigignenti-juglandacerarum* is fatal to butternut, and has caused this tree to be extirpated from some areas in its original range. This fungus is of unknown origin, and causes multiple branch and stem cankers that eventually girdle trees (Crouch 1994, Ostry et al. 1994). Additionally, competition by other tree species may lead to the absence of butternut in forested areas, as this tree must be in the overstory to survive (Rink 1990). Butternut is also susceptible to fire and storm damage (Clark 1965).

Habitat on the FEF
Although not numerous, the butternut is found in almost every compartment on the FEF. This species usually occurs as an isolated tree in a compartment or along a FEF road. Butternut trees are protected from harvesting on the FEF.

Effects of Proposed Project Implementation
Alternative A: No-Action Alternative
This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for butternut would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for butternut on the FEF as a result of the No-Action alternative.

Alternative B: Proposed Action Alternative
***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**
There would be no direct impacts to butternut due to tree harvesting since this species is protected on the FEF. Additionally, silvicultural treatments such as singe-tree selection, group selection, and patch clearcutting would allow more sunlight to reach the forest floor and benefit shade intolerant species such

as the butternut by releasing these trees and encouraging regeneration (Ostry et al. 1994). Therefore, any indirect or cumulative effects of silvicultural treatments would most likely be positive.

Prescribed burning
Butternut tree is susceptible to fire, so prescribed fire has the potential for direct adverse effects on some individual trees. However, less then 10% of the total FEF acreage is scheduled for prescribed burn treatments, and these fires will be low intensity burns. In addition, butternut trees are often located in moist coves or riparian areas where high soil moisture will keep fire at low intensity

Ammonium nitrate fertilization
Fertilization of this watershed has resulted in a slight increase in tree growth in this watershed (M.B. Adams, pers. comm. 2004). Indirect and cumulative effects would be negligible due to the low density of butternut on the FEF and the fact that the effects of ammonium nitrate fertilization are concentrated inside the study area and diminish rapidly with distance from the study boundary.

Determination
Due to possibility of adverse direct effects from prescribed fire, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the butternut on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on the butternut are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to butternut, as this tree would not be treated with herbicides. Application would be directly on targeted plants (Japanese stiltgrass and tree-of-heaven). Because herbicide application would be species-specific, there would be no indirect or cumulative effects to the butternut tree.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the butternut tree on the FEF under the Preferred Alternative.

White monkshood

Distribution and habitat
White monkshood, (*Aconitum reclinatum*), occurs in the mountains and upper Piedmont from southwestern Pennsylvania, south to northern Georgia (Harmon 1995).

Throughout its range, this plant occupies moist areas. In North Carolina, white monkshood grows on seepage boulder fields and stream banks. Stream seepage habitat appears to be very important to this species in low-elevation sites (Harmon 1995). At higher elevations, this plant occurs in rich forests at higher elevations along streams, in coves, seeps, or other moist areas. In WV, white monkshood occurs at higher elevations along streams, seeps, and disturbed sites where seeps and coves meet roadcuts on disturbed sites (Sargent 1996).

This species appears to be resistant to moderate disturbance (Harmon 1995). Logging has occurred on several sites in Pennsylvania with white monkshood. On one site, white monkshood numbers increased from five plants in 1978 to 55 clumps in 1986. However, the long-term effects of logging on white monkshood are still unknown. Single-tree selection or group selection harvesting are recommended in areas with white monkshood to prevent drying out the soil and exposing the plants to direct sunlight. Streamside management zones also provide important habitat for this species (Sargent 1996).

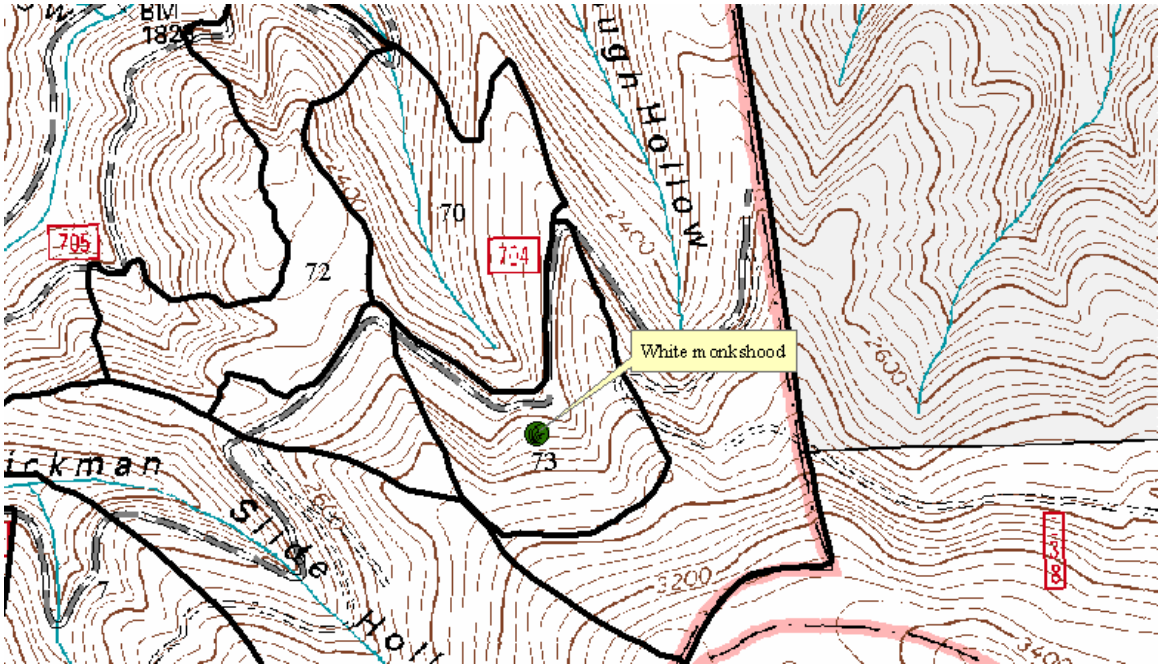
Causes of Past/Current Decline

The close affinity of this plant to riparian areas has made white monkshood populations highly susceptible to draining and filling wetlands and stream changes and channelization. In some cases, logging has altered the habitat (drying out soil, etc) and destroyed some populations. Other causes of white monkshood decline include excessive grazing, trampling by hikers and recreational vehicles, deer browsing, and fungus (Harmon 1995, Sargent 1996).

Habitat on the FEF

The Elklick drainage and various seeps on the FEF provide some suitable habitat for white monkshood. This species has been found in compartments adjacent to compartments 5 and 70 (Figure 12). Botanical surveys in other portions of the FEF have failed to locate other populations of this plant; however, future discoveries of white monkshood populations will be documented.

Figure 12. White monkshood occurrence site on the FEF.



Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for white monkshood would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for white monkshood on the FEF as a result of the No Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

No silvicultural treatments would occur within approximately 750 ft. of where white monkshood is located on the FEF. Therefore, there would be no direct, indirect, or cumulative effects of silvicultural treatments on this species.

Prescribed burning

Prescribed burning would not occur within ¾ mile of the white monkshood populations. Therefore, there would be no direct, indirect, or cumulative effects of prescribed burning on this species.

Ammonium nitrate fertilization

Ammonium nitrate fertilization would occur over two miles from the known white monkshood site. Effects of fertilization are undetectable ¼ downstream from the study site (M.B. Adams, pers. comm. 2004); therefore, there would be no direct, indirect, or cumulative effects due to ammonium nitrate fertilization.

Determination

Because no treatments would occur in or adjacent to the area where white monkshood occurs, a determination of **no impacts** is made for this species on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative

This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on white monkshood are discussed below.

Herbicide Application

Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF; however, no herbicides would be applied in areas where white monkshood is present. Some beneficial indirect or cumulative effects may occur by removing competing exotic plants in areas suitable for white monkshood, thus providing more habitats for this species.

Determination

Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **no impacts** is made for white monkshood on the FEF under the Preferred Alternative.

Nodding pogonia

Distribution and habitat

The range of nodding pogonia (*Triphora trianthophora*) extends from Canada, south to central Florida, east to Texas, and west through the central U.S. to Michigan, Iowa, Missouri, and Arkansas (Correll 1950).

J. Rodrigue

This orchid often grows adjacent to decomposing tree trunks and logs of American beech or in small depressions with thick accumulations of beech leaves; however, these plants never occur directly on top of rotting logs (Keenan 1990, Keenan 1992). In Michigan, nodding pogonia occurs in beech-sugar maple forests on glacial till and in deep, wet organic muck of a glacial lakebed, while in Kentucky it occurs in seasonally flooded karst swamps with less then one inch of organic leaf mulch over a clay mineral soil (Medley 1979). Nodding pogonia is often out-competed by herbaceous and sapling growth on the forest floor (Keenan 1990). The close association of this plant with American beech suggests a relationship between nodding pogonia, mycorrhizae, and American beech roots that allow this plant to receive its nutrients and photosynthate from beech trees (Williams 1994).

This plant is quite shade-tolerant, and initiates growth under conditions of low light levels, high soil temperatures, and low nutrient and water availability, usually in August or September. These conditions may reduce competition from other herbaceous plants (Williams 1994).

Reproduction

Aboveground plants are not produced every year, yet all aboveground plants produce at least one bud, regardless of plant size. In New Hampshire, the flowering period for nodding pogonia occurs from the first week in August to the first week of September; however, open flowers are only present during 5 or 6 days of this period (Keenan 1992). Pollinators include bees from the families Halicitidae and Xylacopidae (Medley 1979).

This plant also spreads by vegetative reproduction. In Massachusetts populations, all nodding pogonia plants have at least one secondary tuberoid, and up to 17 have been counted on a single plant (Williams 1994).

