

# Appendix H

## SPECIES VIABILITY EVALUATIONS

### Introduction

The regulations implementing the National Forest Management Act (36 CFR 219.19) incorporates direction on biodiversity by stating that the Forest Service will meet the following requirements in developing or revising a Land and Resource Management Plan:

*“Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area.”*

Each set of alternative management activities must meet these minimum standards for viability of native and desired nonnative birds, mammals, fish, amphibians, and reptiles. Additional direction (USDA Regulation 9500-4) extends this mandate to include vascular plants. Species Viability Evaluation (SVE) is the process used during the Forest Plan revision to address the viability of plants and animals in the planning area. The Hoosier’s process for SVE included:

- identification of species for which there is potential loss of viability or high public or management concern,
- analysis of identified species in an ecological assessment,
- selection of potential SVE species and compilation of scientific information for these species,
- development of conservation approaches for consideration during the designing of alternatives for the Forest Plan Revision process, and
- the development of GIS-based habitat suitability models to test the effects of proposed management alternatives on selected SVE species.

### Ecological Assessment

The Hoosier-Shawnee Ecological Assessment area encompasses the Central Hardwoods Bird Conservation Region and lies in the Highland Rim and Lexington Plain Physiographic Regions. The assessment area encompasses southwest and south central Indiana, southern Illinois, and western Kentucky. Biologists from the Hoosier and Shawnee National Forests in conjunction with professors from Southern Illinois University and Mike Homoya, Heritage Botanist, from the Indiana Department of Natural Resources, Division of Nature Preserves generated lists of terrestrial animals, aquatic animals, and plant species to be addressed in the Hoosier-Shawnee Ecological Assessment (Thompson ed. 2004). Table H.1 lists the criteria used to select these species. This list contained approximately 500 species. The ecological assessment is a

scientific analysis of the characteristic composition, structure, and processes of ecosystems and should provide an understanding of the ecological integrity of the area to be analyzed under current policies and across ownerships. Ecosystems with integrity maintain their characteristic species diversity and ecological processes, such as productivity, soil fertility, and rates of biogeochemical cycling. The ecological assessment includes information on the current and historic vegetation, terrestrial and aquatic animal species, plant species, aquatic resources, exotic species, and soils. Because ecosystems are dynamic and variable, the concept of the “historic range of variability” (HRV) is used to characterize the variation and distribution of ecological conditions occurring in the past (Committee of Scientists 1999).

Table H.1

**CRITERIA USED TO SELECT TERRESTRIAL ANIMALS,  
AQUATIC ANIMALS, AND PLANT SPECIES**  
(Addressed in the Hoosier-Shawnee Ecological Assessment)

<b>Selection Criteria</b>
Federal, threatened, or endangered species
Viability concern species
Species associated with rare habitats
Species for which there is high management and public interest (e.g. Neotropical migratory bird species, cavity nesters, and game species)
Overabundant species
Cave species
Nonnative invasive species

Traditional approaches to conserving biodiversity have relied on a fine filter approach (species-by-species) which emphasized maintaining habitat for threatened, endangered, and sensitive species (Jensen and Bourgeron 1994). Yet, a more proactive approach to species conservation is the coarse-filter, which assumes that if landscape patterns and processes (similar to those that species evolved with) are maintained, then the full complement of species will persist. The description of historic landscape disturbance regimes and the ecosystem components they maintained (i.e. vegetation composition) provide an initial template for assessing ecosystem health (Jensen and Bourgeron 1994). The application of this concept requires an understanding of the natural variability of landscape patterns and processes.

The timeframe used for describing HRV is chosen based on certain factors; generally a period of similar climate and species presence as exists in current times is chosen. The HRV concept allows comparison of historic conditions to the ecological conditions different proposed alternatives would create. The more the proposed conditions differ from the conditions during recent historic times, the greater the expected risk to native species, their habitats, and their long-term ecological productivity (Committee of Scientists 1999).

Technical elements of the ecological assessment include:

- What is the appropriate scale to analyze, i.e. what Ecological Mapping Units will be included in the analysis area?
- What were the historic and prehistoric ecological conditions (HRV)?
  - What are the effects of disturbance (including natural and human-caused)?
  - Describe disturbance regimes (size, frequency, and intensity) and other significant ecological processes.
- What are the current ecological conditions and trends?