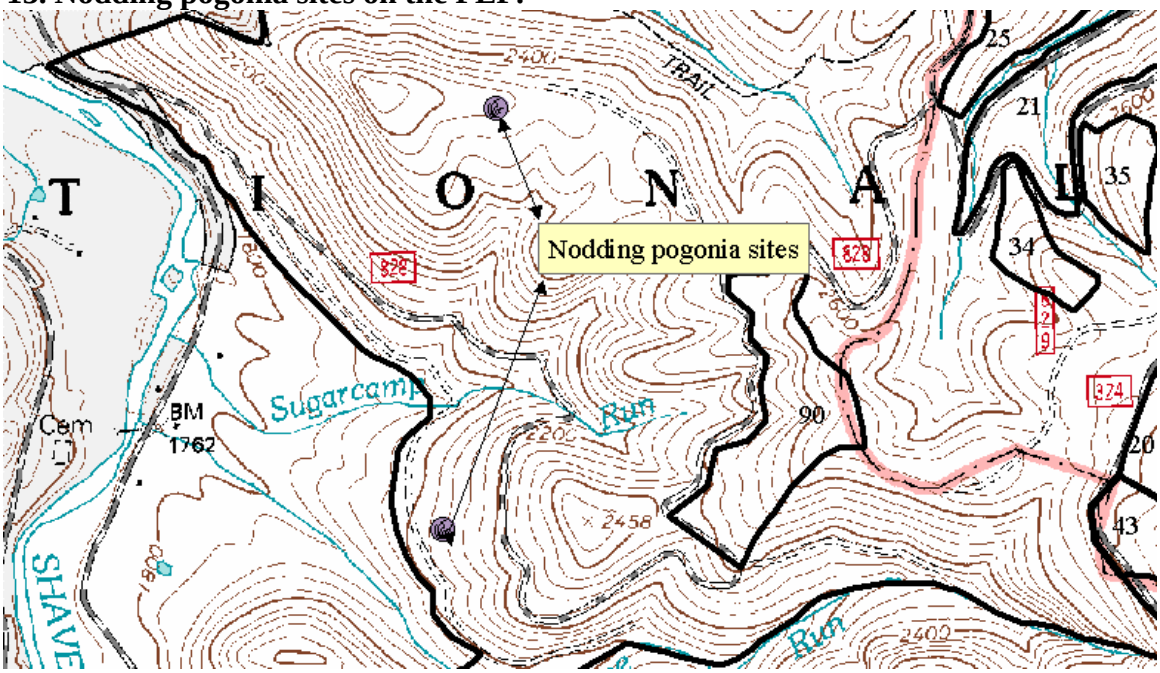
Causes of Past/Current Decline

Road widening, timber harvesting, and commercial or residential development, and herbivore grazing have all been suggested as factors leading to the decline of this species (Zika 1983, Keenan 1992). Additionally, nodding pogonia declines or disappears from areas with dense herbaceous or sapling growth (Keenan 1990). Nodding pogonia plants are commonly consumed by chipmunks and slugs (Williams 1994). Populations of nodding pogonia are difficult to monitor as tuberoids in leaf litter often go years at a time without producing a vegetative shoot (Williams 1994).

Habitat on the FEF

In August 2001, blooming nodding pogonia plants were found on the *Evaluating prescribed fire as a silvicultural tool to promote oak regeneration in the central Appalachians* study sites and control areas (Figure 13). Additional populations were found on these areas in the summers of 2002, 2003, and 2004. All populations sprouted and bloomed each summer, including the areas experiencing spring prescribed burns that year. Numbers of known colonies appear to be remaining stable, and new populations have been found every summer since 2002.

Figure 13. Nodding pogonia sites on the FEF.



Effects of Proposed Project Implementation

Alternative A: No-Action Alternative

This alternative would not include any silvicultural or other manipulative treatments on the FEF, only data collection and monitoring would continue. Therefore, habitat for nodding pogonia would remain relatively unchanged on the landscape, with habitat quality remaining stable. No beneficial or negative effects would occur. A determination of **no impacts** is made for nodding pogonia on the FEF as a result of the No-Action alternative.

Alternative B: Proposed Action Alternative

***Single-tree selection, Patch clearcut, Financial maturity harvest, Diameter-limit cut, Shelterwood cut, Overstory mortality*:**

There would be no direct impacts to nodding pogonia due to tree harvesting since this species would be underground and dormant while harvesting is occurring. However, there may be some adverse indirect effects of timber harvesting on this species due to habitat alteration. Nodding pogonia prefers closed canopy conditions, and after some overstory reduction, too much light may penetrate the canopy for nodding pogonia. Alternatively, beech trees, a species which nodding pogonia appears to have a close affinity with, may continue to provide adequate shade for this species. Little is known about the impacts of these types of silvicultural treatments on this orchid, therefore, indirect and cumulative effects to this species are unknown. Results from these studies may contribute to the knowledge of the natural history of this species.

Prescribed burning

Nodding pogonia would not be directly affected by prescribed burning, as this species would have no aboveground shoots when prescribed burns would occur. Prescribed burning could have both negative and positive indirect effects. Prescribed fire could potentially reduce overstory canopy to a point detrimental to this species. Alternatively, burning may reduce ground cover competition for this species. Populations of nodding pogonia in areas subjected to spring, low intensity prescribed burns reemerged one and two years after burning, and new populations have been found in theses areas. However, there is little information available on the indirect and cumulative effects of fire on this

species. These studies provide a unique opportunity to examine the effects of prescribed fire on nodding pogonia.

Ammonium nitrate fertilization
Nodding pogonia is not known to occur in or adjacent to the proposed study site. Therefore, there would be no direct, indirect, or cumulative effects of ammonium nitrate fertilization on this species.

Determination
Due to possibility of adverse indirect effects from prescribed fire, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for the nodding pogonia on the FEF under the Proposed Action Alternative.

Alternative C – Preferred Alternative
This alternative includes the same actions as the Proposed Action Alternative, and includes herbicide treatments to control exotic, invasive species on the FEF. Effects stated for the Proposed Action Alternative would be the same for the Preferred Alternative. Additionally, the effects of herbicide application on nodding pogonia are discussed below.

Herbicide Application
Herbicide application would be species-specific, targeting exotic plant species that threaten to form monoculture on the FEF. There would be no direct effects to nodding pogonia, as this species would not be treated with herbicides. Application would be directly on targeted plants (Japanese stiltgrass and tree-of-heaven). Because herbicide application would be species-specific, there would be no indirect or cumulative effects to nodding pogonia.

Determination
Taking into account the effects for the Proposed Action Alternative and herbicide application, a determination of **may impact individuals, but is not likely to cause a trend to federal listing or loss of viability** is made for nodding pogonia on the FEF under the Preferred Alternative.

Prepared By:

/s/ Jane Rodrigue 12/14/04
Jane Rodrigue, Ecologist, USFS Northeastern Research Station Date

Approved By:

/s/ W. Mark Ford 12/14/04
W. Mark Ford, Wildlife Research Biologist, USFS Northeastern Research Station Date

/s/ Thomas Schuler 12/14/04
Thomas Schuler, Research Forester, USFS Northeastern Research Station Date

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Appendices.

Appendix 1. Endangered, Threatened, and Sensitive Species Likelihood of Occurrence

1/31/2005

Threatened / Endangered	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Mammals					
Gray wolf	*Canis lupus*	LE/GE/N4/SX	High spruce forest and associated northern mixed hardwood/coniferous forest. Considered extirpated from WV since 1900 when the last wolf was killed in the state.[1, 41]		**Considered extirpated from WV.[1, 41]**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Virginia big-eared bat	*Corynorhinus townsendii virginianus* LE/G4T2/N2/S2	Uses caves during summer (maternity sites) and winter (hibernacula). These caves are typically located in karst regions dominated by oak-hickory or beech-maple-hemlock forest associations. Forage in patchy mosaic habitats[3, 45] Cave Mountain cave (Pendleton Co.) and Cave Hollow/Arbogast cave (Tucker Co.) have been designated as Critical Habitat by USFWS. Significant status is based on Federal Caves Resources Protection Act of 1988. Forest Plan amendment calls for creation of MP 837 for areas 200' from VBEB caves. Reference Forest Plan Amendment. **LOO: Present; has hibernates in Big Springs Cave; may forage on proposed project area.**			

Cave Name	Cave Status	Ownership	Quad
Alpena #1	Extirpated from this cave, within proclamation boundary	Private	Bowden
Alpena #2	Extirpated from this cave, within proclamation boundary	Private	Bowden
Aqua-terra	within proc boundary, hibernacula	Private	Whitmer
Big Springs	Gated, significant, hibernacula	FS	Parsons
Bowden	Significant, hibernacula	Private/FS	Bowden
Brook Stemple	Historical, within 5 miles of Proc boundary	Private	Aurora
Cave Hollow/Arbogast	Critical, gated, significant, hibernacula, maternity	FS	Mozark
Cave Mountain	Gated, significant, critical, maternity	FS	Upper Tract
Cedar Hill	Historical	Private	Petersburg West
Flute	Transient colony	Private	Sugar Grove
Gale Warner	Maternity cave	Private	Circleville
Harper Trail	Hibernacula	FS	Beverly East
Hellhole	Critical, fenced, within proc boundary	Private	Onego
Izaak Walton	Within proc boundary	Private	Beverly East
Keys		Private	Franklin
Mill Run #1	Signed, within proc boundary	Private	Hopeville
Mill Run #2	Signed, within proc boundary	Private	Hopeville
Minor Rexrode	Gated, fenced, maternity and hibernacula, outside proc boundary	Private	Sugar Grove
Mystic	Signed, maternity, within proc boundary	Private	Onego
New Trout	Hibernacula	Private	Sugar Grove
Peacock	Signed, maternity, hibernacula, within proc boundary	Private	Petersburg West

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Eastern cougar	*Puma concolor cougar*	LE/G5TH/NH/SH	Very large, remote, undisturbed, mountainous areas. Hardwood or mixed forest.	Presence in West Virginia is unconfirmed at this time. [1, 41] The last documented eastern cougar is one shot in Pendleton Co. in 1887 but as late as 1936 there were reported tracks in Pocahontas Co. [41]	**Presence in West Virginia is unconfirmed at this time. [1, 41]**
WV northern flying squirrel	*Glaucomys sabrinus fuscus*	LE/G5T2/N2/S2	Associated with boreal habitats, especially spruce-fir and northern hardwood forests. Elevations from 2200-4900'. Northern hardwood forests that contain a conifer component. [2, 26, 45]	Extends southwestward, following the Allegheny Mt., south from Mt. Storm Reservoir (Tucker Co.) in the north to Briery Knob (Pocahontas Co.) and Rabbit Run (Greenbrier Co.) in the south. Also encompassing areas in Randolph, Webster, and Pendleton Co.	**Possible, may occur at higher elevations on FEF; no documentation records exist for FEF.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Indiana bat	*Myotis sodalis*	LE/G2/N2/S1	Winter in caves or mines that satisfy their highly specific need for cold temperatures during hibernation. During summer, roost in trees and forage primarily in riparian and upland forests.[4, 45] Cave Hollow/Arbogast cave (Tucker Co.) has been designated as Critical Habitat by USFWS. Significant status is based on Federal Caves Resources Protection Act of 1988. **LOO: Present.**		

Cave Name	Cave Status	Own.	Quad
Big Springs	Gated, significant	FS	Parsons
Bob Gee	Within proclamation boundary	Private	Trout
Bowden	Significant	Private	Bowden
Cass	Within proclamation boundary	Private	Cass
Cave Hollow/ Arbogast	Critical, Gated, significant	FS	Mozark
Coal Run		Private	Mozark
Falling Spring	Within proclamation boundary	Private	Mingo
Fortlick	Within 5 miles of Proc boundary	Private	Valley Head
Gooseberry	Within 5 miles of Proc boundary	Private	Adolph
Hellhole	Critical, Within proc boundary	Private	Onego
Higginbotham's #1 - #4	Within 5 miles of Proc boundary	Private	Williamsburg
Izaak Walton	Within proclamation boundary	Private	Beverly East
Lobelia Saltpeter	Within 5 miles of Proc boundary	Private	Lobelia
Martha's	Within 5 miles of Proc boundary	Private	Hillsboro
Schoolhouse	Within proclamation boundary	Private	Upper Tract
Simmons	Within proclamation boundary	Private	Mingo
Smoke Hole	Within proclamation boundary	Private	Upper Tract

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Birds					
Bald Eagle	*Haliaeetus leucocephalus*	LT/G4/S1	Typically found along the shores of large rivers and lakes, as main prey is fish and waterfowl. Nests in tall trees or on cliffs near large rivers or lakes. [6]	Grant, Hampshire, Mineral and Hardy Co. Migratory routes traverse areas of the MNF Ranger Districts.	**Absent, FEF does not contain large bodies of water.**
Amphibian					
Cheat Mountain Salamander	*Plethodon nettingi*	LT/G2/S1	Moist spruce or mixed spruce/deciduous forests, including, but not limited to, shaded or moist coves, possibly with rhododendron and/or small emergent rocks within spruce or hemlock forest. Spruce stands containing Bazzania (a liverwort).[7]	Minimum elevation is 2600' on the Cheat district, and 2940' on the Potomac and Greenbrier districts. Range extends east of McGowan Mt. (Randolph Co.) to Dolly Sods (Tucker Co.), south to Spruce Knob (Pendleton & Pocahontas Co.), southwest to Thorny Flat (Pocahontas Co.), north to Barton Knob (Randolph Co.). Not known to occur on the Gauley, Marlinton, or White Sulphur districts.	**Possible; may occur at higher elevations on FEF; no occurrence records exist for FEF.**
Reptiles & Fish					
None					
Plants					
Small-whorled pogonia	*Isotria medeoloides*	LT/G2/S1	Mixed deciduous or mixed-deciduous/coniferous forest in generally second or third growth successional stages; occurs in both fairly young forests and in maturing stands. Majority of occupied sites have: sparse to moderate ground cover; relatively open understory, proximity to logging roads, streams	Occurs on only one site in WV in Greenbrier County, White Sulphur District	**Unlikely, not near known populations in WV, not found during past botanical surveys.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			or other features that create long persisting breaks in canopy; associated species -- witch-hazel, striped maple, hazelnut, serviceberry; highly acidic nutrient-poor soil.[17]		
Shale Barren Rockcress	*Arabis serotina*	LE/G2/S2	Biennial herb found mostly on shale barrens of eastern counties of WV.[8]	Grant, Greenbrier, and Pendleton counties.	**Absent; FEF does not contain shale barrens.**
Virginia Spirea	*Spiraea virginiana*	LT/G2/S1	Clonal shrub found on damp, rocky banks of larger high gradient streams. Flood-scoured mouths of side streams, rocky isles, and seasonally flooded side channels, in shrub thickets between the river and forest. Full sun or shade. [9]	Known from Greenbrier Co. near Greenbrier Youth Camp; National Park Service land in Nicholas Co.	**Absent, high gradient streams do not occur on FEF.**
Running Buffalo Clover	*Trifolium stoloniferum*	LE/G3/S2	Perennial clover found on rich, fertile (limestone geology & soils), semi-shaded habitats. Open, savannah-like forests; lightly disturbed areas such as old logging roads. Also old farmsteads and cemeteries. [9]	Logging roads on the Fernow Experimental Forest; Swecker Ridge, McGowan Mt., Cheat Mt. (Chestnut Ridge), Shavers Fork (Randolph and Tucker Co.). Also found in Greenbrier and Pendleton Co.	**Present.**
Sensitive Species					
Mammals					
Southern rock vole	*Microtus chrotorrhinus carolinensis*	G4T3/S2 (SOC)	Moist rocky areas or mossy rocks and logs in spruce & mixed deciduous-coniferous forests [48], often with birch, other hardwoods & hemlock components. Dense ground cover of mosses, ferns, & northern herbs. Unvegetated talus, grass balds, recent clearcuts, & road-	Tucker, Randolph, Pendleton, Pocahontas, & Greenbrier Co.	**Present.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			fills. Highly associated with surface or subsurface water.[10, 48]		
Eastern small-footed bat	*Myotis leibii*	G3/S1(SOC)	Hibernates in caves, sometimes under stones or in deep crevices. Summer roosts and maternity sites in buildings, caves, rock crevices, tunnels or under bridges. It is thought that rock outcrops are important for this species. Forages over ponds and streams. Summer habitat may or may not be in proximity to hibernation sites. [11, 42]	Preston, Tucker, Grant, Randolph, Pendleton, Pocahontas, and Greenbrier Co.	**Present; hibernates in Big Springs Cave.**
Allegheny woodrat	*Neotoma magister*	G3G4/S3 (SOC)	Extensive rocky areas in deciduous or mixed forests, outcrops, cliffs, rocky talus slopes, caves, riverbanks with sandstone rocks and boulders[12] and buildings[47, 45].	Widespread across the Monongahela in rocky areas and around many caves	**Absent; extensive rock walls and talus slopes do not occur on FEF; has not been captured during survey efforts.**
Southern water shrew	*Sorex palustris punctulatus*	G5T3/S1 (SOC)	Found near streams or other bodies of water. Heavy vegetative cover and plentiful logs, rocks, crevices, or other sources of shelter that offer high humidity and overhead protection [47]. Dominant trees often yellow birch and red maple with dense rhododendron and laurel understory. [13]	Preston, Tucker, Randolph, Pendleton, and Pocahontas Co.	**Present.**
Birds					
Northern Goshawk	*Accipiter gentilis*	G5/ S1B,S1N(SOC)	Coniferous, deciduous, & mixed forests; utilizes a variety of forest types, structural conditions, and	Pocahontas, Randolph, Webster, Tucker Co. They also may be found nesting at	**Absent, FEF does not contain tracts**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			successional stages. Usually nests in trees greater than 12" DBH. WV is on the southern extent of range. [15, 21]	elevations above 2500-3000 feet in Grant, Greenbrier, Mineral, Nicholas, and Preston Co.	**of high elevation spruce forest.**
Peregrine falcon	*Falco peregrinus anatum*	G4/S1B2SN	Nest sites on cliffs, prominent high spots, buildings and bridges. Needs isolation from human disturbance. [5]	Historic nest sites in Grant, Pendleton, and Greenbrier Co. Known nests found on North Fork Mountain and Gauley Gorge.	**Absent, FEF does not contain cliff habitat.**
Migrant Loggerhead shrike	*Lanius ludovicianus migrans*	G4T3Q/ S1BS2N	Most numerous in dry, open, eastern valleys (Shenandoah Valley). Prefers open farm and pasture, usually perching on scattered trees or wires. Favored nesting site: dense brush, most often with thorn trees. [21, 22]	May be found almost any summer in Hampshire, Grant, Pendleton, Greenbrier, and Monroe Co. Rare and local in Nicholas, Pocahontas, Tucker, and Hardy Co. Confirmed nesting in Berkley, Grant, Greenbrier, Monroe, and Mercer Co. [21]	**Absent, FEF does not contain open pasture.**
Reptiles					
Timber rattlesnake	*Crotalus horridus*	G4/S3	Rough mountainous terrain where brushy ridges and rocky hillsides with ledges abound. Common in wooded areas, but may occur in valleys, along streams and among slab piles around old sawmill sites. [17]	In WV, range extends from the Eastern Panhandle across the Alleghenies south into Mercer and Mingo counties.	**Present.**
Amphibians					
Green salamander	*Aneides aeneus*	G3G4/S3 (SOC)	Smaller deeper crevices in rock faces, well-shaded and moist, but not wet, or under bark on trees, rotting logs, etc. Usually below 3000' in northern MNF; below 3500' in southern MNF. [17, 23]	Droop Mtn.; Blackwater Falls State Park; Tucker, Pocahontas, Randolph, Webster, and Nicholas Co. [30]	**Absent; sandstone or granite rock faces with deep crevices do not occur**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
					on FEF.
Hellbender	*Cryptobranchus alleghaniensis*	G3G4/S2 (SOC)	Cool, clear, larger permanent streams. Found throughout the Ohio River drainage. They spend most of their time under flat rocks, emerging at night to forage for food. [17, 23]	Tucker, Randolph, Pocahontas, Webster, Nicholas, and Greenbrier Co.	**Absent; Elklick not large enough stream, absent in all surveys.**
Fish					
Redside dace	*Clinostomus elongatus*	G4/S1S2	Clear, cool streams, in small pools or backwater areas; most often found over gravel or cobble substrates and not typically found in association with aquatic vegetation. Found in the Monongahela River basin, the upper main channel of the Ohio River, and Middle Grave Creek; patchily distributed and uncommon.	Species has not been taken within MNF boundaries. The closest known localities are from Blackwater River above the falls (i.e. Canaan Valley), and Laurel Creek in Preston Co. [24, 25]	**Absent, Blackwater River and Laurel Creek do not occur on FEF.**
Candy darter	*Etheostoma osburni*	G3/S2(SOC)	Occupies rocky riffles, appears to be most common in cool to cold sections of moderate to small streams. Widely distributed, locally common endemic of lower New River drainage. [49, 18]	Gauley & New River drainages.	**Absent, Gauley and New River drainages do not occur on FEF.**
Pearl dace	*Margariscus margarita*	G5/S3S4	Small, clear, cold streams; often near springs over fine gravel substrates [49]; frequently occupies bogs and ponds created by beaver dams.	In WV restricted to the Potomac and Monongahela Rivers; most abundant in Shavers Fork of the Cheat River and the two eastern-most tributaries of the Potomac River. [25]	**Absent, Potomac, Cheat, and Monongahela Rivers do not occur on FEF.**
New River shiner	*Notropis scabriceps*	G4/S2	Pools or slow runs in small or medium-sized streams, usually over bedrock or gravel substrates.	An endemic species with patchy distribution in the northern tributaries of the New River and definitely located	**Absent, New, Gauley,and Greenbrier River drainages do not**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
				within boundaries of the MNF. Has almost disappeared from the Gauley River drainages, but can still be found in the eastern tributaries. Is still fairly common in the Greenbrier River waters. [24, 25]	**include FEF.**
Cheat minnow	*Pararhinichthys bowseri*	G1G2/ S1S2(SOC)	Most often found in deep runs over gravel/rubble substrate. [20]	Found only in the Monongahela River drainages of the Ohio River Basin in WV and in waters on the Appalachian Plateau and Allegheny Mt. Provinces.	**Absent, Elklick not suitable habitat.**
Appalachia darter	*Percina gymnocephala*	G4/S3	Pools and runs of mid-sized to large streams and rivers.	New River, Greenbrier and Gauley Rivers, East Fork of the Greenbrier River and Laurel Creek, Gauley drainage. [25]	**Absent, Elklick not suitable habitat.**
Kanawha minnow	*Phenacobius teretulus*	G3G4/S1 (SOC)	Endemic to New (upper Kanawha) River drainage. Juveniles and adults typically occupy riffles and runs of gravel, rubble and boulder in cool to warm medium to large streams [49]. Apparently has a preference for soft water [19].	Upper Gauley River & New River tributaries. Pocahontas, Webster and Greenbrier Counties. May only inhabit the east and west forks of the Greenbrier River.	**Absent, Elklick not suitable habitat.**
Mollusks					
Elktoe	*Alasmidonta marginata*	G4/S2(SOC)	A freshwater mussel requiring a fish host. Typically found in smaller streams, but occurs in large to medium stream. Described as a riffle species that is found in swift current in firmly paced fine to course gravel. [51]	Present in Greenbrier River, Cloverlick down through Hosterman to the mouth of the Greenbrier and into the New River.	**Absent, Greenbrier and New River do not occur on FEF.**