- What effects have current and past management practices had on the health and integrity of forest vegetation?
- What are the current and historic soil conditions?
- What are the current and historic aquatic habitat conditions?
- What effects have native and exotic (nonnative) pests had on forest ecosystems?
- Identify SVE species
  - What plant, animal, and aquatic species occur and what are their habitat associations?
  - What are the status, trends, and habitat associations of animal, plant, and aquatic populations for:
    - Federal threatened and endangered (T&E) species,
    - viability concern species,
    - species associated with rare communities,
    - species for which there is high management and public interest, and
    - overabundant species?
  - What habitat types, habitat parameters, and management activities are important for maintaining viable populations of the above species?
  - What conditions are needed in the ecological analysis area to:
    - Conserve populations of threatened and endangered and viability concern species,
    - maintain existing species and community diversity, and
    - provide suitable populations on national forests?

## Species Selection

The Committee of Scientists (1999) recognized that it was impossible to monitor the status and assess the viability of all species, and identified the need to focus on a small subset of species (SVE species). A matrix was generated for each group of species (terrestrial, aquatic, and plant) incorporating all of the habitat types found on NFS land on the Hoosier and Shawnee National Forests (instead of within the ecological assessment area). The two national forests used this matrix as a screen in combination with the following criteria to select SVE species for viability assessment: species listed as Region 9 Regional Forester sensitive species (RFSS); species listed as Federally threatened, endangered, or proposed; species representative of each of the habitat types located on both national forests; the availability of literature on a species; and species occurrence in the last 25 years. This resulted in a list of 53 preliminary species to carry forward in the SVE process. Species viability evaluation species serve an umbrella function because their large area requirements or use of multiple habitats encompass the habitat requirements of numerous other species, because they perform key roles in ecological processes, or because they convey information about the status and integrity of the larger ecosystem in which they occur.

The proposed list of SVE species along with all related documentation was sent to Midwest experts for plants, animals, and aquatics. Experts were considered those people who are recognized by their peers as having expertise (research, education, study, or experience) in the biology, ecology, or management of the species under review. Experts (Table H.2) included representatives from:

- Butler University
- Environmental Solutions and Innovations
- Illinois Department of Natural Resources
- Illinois Natural History Survey

- Indiana Department of Natural Resources
- Indiana State University
- Indiana University
- Missouri Botanical Gardens
- North Central Research Station
- Purdue University
- Southern Illinois University
- The Nature Conservancy
- University of Louisville
- U.S. Fish and Wildlife Service

Experts were given 30 days to review the proposed list and make suggestions on species that should be added or subtracted. In addition, we asked them to validate the SVE process and the rationale for eliminating or proposing to carry species through the process.

Table H.2

**MIDWEST EXPERTS WHO ATTENDED ONE OR MORE SPECIES VIABILITY EVALUATION PANELS, AND THEIR AFFILIATION.**

<b>Person</b>	<b>Organization</b>
Dr. Rebecca Dolan	Butler University
Dr. Virgil Brack	Env. Solutions/Innovations
Alice Heikens	Franklin College
Cynthia Basile	Hoosier National Forest
Kirk Larson	Hoosier National Forest
Clark McCreedy	Hoosier National Forest
Steve Olson	Hoosier National Forest
Kelle Reynolds	Hoosier National Forest
Tom Thake	Hoosier National Forest
Scott Ballard	Illinois Department of Natural Resources
Bob Bluett	Illinois Department of Natural Resources
Larry David	Illinois Department of Natural Resources
Joe Kath	Illinois Department of Natural Resources
Jody Shimp	Illinois Department of Natural Resources
Steve Bailey	Illinois Natural History Survey
Dr. Steven Hill	Illinois Natural History Survey
Dr. Joyce Hoffman	Illinois Natural History Survey
Dr. Jeff Hoover	Illinois Natural History Survey
Dr. L. Rick Phillippe	Illinois Natural History Survey
Dr. Christopher Phillips	Illinois Natural History Survey
Scott Robinson	Illinois Natural History Survey
Dr. Chris Taylor	Illinois Natural History Survey
Steve Backs	Indiana Department of Natural Resources
John Castrale	Indiana Department of Natural Resources
Brant Fisher	Indiana Department of Natural Resources
Mike Homoya	Indiana Department of Natural Resources
Scott Johnson	Indiana Department of Natural Resources
Bruce Plowman	Indiana Department of Natural Resources