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>Organ cavesnail</td><td>Fontigens tartarea</td><td>G2/S2</td><td>Small freshwater cave snail. Inhabits cave streams under flat rocks.[43] [30]
<table>
<tr><th>Cave</th><th>Owners hip</th><th>Quad</th></tr>
<tr><td>Bazzle</td><td>Private</td><td>Harman</td></tr>
<tr><td>Bowden</td><td>FS</td><td>Bowden</td></tr>
<tr><td>Bowden/Bear Heaven</td><td>FS</td><td>Bowden</td></tr>
<tr><td>Dreen</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Harper</td><td>Private</td><td>Mozark Mt.</td></tr>
<tr><td>Martha’s</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
<tr><td>Simmons-Mingo</td><td>Private</td><td>Mingo</td></tr>
</table></td><td></td><td>Absent, does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Green floater</td><td>Lasmigona subviridis</td><td>G3/S2(SOC)</td><td>Fine gravel and sand in backwater and slower water. Patchy occurrence in small to large rivers away from fast current and large boulders.</td><td>Currently in Greenbrier River & Clover Creek. Past record from New River drainage. Any Greenbrier River tributary is potential habitat. Two sites on west fork of Greenbrier above Durbin. From Cass south on Greenbrier is good potential. [14, 26]</td><td>Absent, Greenbrier River does not occur on FEF.</td></tr>
<tr><td colspan="6">Insects</td></tr>
</table>

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
A tiger beetle	*Cicindela ancocisconensis*	G3/S3	Habitat specialist. Prefers open sand or a matrix of sand and cobble along permanent streams or medium-sized rivers. Usually found along rocky mountain streams and small rivers in partially shaded areas such as sand banks and sand bars. Apparently prefers to breed in sandy loam and adults are usually on sandy patches. [51]	Known from South branch of the Potomac (Redman Run, Big Bend)), shirk gap, Elk River, and the Cheat bridge on the Shavers Fork. [52]	**Absent, Potomac River and Shavers Fork do not occur on FEF.**
Barren's tiger beetle	*Cicindela patruela*	G3/S2S3	Terrestrial habitats include: bare rock/talus and woodland-conifer, woodland-hardwood mix. Specialized to sandy/coarse gravel or eroding sandstone. Open mixed or deciduous (mainly oak) woodlands where open ground exists, such as along trails, outcrops or on ridge summit openings dominated by lichen and dry mosses.[51]	Known from North Fork Mountain Trail and Brushy Run Road in Onego. [52]	**Absent, North Fork Mountain Trail and Brushy Run Road do not occur on FEF.**
A cave beetle	*Pseudanophthalmus fuscus*	G2G3/S2	Usually near damp or wet places under rocks or rotting wood near cave streams. [35] [30]		**Absent, does not occur in Big Springs Cave on FEF.**

Cave	Ownership	Quad
Blue Springs	Private	Hillsboro
Bolling	Private	Denmar
Fox	Private	Droop
Higginbotham's	Private	Williamsburg
McClung	Private	Williamsburg
Piddling Pit	Private	Edray

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Timber Ridge cave beetle	*Pseudanophthalmus hadenoecus*	G1/S1	Twilight zone or deeper in caves; on moist soil, often near streams or drip areas. Probably do burrow some; often found under rocks or debris. [31]	Occurs in Mystic Cave, Pendleton Co., Onego Quad (right on Proclamation Boundary). [30]	**Absent, beetle does not occur in Big Springs Cave on FEF.**
A cave beetle	*Pseudanophthalmus hypertrichosis*	G3/S3	Damp clay banks in caves. [43] [30]		**Absent, beetle does not occur in Big Springs Cave on FEF.**

Cave	Ownership	Quad
Arbuckle	Private	Lewisburg
Blue Springs	Private	Hillsboro
Bolling	Private	Denmar
Cass	Private	Cass
Crawford#1	Private	Valley Head
Devils Kitchen	Private	Mingo
Dreen	Private	Mingo
Friels	Private	Hillsboro
Grimes	Private	Cass
Linwood	Private	Mingo
Martens	Private	Lobelia
Martha's	Private	Hillsboro
McClung	Private	Williamsburg
Piddling Pit	Private	Edray
Simmons-Mingo	Private	Mingo
Simmons-Mingo	Private	Mingo
Tub	Private	Hillsboro

Dry Fork Valley cave beetle	*Pseudanophthalmus montanus*	G1/S1(SOC)	Twilight zone or deeper in selected caves, in or on moist soil, often near streams or drip areas, often under rocks or debris.	Known from only four WV caves in Tucker and Randolph Co. The only MNF cave is Cave Hollow/Arbogast Cave, Tucker Co.[30]	**Absent, beetle does not occur in Big Springs Cave on FEF.**
A beetle	*Pseudanophthalmu*	G1/S1		Bowden cave [52]	**Absent, beetle**

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>(unnamed)</td><td>s sp. 2</td><td></td><td></td><td></td><td>does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Gandy Creek cave springtail</td><td>Pseudosinella certa</td><td>G1/S1</td><td>Clay banks, damp places on or near organic debris in caves. [33]</td><td>Occurs within 5 miles of the Proclamation Boundary in Stillhouse Cave, Randolph Co., Sinks of Gandy quad.[30]</td><td>Absent, springtail does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>A springtail</td><td>Pseudosinella gisini</td><td>G3G4/S3</td><td>Found in damp places on or near bits of organic material in caves. [33] [30]
<table>
<tr><th>Cave</th><th>Owners hip</th><th>Quad</th></tr>
<tr><td>Allison</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Arbuckle</td><td>Private</td><td>Lewisburg</td></tr>
<tr><td>Buckeye Creek</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Clyde Cochrane Sinks</td><td>Private</td><td>Droop</td></tr>
<tr><td>Friars Hole</td><td>Private</td><td>Droop</td></tr>
<tr><td>Friels</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Fuells Fruit</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Grimes</td><td>Private</td><td>Cass</td></tr>
<tr><td>Higginbotham’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Ludington</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>McClung</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>My Cave</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
<tr><td>Rapp’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>The Hole</td><td>Private</td><td>Anthony</td></tr>
<tr><td>Tub</td><td>Private</td><td>Hillsboro</td></tr>
</table></td><td>Absent, springtail does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Appalachian Grizzled skipper</td><td>Pyrgus wyandot</td><td>G2/S1</td><td>Shale barrens, pastures and powerlines on south to west facing shale slopes always with much bare rock or soil. [51] Distribution based on available natural heritage records from Greenbrier, Hampshire, Hardy, Kanawha, Mineral and Pendleton counties. Greenbrier Mountain [52]</td><td></td><td>Absent, FEF does not contain shale barrens.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>A springtail</td><td>Sinella agna</td><td>G2G3/S1</td><td>Damp places in caves on or near bits of organic material. [33] [30]
<table>
<tr><th>Cave</th><th>Ownership</th><th>Quad</th></tr>
<tr><td>Dreen</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Harper</td><td>Private</td><td>Mozark Mt.</td></tr>
<tr><td>Just</td><td>Private</td><td>Mingo</td></tr>
<tr><td>My Cave</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
</table></td><td></td><td>Absent, springtail doe not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Diana fritillary</td><td>Speyeria diana</td><td>G3/S2S3</td><td>Inhabits mountainous areas in WV; prefers moist and well-shaded forest covers with rich soils; utilizes small openings and roadsides in search of nectar plants but will not stray far from woods; usually found nectaring along woodland edges. Nectar sources: milkweeds, thistles, butterfly weed, wild bergamot, Joe-pye-weed and ironweed. Larval host – woodland violets. [37]</td><td>Found in the southern third of the state, south from lower Pocahontas Co., and west to Kanawha and Lincoln Co.; may also occur occasionally in other surrounding counties, as well as the southern counties, with no records to date.[37]</td><td>Absent, FEF occurs north of known distribution.</td></tr>
<tr><td colspan="6">Invertebrates</td></tr>
<tr><td>Dry Fork Valley cave pseudoscorpion</td><td>Apochthonius paucispinosus</td><td>G1/S1</td><td>Damp leaf litter in caves</td><td>Bennett Cave, Mozark Mountain Quad, Tucker Co. (within Proclamation Boundary) [30]</td><td>Absent, does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Cheat Valley Cave Isopod</td><td>Caecidotea cannula</td><td>G2/S1(SOC)</td><td>Found under flat rocks in subterranean streams and pools in caves. May also be found in springs flowing out of caves.</td><td>Only known to occur in southern Tucker and northern Randolph Counties. MNF caves are Bowden cave* and Cave Hollow/Arbogast cave.</td><td>Absent, does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Greenbrier Valley cave isopod</td><td>Caecidotea holsingeri</td><td>G3/S3</td><td>The most common and widespread troglobitic isopod in WV. In cave stream gravel, under rocks, on decaying wood in streams, and</td><td>Only known to occur in Bowden cave* on National Forest Land, Randolph Co.</td><td>Absent, does not occur in Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td></td><td></td><td></td><td>occasionally in drip pools.</td><td></td><td></td></tr>
<tr><td>An isopod</td><td>Caecidotea simonini</td><td>G1/S1</td><td colspan="2"><table><tr><th>Cave</th><th>Ownership</th><th>Quad</th></tr><tr><td>Flower Pot</td><td>Private</td><td>Whitmer</td></tr><tr><td>Stillhouse</td><td>Private</td><td>Sinks of Gandy</td></tr></table>Cavepools. [33, 30]</td><td>Absent, isopod does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>An isopod</td><td>Caecidotea sinuncus</td><td>G1/S1</td><td>Under flat rocks in cave streams [33]</td><td>Within Proclamation Boundary, Blowhole, Keel spring, and Mystic caves, Onego Quad, Pendleton Co. [30]</td><td>Absent, isopod does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>An Underground crayfish</td><td>Cambarus nerterius</td><td>G2G3/S1</td><td colspan="2">WV’s only cave crayfish. Generally in subterranean streams, but small specimens have been collected from dry streambeds (but nearly saturated humidity). [28, 29, 30]<table><tr><th>Cave</th><th>Ownership</th><th>Quad</th></tr><tr><td>Buckeye Creek</td><td>Private</td><td>Williamsburg</td></tr><tr><td>Clyde Cochrane Sinks</td><td>Private</td><td>Droop</td></tr><tr><td>Ludington</td><td>Private</td><td>Williamsburg</td></tr><tr><td>Matt’s Black</td><td>Private</td><td>Williamsburg</td></tr><tr><td>McClung</td><td>Private</td><td>Williamsburg</td></tr><tr><td>My Cave</td><td>Private</td><td>Mingo</td></tr></table></td><td>Absent, crayfish does not occur in Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>Hoffmaster's cave flatworm</td><td>Macrocotyla hoffmasteri</td><td>G2G3/S3</td><td colspan="2">In first order and small second order streams of caves. [27] [30]
<table>
<tr><th>Cave</th><th>Ownership</th><th>Quad</th></tr>
<tr><td>Bazzle</td><td>Private</td><td>Harman</td></tr>
<tr><td>Harper</td><td>Private</td><td>Mozark Mt</td></tr>
<tr><td>Levisay</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>McClung</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Mystic</td><td>Private</td><td>Onego</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
</table></td><td>Absent, flatworm does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>A cave obligate planarian</td><td>Phagocata angusta</td><td>G1G3/SU</td><td>A sub-aquatic, subterranean obligate.</td><td>WV Heritage records from Harper Cave, Tucker Co. [52,51]</td><td>Absent, planarian does not occur Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>Greenbrier Valley cave millipede</td><td>Pseudotremia fulgida</td><td>G2G3/S2</td><td colspan="2">Mud/clay banks in caves; sometimes associated with organic debris.
30
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Allison’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Arbuckle</td><td>Private</td><td>Lewisburg</td></tr>
<tr><td>Blue Springs</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Clyde Cochrane Sinks</td><td>Private</td><td>Droop</td></tr>
<tr><td>Durbin</td><td>Private</td><td>Durbin</td></tr>
<tr><td>Friars Hole</td><td>Private</td><td>Droop</td></tr>
<tr><td>Friels</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Higginbotham’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Hughes Creek</td><td>Private</td><td>Lobelia</td></tr>
<tr><td>Ludington</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Martha’s</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>McClung</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Overholt Blowing</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
<tr><td>Poor Farm</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>Poor Farm</td><td>Private</td><td>Denmar</td></tr>
<tr><td>Rapp’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Steam</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>The Hole</td><td>Private</td><td>Anthony</td></tr>
</table></td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Germany Valley cave millipede</td><td>Pseudotremia lusciosa</td><td>G1/S1</td><td colspan="2">Mud/clay banks in caves; sometimes associated with organic debris. [33]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Hell Hole</td><td>Private</td><td>Onego</td></tr>
<tr><td>Schoolhouse</td><td>Private</td><td>Upper Tract</td></tr>
<tr><td>Seneca Caverns</td><td>Private</td><td>Onego</td></tr>
<tr><td>Stratosphere Balloon</td><td>Private</td><td>Onego</td></tr>
</table>
30</td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>South Branch Valley cave millipede</td><td>Pseudotremia princeps</td><td>G1/S1</td><td>Mud/clay banks in caves; sometimes associated with organic debris.[33] [30]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Kenny Simmons</td><td>Private</td><td>Moatstown</td></tr>
<tr><td>Mystic</td><td>Private</td><td>Onego</td></tr>
<tr><td>Peacock</td><td>Private</td><td>Petersburg</td></tr>
<tr><td>Smoke hole</td><td>Private</td><td>Upper Tract</td></tr>
</table></td><td></td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Culver’s planarian</td><td>Sphalloplana culveri</td><td>G1/S1</td><td>In small streams under rocks and pieces of wood in caves. [33]</td><td>Within Proclamation Boundary in Harper Cave, Mozark Mt. Quad, Tucker Co. [30]</td><td>Absent, planarian does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Culver’s cave isopod</td><td>Stygobromus culveri</td><td>G1G2/S1</td><td>Seep and drip pools or in small streams in caves. [33, 30]
<table>
<tr><th>Cave</th><th>Owners hip</th><th>Quad</th></tr>
<tr><td>Flower Pot</td><td>Private</td><td>Whitmer</td></tr>
<tr><td>Red Run</td><td>FS</td><td>Mozark Mountain</td></tr>
<tr><td>Stillhouse</td><td>Private</td><td>Sinks of Gandy</td></tr>
</table></td><td></td><td>Absent, does not occur in Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>Greenbrier cave amphipod</td><td>Stygobromus emarginatus</td><td>G3/S3</td><td>In caves under gravel in streambeds and occasionally in pools. Most abundant in smallest trickles of water. Primarily in tiny first and second order headwater cave streams. [27, 35]
[30]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Bazzle</td><td>Private</td><td>Harman</td></tr>
<tr><td>Big Springs</td><td>FS</td><td>Parsons</td></tr>
<tr><td>Bonner Pit</td><td>Private</td><td>Mozark Mtn</td></tr>
<tr><td>Bowden</td><td>FS</td><td>Bowden</td></tr>
<tr><td>Clay Pit</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Dreen</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Flower Pot</td><td>Private</td><td>Whitmer</td></tr>
<tr><td>Harper</td><td>Private</td><td>Mozark Mtn</td></tr>
<tr><td>Levisay</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Linwood</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Martha’s</td><td>Private</td><td>Hillsboro</td></tr>
<tr><td>My Cave</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
<tr><td>Poor Farm</td><td>Private</td><td>Denmar</td></tr>
<tr><td>Rapp’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Sharps</td><td>Private</td><td>Mingo</td></tr>
<tr><td>The Hole</td><td>Private</td><td>Anthony</td></tr>
<tr><td>Upper Martha’s</td><td>Private</td><td>Hillsboro</td></tr>
</table></td><td></td><td>Present.</td></tr>
<tr><td>Pocahontas cave amphipod</td><td>Stygobromus nanus</td><td>G1/S1</td><td>Mud bottoms of small streams and seep pools in caves.[33]</td><td>Occurs within Proclamation Boundary in Pocahontas Co., Edray Quad – Piddling Pit cave. [30]</td><td>Absent, amphipod does not occur in Big Springs Cave on FEF.</td></tr>
</table>