<b>Person</b>	<b>Organization</b>
Katie Gremillion-Smith	Indiana Department of Natural Resources
Zach Walker	Indiana Department of Natural Resources
Bruce Kingsbury	Indiana-Purdue University
Marion Jackson	Indiana State University
Dr. John Whitaker, Jr.	Indiana State University
Dr. Michael Ewert	Indiana University
George Yatskievych	Missouri Botanical Garden
Kay Yatskievych	Missouri Botanical Garden
Bob DeStafano	Missouri Dept. of Conservation
Jeff Ehman	Pangaea Information Technologies, Inc.
Dr. John Dunning	Purdue University
Dr. Harmon Weeks	Purdue University
Sybill Amelon	North Central Research Station
Dirk Burhans	North Central Research Station
Bill Dijak	North Central Research Station
Frank Thompson	North Central Research Station
Adam Bump	Ruffed Grouse Society
Becky Banker	Shawnee National Forest
Michael Spanel	Shawnee National Forest
Beth Shimp	Shawnee National Forest
Chad Stinson	Shawnee National Forest
Steve Widowski	Shawnee National Forest
Ginny Adams	Southern Illinois University
Reed Adams	Southern Illinois University
Dr. Ronald Brandon	Southern Illinois University
Dr. Brooks Burr	Southern Illinois University
Tim Carter	Southern Illinois University
Dr. George Feldhamer	Southern Illinois University
Dr. James Garvey	Southern Illinois University
John Roseberry	Southern Illinois University
Alan Woolf	Southern Illinois University
Dr. Jim Herket	The Nature Conservancy
Andy King	U.S. Fish and Wildlife Service
Mike Thomas	U.S. Fish and Wildlife Service
Chris Frisbee	USDA Forest Service
Ted Schenck	USDA Forest Service
Norm Weiland	USDA Forest Service
Bill Pearson	University of Louisville
Chadwick D. Rittenhouse	University of Missouri- Columbia

To thoroughly address population viability in the Forest Plan revision process, we made arrangements with three universities to conduct an exhaustive search of the literature that pertains to the Central Hardwoods Region in Illinois and Indiana, as well as a less exhaustive search of literature needed to address rangewide conditions for each SVE species. Literature source locations included libraries, Internet, The Nature Conservancy and Natural Heritage Inventory species abstracts, and informal consultation with experts. Once the literature information was compiled, the two national forests evaluated the species. To further reduce the number of species to be addressed in the SVE process, we used information from the literature

search, conservation assessments, recommendations from experts, and an assessment of risks and benefits to the species from potential vegetation management. Resource specialists decided that only species affected, either positively or negatively by forest management would be carried forward through the process. Forest botanists reduced the number of plant species from 25 to 20 and completed an evaluation for each species to assess the following risk factors: abundance, distribution, population trend, habitat integrity, and population vulnerability. Using these criteria, we reduced the number of terrestrial and aquatic animal species from 27 animals to 16.

## **Species Data Collection Form**

We completed an exhaustive literature search gathering the best available information on all SVE species, and developed a Species Data Collection Form to organize all information collected during the literature review and panel discussions for each species. Each form represents a synthesis of the most current scientific data obtained from peer-reviewed literature, agency reports, local surveys, and discussions from species experts. The Species Data Collection Form served as a source of information for the development of desired conditions, objectives, Proposed Plan direction, and direction for the development of management alternatives during the Forest Plan Revision process. We collected the following information on this form:

- historical and current range
- historical and current population
- life history
- habitat requirements
- habitat and population trends
- threats to population viability for two time periods – 10 and 100 years in the future

## **Species Viability Evaluation Panels**

Species Viability Evaluation panels convened in Terre Haute, Indiana in May of 2002. To facilitate participation a large number of species experts, we held 10 one-day panel meetings to discuss the following: (1) forest birds; (2) early successional birds; (3) threatened and endangered birds (bald eagle); (4) game birds; (5) reptiles and amphibians; (6) threatened and endangered mammals (Indiana bat); (7) other mammals; (8) aquatic species – cavefish, crayfish, and darters; (9) dry forest plants; and (10) moist forest plants. Because the time commitment needed from experts was limited, there was approximately a 95 percent turnout for those invited to the animal panels. However, there was only about a 40 percent turnout for plant panels as we held the meetings during the field season.

Each grouping of species had a minimum of three species experts at the panel discussions. Experts reviewed literature summaries and identified missing or inaccurate information. This synthesis of published and unpublished information from experts was a major accomplishment of the panel sessions. The experts discussed the literature summaries item by item, but the panel discussions concentrated on threats to the species, potential management activities to maintain or enhance habitat quality, and monitoring. We provided a facilitator and a scribe to each of the expert panels to aid in the process of gathering and recording information. Resource specialists were also available to discuss the reasons for evaluating each species and answer any questions raised by species experts.

We incorporated all information gathered at the panel discussions, including comments from the experts and literature not previously considered, into the Species Data Collection Form. We also added discussions on management considerations, monitoring, limiting factors, role of national forests, and suitability of species for use in designing forest plan alternatives. In addition, we also recorded the recommendation to carry or not carry a species forward. Following these additions, the Forest edited the form to streamline the document and remove redundancy. The recommendations of the species experts and final review completed by resource specialists resulted in a list of 20 SVE species (Table H.3). All species were recommended to be carried forward on the Hoosier unless otherwise noted.

TABLE H.3  
SVE SPECIES CHOSEN TO REPRESENT EACH HABITAT TYPE  
LOCATED ON THE HOOSIER NATIONAL FOREST

Species Name	Scientific Name	Habitat Association(s)	SVE Panel Recommendation
ANIMALS			
American Woodcock	<i>Scolopax minor</i>	Dry Upland Forest, Mesic Forest, Openland/Brushland	Added to list because of its dependence on young to mid-age forests interspersed with openings for nests and young broods.
Cerulean Warbler	<i>Dendroica cerulea</i>	Mesic Forest, Floodplain – Mesic	Suitable habitat for this species may be affected by vegetation management.
Gray Treefrog <sup>1</sup>	<i>Hyla versicolor</i>	Mesic Forest, Wetlands-Swamps, Acidic Swamp/Seep Springs, Streams/Rivers, Ponds/Lakes, Floodplain-Mesic	This species uses a variety of forested habitats, many of which would not be affected by management. This species is not scarce, and is resilient and adaptable. Other species that we carry forward will adequately represent this habitat type.
Henslow's Sparrow	<i>Ammodramus henslowii</i>	Openland/Brushland	This species uses habitat that needs disturbance – large openings. This species could be positively affected by land acquisitions containing open habitat.
Indiana Bat	<i>Myotis sodalis</i>	Dry Upland Forest, Mesic Forest, Openland/Brushland, Barrens Sandstone/Siltstone, Barrens-Limestone, Wetlands-Swamps, Acidic Swamp/Seep Springs, Streams/Rivers,	Forages in virtually every habitat type. Activities on both forests have the potential to positively or negatively affect suitable habitat for this species.

Species Name	Scientific Name	Habitat Association(s)	SVE Panel Recommendation
		Ponds/Lakes, Floodplain-Mesic, Caves/Springs	
Indiana Crayfish	<i>Orconectes indianensis</i>	Streams/Rivers	Recreational trails have potential to negatively affect this species.
Northern Bobwhite	<i>Colinus virginianus</i>	Dry Upland Forest, Openland/Brushland, Barrens – Limestone	This species is dependent on early successional habitat.
Northern Cavefish	<i>Amblyopsis spelaea</i>	Caves/Springs	There are opportunities to benefit this species through land acquisitions. Threats to this species include impacts to streams and recharge areas. Many of the cavefish sites are in special areas. These caves are also protected under the Cave Resources Protection Act.
Northern River Otter	<i>Lutra Canadensis</i>	Wetlands-Swamps, Streams/Rivers, Ponds/Lakes, Floodplain-Mesic	River otters have been reintroduced in Indiana. Species and habitat can be positively affected with land acquisitions and wetland restoration. This species is a true wetland, stream, riparian-dependent species.
Ruffed Grouse	<i>Bonasa umbellus</i>	Dry Upland Forest, Mesic Forest, Openland/Brushland	This species is dependent on early successional habitat.
Timber Rattlesnake	<i>Crotalus horridus</i>	Dry Upland Forest, Barrens-Sandstone/Siltstone, Barrens-Limestone, Cliffs – Dry Sandstone	The populations of many sites on the Shawnee are declining, which may be caused partly by human disturbance. In addition, den and birthing sites for this species can become unsuitable if the sites are shaded by vegetation.
Wood Thrush	<i>Hylocichla mustelina</i>	Mesic Forest, Floodplain – Mesic	Shrub/understory nester. Suitable habitat for this species could be affected by management activities affecting the shrub layer.
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	Dry Upland Forest, Mesic Forest	Ground nester. Suitable habitat for this species could be affected by activities that