<table>
<tr><th></th><th>Scientific Name</th><th>Species Rank</th><th>Habitat</th><th>MNF Range</th><th>Likelihood of Occurrence</th></tr>
<tr><td>Minute cave amphipod</td><td>Stygobromus parvus</td><td>G1G2/S1</td><td>Found in mud-bottomed, drip and seep pools in caves; tolerant of substrate, but prefers standing water.[34,30]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Bonner</td><td>Private</td><td>Mozark Mt.</td></tr>
<tr><td>Cassell</td><td>Private</td><td>Cass</td></tr>
<tr><td>Crawford #2</td><td>Private</td><td>Valley Head</td></tr>
<tr><td>Piddling Pit</td><td>Private</td><td>Edray</td></tr>
</table></td><td></td><td>Absent, amphipod does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>WV blind cave millipede</td><td>Trichopetalum krekeleri</td><td>G1/S1</td><td>In selected caves, under rocks, around organic debris or on damp silt banks near streams.</td><td>Known from only 5 WV caves. The only MNF cave is Bowden cave*, Randolph Co.</td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Grand Caverns blind cave millipede</td><td>Trichopetalum weyeriensis</td><td>G3Q/S2</td><td>Damp areas in caves on organic debris.[33, 30]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Arbuckle</td><td>Private</td><td>Lewisburg</td></tr>
<tr><td>Cass</td><td>Private</td><td>Cass</td></tr>
<tr><td>Dreen</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Higginbotham’s</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>Kenny Simmons</td><td>Private</td><td>Moatstown</td></tr>
<tr><td>Linwood</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Ludington</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>McClung</td><td>Private</td><td>Williamsburg</td></tr>
<tr><td>My Cave</td><td>Private</td><td>Mingo</td></tr>
<tr><td>Mystic</td><td>Private</td><td>Onego</td></tr>
<tr><td>The Hole</td><td>Private</td><td>Anthony</td></tr>
</table></td><td></td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
<tr><td>Luray Caverns blind cave millipede</td><td>Trichopetalum whitei</td><td>G2G3Q/S1</td><td>Damp areas in caves on or near organic debris.[33,30]
<table>
<tr><th>Cave</th><th>Own.</th><th>Quad</th></tr>
<tr><td>Hellhole</td><td>Private</td><td>Onego</td></tr>
<tr><td>Stratosphere Balloon</td><td>Private</td><td>Onego</td></tr>
<tr><td>Trout</td><td>Private</td><td>Sugar Grove</td></tr>
</table></td><td></td><td>Absent, millipede does not occur in Big Springs Cave on FEF.</td></tr>
</table>