Species Name	Scientific Name	Habitat Association(s)	SVE Panel Recommendation
			affecting the ground.
Yellow-breasted Chat	<i>Icteria virens</i>	Openland/Brushland, Barrens - Limestone	Use habitat with a larger brush component than Henslow's sparrow. This species uses habitat that needs disturbance – openings and barrens. This species could be positively affected by land acquisitions containing open habitat.
PLANTS			
Carolina Thistle	<i>Cirsium carolinianum</i>	Dry Upland Forest	Eight sites in one county on Hoosier; responds favorably to prescribed fire in dry forests of Shawnee Hills.
Climbing Milkweed	<i>Matelea oblique</i>	Barrens Limestone	Do not carry forward: many occur in protected sites on the Hoosier, enhanced by prescribed fire.
French's Shootingstar	<i>Dodecatheon frenchii</i>	Cliffs-Moist Sandstone	Some populations on the Hoosier damaged by illegal ATV use.
Illinois Wood-sorrel	<i>Oxalis illinoensis</i>	Mesic Forest	Occurs on limestone-derived soils: about 15 sites in four counties on the Hoosier, some occur on protected MAs, threatened by illegal ATVs.
Prairie Parsley	<i>Polytaenia nuttallii</i>	Dry Upland Forest, Barrens Sandstone/Siltstone	One site on Hoosier, needs prescribed fire.
Yellow Gentian	<i>Gentiana alba</i>	Barrens Limestone	Four sites in one county on the Hoosier, habitat loss, needs prescribed fire.

<sup>1</sup>After reconvening the SVE Panels in 2003, the reconvened SVE panel members dropped this species and added the Spotted Salamander (*Ambystoma maculatum*) to ensure that the group of amphibians using upland ponds and waterholes was covered in the SVE Process.

The Forest compiled and delivered the information obtained from the first set of expert panels to the Forest Plan Interdisciplinary Core Team for drafting alternatives, goals, and standards and guidelines. The Team identified conservation practices needed to ensure species viability, identified the management practices that are effective in maintaining species viability, and recommended a coarse-filter approach, which will provide suitable habitat for the vast majority of species on the Forest by managing for broader ecosystems rather than species-specific habitat requirements.

# Geographic Information System (GIS)-Based Habitat Suitability Models

## Introduction

Demonstrating the effects of each of the proposed Forest Plan alternatives on each SVE species was a critical component of our Forest Plan revision process. For most wildlife species, habitat quality models have not been developed, and existing models could be greatly improved by incorporating updated wildlife knowledge. Of the models that do exist, very few have incorporated spatial data or applied the model across a large landscape. The Forest used remote sensing and GIS data to develop spatially explicit wildlife models for each SVE species to evaluate wildlife habitat quality on the Hoosier.

## LANDIS

The Hoosier contracted with North Central Research Station and Pangaea Information Technologies, Inc. to create GIS-based habitat suitability models for each of the SVE species. Scientists and resource managers can use GIS-based habitat suitability index (HSI) models to guide decisions in habitat conservation initiatives and to evaluate wildlife-habitat relationships, especially at a landscape level. Professionals working with LANDIS developed the base inputs for all wildlife models. LANDIS is a spatially explicit model designed to simulate ecological dynamics, including forest succession, disturbance, seed dispersal and establishment, fire and wind disturbance, and the interactions of these dynamics. The purpose of this model is to simulate long-term changes in patterns of forest vegetation across large landscapes while maintaining reasonable realism in important ecological processes and their spatial interactions. LANDIS also has capabilities to simulate forest vegetation management including harvest (Gustafson *et al.* 2000). LANDIS operates on raster GIS maps where each cell is a spatial object containing species, environment, disturbance, and harvesting information. Each cell contains information on the tree species and their 10-year old cohort age present along with information about the number and size of individual stems. The LANDIS model differs from most landscape models by simulating multiple landscape processes in combination with the simulation of succession dynamics. For a more detailed account of LANDIS, review He *et al.* 2003, He *et al.* 1999, Mladenoff and He 1999, and Gustafson *et al.* 2000.

## Habitat Suitability Index Models

Habitat Suitability Index (HSI) models provide a numerical index of habitat quality (usually ranging from 0 to 1) based on measured features such as overstory canopy cover, tree height (Schamberger *et al.* 1982). GIS-based habitat models are much easier and faster to apply to large geographic areas than traditional HSI modeling because it eliminates labor-intensive collection of field data. Demand for information to use in managing wildlife species at a landscape level has become increasingly important because of concern over declining populations. To compare alternative land management scenarios over time, biologists can use GIS-based HSI models to evaluate landscapes simulated by spatially explicit forest landscape models (such as LANDIS). These HSI models use digital maps of ecological land types and age and species group of dominant overstory trees, which are available from a variety of sources such as forest inventories, interpreted aerial photos, and classified satellite imagery.

North Central Research Station, with assistance from Hoosier resource specialists, developed HSI models for the following SVE terrestrial wildlife species: American woodcock, cerulean warbler, Henslow's sparrow, Indiana bat, northern bobwhite, ruffed grouse, wood thrush, worm-eating warbler, and yellow-breasted chat. Pangaea Information Technologies, Inc. developed models for the following aquatic wildlife species and plant species: Carolina thistle, climbing milkweed, French's shootingstar, Illinois wood-sorrel, Indiana crayfish, northern cavefish, prairie parsley, river otter, spotted salamander, and yellowish gentian. Our HSI models were based on the life history traits for each species (collected during our literature search and from species experts). The incorporation of life history data provides a good approximation of the habitat and landscape settings likely to be suitable for each of these species (Hansen and Urban 1992).

## **Reconvening of the Species Viability Evaluation Panels**

After developing all models, species experts were once again invited to participate in the SVE process. SVE Panels reconvened in Terre Haute, Indiana in January of 2004 to review and refine the GIS-based models developed for each SVE animal and plant species. Experts also evaluated the expected effects of each of the proposed alternatives on their specialty species. We sent participants a packet containing a species overview, model conceptualization, and model structure. We held one session for each species. The species experts reviewed the models, and we recorded their suggestions. Once again, we provided a facilitator and a scribe to each of the expert panels to aid in the process of gathering and recording information. Resource specialists and model developers from North Central Research Station or Pangaea Information Technologies were also available to discuss the habitat suitability indices of each model and to answer any questions raised by species experts.

The experts made minor revisions to the bird species models. Experts agreed that, with the completion of the modifications, all of the bird model results would be valid. The timber rattlesnake and Indiana bat models required more extensive revision. The Forest presented redesigned models to experts via individual meetings or conference calls. The experts accepted the plant models as valid with only minor modifications. Information provided by species experts guided a complete revision of the models developed for the Indiana crayfish, northern cavefish, and river otter. Species experts dropped the green tree frog from the SVE aquatic animal list, because the group agreed that the spotted salamander would be more representative of upland ponds across the Forest. Forest staff sent a completed literature review of this species to Pangaea in April 2004 to use in model development. At about the same time, the modelers sent newly developed and revised models to species experts for their final review and approval. Information on model parameters is available from the Supervisor's Office, Bedford Indiana.

The *Forest Plan* has many conservation measures in place to conserve habitat for species at risk including measures to protect and conserve habitat for the Indiana bat and bald eagle. Through the SVE process, the experts and biologists developed conservation approaches for 20 plant and animal species for which loss of viability is a concern. These species represent the habitats located across the Hoosier. The SVE process brought to light many key issues that the Planning Team considered during the development of alternatives and in Plan direction. Key issues were:

- the necessity of providing a diversity of habitat types,
- the importance of maintaining mixed oak ecosystems,

- the threat that nonnative invasive species pose to plant and animal community health and diversity, and
- the ability of Forest Service managers to use a variety of forest vegetation management methods including timber harvesting (even and uneven age), prescribed fire, mowing, and herbicide use (for treatment of nonnative invasive species).

Through the development of Habitat Suitability Models, the experts estimated the effect of each alternative for each SVE species, thus ensuring that all alternatives provide for viability. The input of local species experts, North Central Research Station personnel, Pangaea Information Technologies, Inc. personnel, and resource specialists was essential for the development of valid models.