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Plants					
Fraser fir	*Abies fraseri*	G2	Coniferous tree, generally found above 4500'.	Known from Blister Run, and Beaverdam Run, Randolph Co. According to Heritage Program records, is not native to WV. All known sites in WV are planted.[36]	**Absent, elevations above 4500 ft. do not occur on FEF.**
White monkshood	*Aconitum reclinatum*	G3/S3	Perennial herb found in mesic northern hardwood forests with acidic bedrock, 2500-4000' elev. Common on NE aspects, especially in coves. In wet but not flooded soil in partial shade, often in a seep at the edge of a road or river where the soil has been worn away (e.g. clay content) by the water moving down the hill. Also along high elevation roads. Most commonly on Cateache soils with Mauch Chunk geology.	Gay Knob Area (Edray), Chestnut Ridge (Paddy Knob), Spruce Knob Roadside 112 (Spruce Knob), & side slope of Laurel Run (Sharp Knob); occurs in Pocahontas, Randolph, Preston, Pendleton, Grant and Tucker Co.	**Present.**
Arctic bentgrass	*Agrostis mertensii*	G5/S1	Open riparian at high elevations. Peaty or rocky soil. [38,46,47]	Known along the upper Shavers Fork above Cheat Bridge on the Mower tract. [30]	**Absent, FEF does not contain high elevation, peaty soil.**
Lillydale onion	*Allium oxyphilum*	G2Q/S2	Odiferous herb with bulb; endemic to acidic shale or sandstone geology mainly on shale barrens.	Found in White Sulphur Springs, & Greenbrier, Pendleton, & Grant Co.	**Absent, FEF does not contain shale barrens.**
Spreading rockcress	*Arabis patens*	G3/S2	Moist, rocky woods, limestone outcrops and shady riverbanks	In the Eastern panhandle; Jordan Run Road, Grant Co.; "Dry Trough" Hampshire Co.; Wardensville, Hardy Co.; and Terrapin Neck, Jeff. Co.	**Absent, FEF is not occur in Eastern panhandle.**
Cooper's milkvetch	*Astragalus neglectus*	G4/S1	Annual herb found on drier, limestone-based soils in the eastern part of the state.	Only known site is on Cave Mt., Grant Co., in what is considered a prairie extant	**Absent, FEF does not contain prairie habitat.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
				community	
Lance-leaf grapefern	*Botrychium lanceolatum v. angustisegmentum*	G5T4/S1	Subarctic and boreal plant of mountain slopes and meadows. Occurs in moist shady woods and margins of swamps. [47]	Collected in Greenbrier, Pocahontas, Preston, Randolph, and Upshur Co. [38]	**Absent, FEF does not contain boreal or subarctic habitat.**
Blunt-lobed Grapefern	*Botrychium oneidense*	G4Q/S1	Mostly occurs in low, wet, acid, secondary woods and swamps.[51]		**Absent, FEF does not contain acidic wet woods or swamps.**
Showy lady's slipper	*Cypripedium reginae*	G4/S1	June-Sept. Low, downy, perennial herb occurring in swamps and woods	Rare in WV, known to occur on MNF only near White Sulphur Springs, Greenbrier Co. [38]	**Absent, FEF is not located in Greenbrier co. and does not contain swamps.**
Tall larkspur	*Delphinium exaltatum*	G3/S2(SOC)	Perennial herb found in open limestone woods, mainly in the mountains in the eastern part of the state.	Found at Smokehole in Pendleton Co., Hardy and Greenbrier Co.	**Absent, FEF does not contain dry, limestone woods.**
Yellow buckwheat	*Eriogonum allenii*	G4/S2	Perennial herb found on the most sterile and barest of sites on shale barrens.	Greenbrier Co.; Ugly Mt., Pendleton Co.	**Absent, FEF does not contain shale barrens.**
Darlington's spurge	*Euphorbia purpurea*	G3/S2(SOC)	Annual herb with milky juice found in mountain glades and swampy woods (particularly where 2 river points come together, e.g. where Warner Run flows into Gandy Creek). Possibly mountain bogs, riparian areas. Moist to saturated soils.	Known from Blister Swamp, Pocahontas Co.; Terra Alta, Preston Co.; Laurel Fork, Randolph Co.; Tucker Co.; Canaan Valley, Laurel Fork Wilderness (N&S), McGowan Mt., Cunningham Knob, Yokum Knob, Narrow Ridge, Blue Knob (Cranberry Glades Bog Area).	**Absent, FEF does not contain swampy woods.**
Box huckleberry	*Gaylussacia brachycera*	G3/S2	Smooth shrub found in acidic sandy soil within submesic forests & on	Largest population on border of GWNF and MNF in the	**Absent, FEF does not contain sandy**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			woodland slopes. Under hardwoods, with mixed pine, mt. laurel & other heaths in understory.	eastern part of the state. In Greenbrier & Pocahontas Co., North Fork Mt., Redman Run Trail & Smokehole.	**soils.**
Appalachian oak fern	*Gymnocarpium appalachianum*	G3/S1	Primarily occurs in rocky maple-birch-hemlock woods on mountain slopes and summits, on moist sandstone, talus slopes or bouldery colluvium. Requires a cool, moist microclimate and typically occurs on north-facing slopes with cold air seepage at elevations above 2,000 ft.; occasionally at lower elevations, particularly on the fringes of its range. [39]	Endemic to the Appalachian region, most common in Virginia (the center of its range), where it occurs at 30-100 localities. Pendleton Co. [30]	**Absent, FEF is at the periphery of this species range, microhabitat on FEF not suitable for this species.**
Sweet-scented Indian plantain	*Hasteola suaveolens*	G3/S2		Found near Otter Creek cabin [52]	**Absent, not found during botanical surveys on FEF.**
White alumroot	*Heuchera alba*	G2Q/S2	Erect perennial herb found in dry, open woods in the eastern part of the state. Found on sandy soils with Tuscarora sandstone (e.g. North Fork Mt.), on rock outcrops within the woods (Gay Knob, Edray Quad) & on rock outcrops on roadside (Rd. 112, Spruce Knob, Pendleton Co.).	Found in higher elevations of North Fork Mt., Grant Co.; Spruce Knob, Pendleton Co.; Crouch Knob, Randolph Co.; Cass, Pocahontas Co	**Absent, FEF does not contain sandy soils or rock outcrops.**
Crested coralroot	*Hexalectris spicata*	G5/T4T5/S1	July-Aug. A leafless herb occurring in rich woods.	Smoke Hole, Pendleton Co.; approaching the northern limit of its range. [38]	**Absent, FEF is outside of range.**
Blue Ridge St. John's wort	*Hypericum mitchellianum*	G3/S1		Found near Cheat bridge. [52]	**Absent, FEF does not contain river banks.**
Long-stalked holly	*Ilex collina*	G3/S3	Deciduous shrub or tree found in riparian areas along high-energy	Selected sites on Cheat, Greenbrier and Gauley RDs.	**Absent, FEF does not contain high-**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			streamsides at higher elevations. Moist soil; wet meadows and bogs.	Along Gauley and Cranberry Rivers.	**energy streamsides.**
Butternut	*Juglans cinerea*	G3G4/S3 (SOC)	Deciduous shade-intolerant tree found in rich loamy soils, mixed hardwood forests, shade intolerant, regeneration in open fields, riparian zones, along ridges, or in edge habitat. Found in association with hawthorn on Greenbrier River shoreline in Greenbrier Co.	From valley to 3200'. Along streams (Laurel & Shavers Forks), & near the Gay Knob area (USFS Road 201) of Randolph Co.; also found in similar areas in adjacent counties. Also found on Landis Trail of North Fork Mt., Pendleton Co., and in Webster Co.	**Present.**
Thread rush	*Juncus filiformis*	G5/S2	June-Aug. Perennial grass-like herb occurring in bogs	Canaan Valley, elev. 3,000', Tucker Co.; and near Cheat Bridge, Randolph Co. – the southernmost known localities for this species. [38]	**Absent, FEF does not contain bogs.**
Highland rush	*Juncus trifidus*	G5/S1	Rock crevices and alpine meadows.[47]	Known only from the rocky cliff tops on North Fork Mountain. Global range is Europe and NE America south to mtns. of Virginia and North Carolina. [30, 46]	**Absent, FEF does not contain alpine meadows or rocky cliff tops.**
Turgid gay feather	*Liatris turgida*	G3/S2	Erect perennial herb in xeric environments associated with clay soils, gravel, shale barrens, & rocky outcrops; can also colonize road cuts. Occurs in shale barrens in WV. Associates include mt. laurel, black gum, red pine, chestnut oak, & sassafras.	(E.g. Slaty Fork TNC Reserve in Monroe Co.) & along roadside (McDowell Co.) White Sulphur Springs, Greenbrier, & Nicholas Co.	**Absent, FEF does not contain xeric sites.**
Large-flowered Barbara's buttons	*Marshallia grandiflora*	G2/S2(SOC)	Smooth perennial aster found on sandy or rocky river banks of larger (3rd to 4th order) streams in	Along the western slopes of Alleghenies. Shaver's Mt., Cheat Mt., Hopkin's Mt.,	**Absent, FEF does not contain river banks.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
			mountains. Requires hydrology of flood-scouring and full sun, with little competition. Also found in bedrock crevices and sparsely vegetated shores with small stones.	Shaver's Fork, Cherry River, Horse Ridge, Gun Powder Ridge, Huttonsville; Blue Bend (Greenbrier Co.), along lower Gauley River, Nicholas Co.; Cheat River, Preston Co.	
Bog buckbean	*Menyanthes trifoliata*	G5/S1	April-June. Smooth, perennial marsh herb occurring in bogs and marshy places.	Backbone Mt., Tucker Co.; Cranberry Glades, Pocahontas Co.; historic site at Cranesville, Preston Co. [38]	**Absent, FEF does not contain bogs or marshes.**
Smokehole bergamot	*Monarda fistulosa v. brevis*	G5T1/S1(SOC)	Perennial, aromatic herb found only on limestone-derived communities of Cave Mt. ecosystem including the south branch of Potomac side slopes, cedar glades and rock outcrops.	Cave Mountain	**Absent, FEF is outside known distribution.**
Canada Mountain rice grass	*Oryzopsis canadensis = Piptatherum canadense*	G5/S1	June-July. A perennial grass occurring on sandy barrens	Summit of Panther Knob, Pendleton Co., elev. 4,500', the southernmost station known for the species. [38]	**Absent, FEF does not contain sandy barrens.**
Silver Nailwort	*Paronychia argyrocoma*	G4/S3	July-Sept. Low perennial herb occurring on White Medina sandstone	New Creek Mt., Grant Co.; Lost River State Park, Hardy Co.; Seneca Rocks, North Fork Mt., Pendleton Co. [38]	**Absent, FEF does not contain White Medina sandstone.**
Yellow nailwort	*Paronychia virginica v. virginica*	G4/S1(SOC)	Perennial mat-like, wiry plant found on limestone-based rocky cliffs, sandstone banks, crevices along riverbanks, & cedar glades.	Cave Mtn., Eagle Rock & Ship Rock in the Smokehole, Pendleton Co.	**Absent, FEF does not contain cliffs, banks, or cedar glades.**
Canby's Mountain lover	*Paxistima canbyi*	G2/S2(SOC)	Low evergreen shrub found in dry open woods. Calcareous rocks and slopes in the mountains.	Found only in Potomac and New-Kanawha watersheds in Grant, Pendleton and Greenbrier Co.	**Absent, FEF is outside known distribution.**
Swamp lousewort	*Pedicularis lanceolata*	G5/S2	Aug.-Oct. Herb occurring in swampy places, often calcareous.	Altona Marsh, Jefferson Co.; Buckeye, Dunmore & Minnehaha Springs,	**Absent, FEF does not contain swampy habitat.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
				Pocahontas Co.; Sweet Springs, Monroe Co.; near Elkins, Randolph Co. – only known colonies in state. [38]	
Sword-leaved phlox	*Phlox buckleyi*	G2/S2	Perennial herb found on shale slopes in eastern woods. Road banks, open woods.	E. Pocahontas Co. near WV55 and WV39, and in Greenbrier Co.	**Absent, FEF does not contain shale slopes.**
Jacob's ladder	*Polemonium van-bruntiae*	G3/S2	Perennial herb found in swamps and sphagnum bogs and along riparian zones at higher elevations.	Pocahontas and Preston Co. Southernmost population in Cranberry Glades bog. Also, in Canaan Valley, Tucker Co.	**Absent, FEF does not contain swamps or bogs.**
Tennessee pondweed	*Potamogeton tennesseensis*	G2/S1	Aquatic herb found in standing or slow-flowing shallows of rivers.	Greenbrier, Pocahontas, Preston, and Webster Co.	**Absent, FEF does not contain any rivers.**
Rock skullcap	*Scutellaria saxatilis*	G3/S2	Perennial herb found on wooded rocky hillsides, moist cliffs, 2,500+'; talus slopes/bluffs; moist openings such as riverbanks or talus.	Greenbrier, Pocahontas & Tucker Co.	**Absent, FEF does not contain rocky cliffs, slopes, or bluffs.**
Robust fire pink	*Silene virginica v. robusta*	G5T1Q/S1 (SOC)	Narrow endemic perennial herb in dry open woods or riparian areas of Smokehole Rec. Area. Associated with limestone.	Petersburg Gap in Grant and Pendleton Co.	**Absent, FEF does not contain dry limestone habitat.**
Ammon's tortula	*Syntrichia ammonsiana*	G1/S1(SOC)	Moss found on wet, cool rock outcrops on cliff overhangs adjacent to waterfalls. Sandstone walls.	Falls of Hills Creek, Pocahontas Co. [40]	**Absent, FEF does not contain waterfalls.**
Appalachian bristle fern	*Trichomanes boschianum*	G4/S1	Delicate fern occurring on dripping rocks. The gametophytes will probably be found in deep shaded recesses of sandstone and quartzite rocks. In the Appalachians it is more common and widespread than the sporophyte, but is overlooked because it resembles a filamentous alga.	Kanawha State Forest, Kanawha Co.; Webster Springs, Webster Co. This represents a northeastern extension of the range of this species. [38]	**Absent, FEF occurs outside of known range.**

	Scientific Name	Species Rank	Habitat	MNF Range	Likelihood of Occurrence
Kate's Mountain clover	*Trifolium virginicum*	G3/S3	Perennial, non-stoloniferous clover found on south-facing slopes of very sterile shale barrens and in dry-shale soils.	Eastern portion of the MNF including: Kate's Mt., Greenbrier Co.; Smokehole (above Big Bend campground); Hardy, Nicholas (Devonian shale's), Pendleton Co.	**Absent, FEF does not contain shale habitat.**
Nodding pogonia	*Triphora trianthophora*	G3G4/S2	Aug.-Sept. Rich woods, infrequent.	Fernow Experimental Forest, Tucker Co.; Short Creek, Fayette Co.; Spring Hill, Kanawha Co.; Mt. Lookout, Nicholas Co.; French Creek, Upshur Co.; and Holly River State Park, Webster Co.[38]	**Present.**
Appalachian blue violet	*Viola appalachiensis*	G3/S2S3	Short perennial stoloniferous herb (mat-forming). Moist floodplains of high-energy streams, alluvial pond shores, old logging roads, and old mounds of up-rooted cherry trees.	Found on all districts. Grant, Hardy, Nicholas, Pendleton, Pocahontas, Preston, Randolph, Tucker, and Webster Co.	**Absent, moist floodplains and similar habitat does not occur on FEF; not found in previous botanical surveys.**
Sand grape	*Vitis rupestris*	G3/S1	Brushy, shrub-like grape found climbing on calcareous or gravelly banks, river bottoms, streambeds, washes, and scoured boulders and cobbles.	Found in Grant, Greenbrier, Pendleton and Preston Co	**Absent, FEF does not contain river streambed habitat.**
Netted chain fern	*Woodwardia areolata*	G5/S1	Large fern occurring in swamps and wet woods, chiefly in acid soil.	In WV, known only from Clay, Greenbrier, Mineral, Nicholas, Pocahontas, and Upshur counties.	**Absent, FEF does not contain swamps or wet woods.**

Species Rank: US ESA Status/Global Heritage Status/National Conservation Status/ State Status

ESA Status: LE: Legally Endangered
LT: Legally Threatened

Global Heritage Status: G: Global conservation
T: Subspecies, varieties and populations

Global Status		**State Conservation Status**	
GX or TX	Presumed Extinct	SX	Presumed Extirpated
GH or TH	Historical	SH	Historical
G1 or T1	Critically Imperiled	S1	Critically Imperiled
G2 or T2	Imperiled	S2	Imperiled
G3 or T3	Vulnerable	S3	Vulnerable
G4 or t4	Apparently Secure	S4	Apparently Secure
G5 or t5	Secure	S5	Secure
GU or TU	Unrankable	SZ	Zero Occurrences
G? or T?	Not Yet Ranked	SU	Unrankable
		SR	Reported
		S?	Not yet ranked
		B	Breeding
		N	Non-breeding

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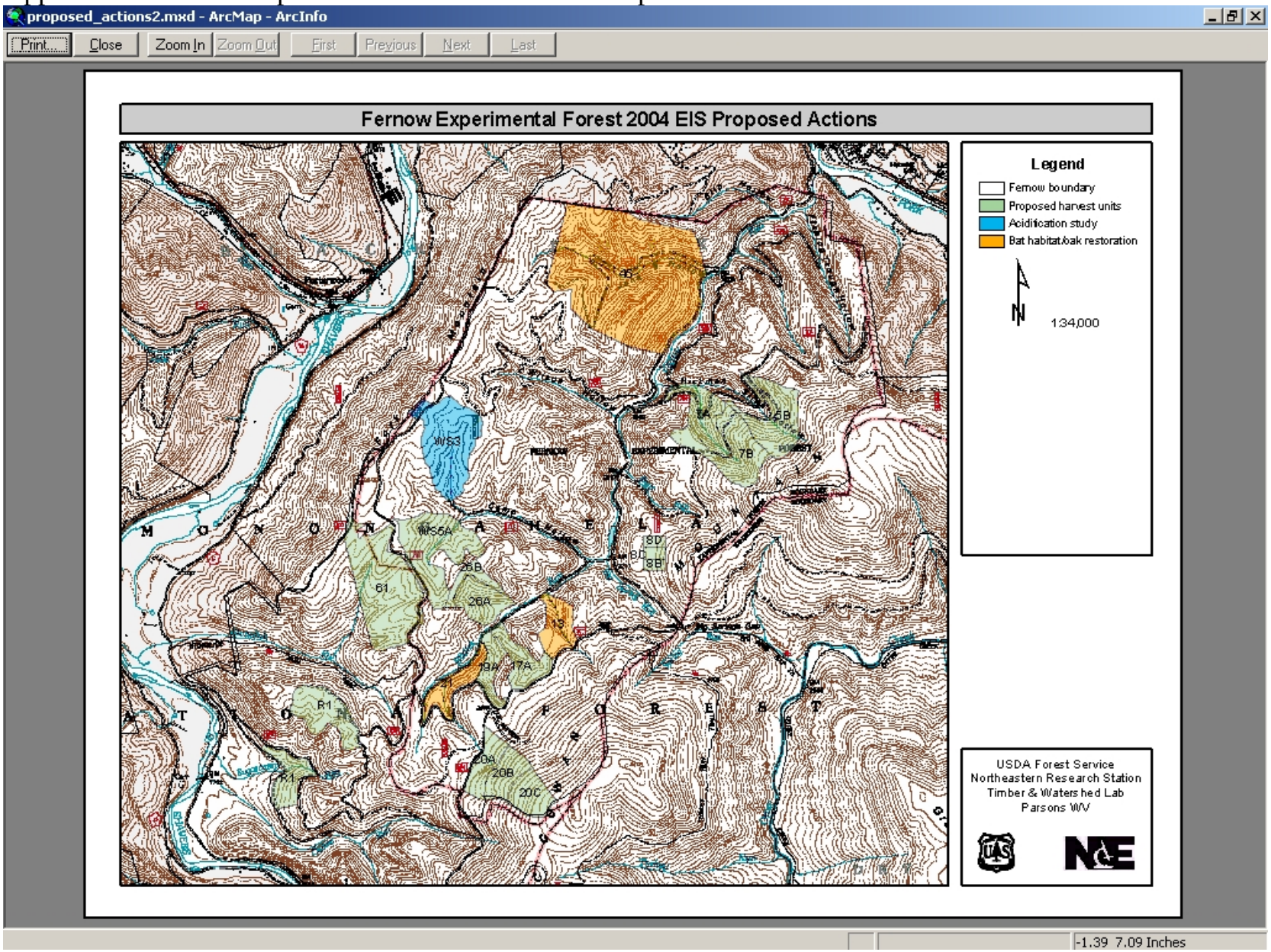
Vertebrate Species of Concern in WV: Green salamander, page 41A; Northern goshawk, page 69A; Bald eagle, page 72A; Peregrine falcon, page 73A; Small-footed myotis, page 91A; Virginia Big-eared bat, page 95A.

Appendix 2: Big Springs Cave winter bat surveys, Fernow Experimental Forest.

Date	Species	#Bats
Winter 1952	*Myotis sodalis*	~ 150
Winter 1953	*Myotis sodalis*	119
Winter 1972	*Myotis sodalis*	~130-150
January 1973	*Myotis lucifugus*	unknown
January 1973	*Myotis septentrionalis*	unknown
January 1973	*Myotis sodalis*	unknown
January 1973	*Pipistrellus subflavus*	unknown
December 1973	*Myotis sodalis*	~130-150
January 1976	*Myotis sodalis*	~150
March 1982	*Myotis sodalis*	~150
March 3, 1984	*Myotis lucifugus*	208
March 3, 1984	*Myotis septentrionalis*	2
March 3, 1984	*Myotis sodalis*	77
March 3, 1984	*Pipistrellus subflavus*	5
March 24, 1984	*Myotis sodalis*	5
January 1985	*Myotis lucifugus*	147
January 1985	*Myotis sodalis*	78
January 1985	*Pipistrellus subflavus*	5
January 1987	*Myotis lucifugus*	164
January 1987	*Myotis sodalis*	82
January 1987	*Pipistrellus subflavus*	21
January 1989	*Myotis lucifugus*	355
January 1989	*Myotis sodalis*	77
January 1989	*Pipistrellus subflavus*	26
January 1991	*Myotis lucifugus*	879
January 1991	*Myotis septentrionalis*	3
January 1991	*Myotis sodalis*	112
January 1991	*Pipistrellus subflavus*	96
January 1993	*Myotis lucifugus*	634
January 1993	*Myotis sodalis*	176
January 1993	*Pipistrellus subflavus*	42
January 1995	*Myotis leibii*	1
January 1995	*Myotis lucifugus*	778
January 1995	*Myotis septentrionalis*	3
January 1995	*Myotis sodalis*	254
January 1995	*Pipistrellus subflavus*	95
February 2, 1996	*Pipistrellus subflavus*	146
February 23, 1996	*Myotis lucifugus*	652
February 23, 1996	*Myotis septentrionalis*	9
February 23, 1996	*Myotis sodalis*	183
February 23, 1996	*Pipistrellus subflavus*	146
February 1997	*Myotis leibii*	1
February 1997	*Myotis lucifugus*	687
February 1997	*Myotis septentrionalis*	3

Date	Species	#Bats
February 1997	*Myotis sodalis*	200
February 1997	*Pipistrellus subflavus*	96
January 1999	*Myotis lucifugus*	788
January 1999	*Myotis septentrionalis*	1
January 1999	*Myotis sodalis*	210
January 1999	*Pipistrellus subflavus*	79
December 2000	*Myotis lucifugus*	354
December 2000	*Myotis septentrionalis*	4
December 2000	*Myotis sodalis*	240
December 2000	*Pipistrellus subflavus*	57
January 2003	*Myotis lucifugus*	769
January 2003	*Myotis septentrionalis*	1
January 2003	*Myotis sodalis*	199
January 2003	*Pipistrellus subflavus*	58
January 2003	*Corynorhinus townsendii virginiaus*	2

Appendix 3. Fernow Experimental Forest 2004 EIS Proposed Actions.



Appendix 4: Summer and fall bat surveys by mist net and harp traps, Fernow Experimental Forest.

Date	Species	#Bats
April-November 1995	*Corynorhinus townsendii*	1
April-November 1995	*Eptesicus fuscus*	18
April-November 1995	*Lasionycteris noctivagans*	4
April-November 1995	*Lasiurus borealis*	51
April-November 1995	*Lasiurus cinereus*	4
April-November 1995	*Myotis lucifugus*	363
April-November 1995	*Myotis septentrionalis*	307
April-November 1995	*Myotis sodalis*	69 (only males in June & July)
April-November 1995	*Pipistrellus subflavus*	237
September 1996	*Eptesicus fuscus*	1
September 1996	*Lasionycteris noctivagans*	1
September 1996	*Lasiurus borealis*	5
September 1996	*Lasiurus cinereus*	1
September 1996	*Myotis lucifugus*	13
September 1996	*Myotis septentrionalis*	13
September 1996	*Pipistrellus subflavus*	10
May 1999	*Lasionycteris noctivagans*	1
May 1999	*Myotis lucifugus*	2
June 1999	*Eptesicus fuscus*	2
June 1999	*Lasiurus borealis*	3
June 1999	*Myotis lucifugus*	1
June 2001	*Eptesicus fuscus*	28
June 2001	*Lasiurus borealis*	8
June 2001	*Lasiurus cinereus*	1
June 2001	*Myotis lucifugus*	13
June 2001	*Myotis septentrionalis*	9
June 2001	*Myotis sodalis*	2
June 2003	*Myotis septentrionalis*	17
September 2004	*Myotis lucifugus*	6
September 2004	*Myotis septentrionalis*	2
September 2004	*Myotis sodalis*	16