Mark Twain National Forest
Missouri

Programmatic Biological Assessment
Forest Plan Revision

June 14, 2005

USDA Forest Service
Eastern Region
Milwaukee, Wisconsin

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Species

Plants	
Asclepias meadii	Mead's milkweed
Helenium virginicum	Virginia sneezeweed
Trifolium stoloniferum	Running buffalo clover
Insects	
Somatochlora hineana	Hine's emerald dragonfly
Naiades	
Antrobia culveri	Tumbling Creek cavesnail
Lampsilis orbiculata	Pink mucket pearlymussel
Leptodea leptodon	Scaleshell mussel
Fish	
Notropis topeka	Topeka shiner
Birds	
Haliaeetus leucocephalus	Bald eagle
Mammals	
Myotis grisescens	Gray bat
Myotis sodalis	Indiana bat

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Summary of Biological Assessment
Programmatic Consultation
Mark Twain National Forest, Missouri
Forest Plan Revision

Federal agencies are required to comply with provisions of the Endangered Species Act of 1973, as amended. This includes the requirement to consult with the USDI Fish and Wildlife Service on projects which may affect species federally listed as threatened or endangered (ESA section 7(a)(2)).

Consultation History: In August 1985, formal consultation was completed for the newly developed Mark Twain National Forest Land and Resource Management Plan (Forest Plan). Seven species were covered during that consultation. No incidental take statement was issued with the 1985 opinion.
The biological opinion stated:

"if standards and guidelines as modified were followed, the proposed action is likely to promote the conservation of TE species" and is "not likely to jeopardize the continued existence of the species listed or result in destruction or adverse modification of their critical habitat".

Continuing research and inventory of TE species populations, as well as a refinement of our knowledge of species' habitat requirements led to the development of a new Biological Assessment and formal consultation on four species in 1998. The Biological Opinion issued in June 1999 stated:

"it is the Service's biological opinion that forest management and other activities authorized, funded, or carried out by the MTNF through implementation of the LRMP, are not likely to jeopardize the continued existence of"…the gray bat, bald eagle, Indiana bat, or Mead's milkweed.

"the Service concluded that activities outlined in the LRMP were not likely to adversely affect running buffalo clover or the Tumbling Creek cavesnail and stated that a "no effect" determination was appropriate for Topeka shiner, Curtis' pearly mussel, pink mucket pearly mussel, and Hall's bulrush."

and

"Because critical habitat has not been designated for this species (gray bat, bald eagle, Mead's milkweed), none will be adversely affected by the continued implementation of the LRMP." "Of the six caves in Missouri designated as critical habitat, none are owned by the MTNF and none will be adversely affected by the continued implementation of the LRMP."

Forest Plan Amendment #25, dated March 2000, incorporated the RPM/TC into the Forest Plan. Forest Plan Amendment #26, dated August 2002, added Management Prescription 3.5 as areas of influence (AOI) for Indiana bat habitat. On August 13, 2004, the Forest Supervisor made the decision to amend the Forest Plan to incorporate the Brown's Hollow Area of Influence for a newly discovered maternity colony on MTNF.

Since the issuance of the 1999 programmatic BO, hundreds of individual consultations have occurred for site-specific projects to implement the Plan. In addition, MTNF has monitored the level of incidental take for bald eagle, gray bat and Indiana bat. There has

been no documented take for bald eagle or gray bat from 1999-2004. Incidental take for Indiana bats has been measured in acres of forest cover affected by various management activities (USFWS 1999).

Table BA-1: Indiana Bat Take Acres Baseline (1999-2004)

Activity	Forested Acres Annual Maximum	1999	2000	2001	2002**	2003	2004	TOTAL	Total 6 Year Maximum Acres	% Maximum Annual Acres	% MTNF
Timber harvest	20,000	12,011	2,648	5,259	8,845	8,506	9,276	46,545	120,000	39%	4%
Prescribed fire	12,000	9,429	5,878	8,656	10,478	6,581	6,195	47,217	72,000	66%	4%
Wildlife habitat improvement	2,000	95	1,716	223	112	266	470	2,882	12,000	24%	0.33%
Timber stand improvement	4,000	1,107	2,570	2,689	1,896	3,660	3,146	15,068	24,000	63%	1%
Soil & water improvement	150	52	2	55	50	74	62	295	900	33%	0.03%
Range management	50	38	10	15	0	0	0	63	300	21%	0.01%
Mineral exploration & development	50	6	4	7	5	10	12	44	300	15%	0.01%
Wildfire fire lines	50	47	10	31	22	35	21	166	300	55%	0.01%
Special uses	50	2	2	6	5	43	0	58	300	19%	0.01%
Road construction*	25	8	7	19	8	0	0	42	150	28%	0.004%
TOTAL	38,375	22,795	12,847	16,960	21,421	19,175	19,182	150,755	230,250	65%	10%

*All acres are road reconstruction - No acres of new road construction.

**Numbers may not match Annual Report - chart in 2002 Annual Report was copied from 2001 and never updated - numbers in this chart are more accurate…. Jae 1/14/05

The acres in this chart do not match total acres accomplished in a year for some activities because a) activities for which there was a No Effect or Not likely to Adversely Affect determinations by definition do not have incidental take, and therefore do not count toward the incidental take acres tracked here; and b) only acres in forest cover are included in the estimation of incidental take; i.e. activities which take place on acres of open pasture, open glade or other openlands are not included in the incidental take estimate.

Consultation Need: The Mark Twain National Forest is in the process of revising the existing Forest Plan. This Biological Assessment analyzes the potential effects of that revision on federally listed species.

Critical Habitat: There is no critical habitat designated on Mark Twain National Forest for any of the listed species that occur on or may be affected by Mark Twain National Forest management (Theresa Davidson, USFWS pers. comm.. 12/01/04). Therefore, there would be no destruction or adverse modification of critical habitat due to actions proposed in the Revised Mark Twain National Forest Land and Resource Management Plan.

Federal Species List: On June 27, 2003 the Mark Twain National Forest submitted a species list to USDI FWS for review and concurrence. ON July 14, 2003, the FWS replied concurring with the submitted species list including 11 federally listed species to consider in evaluation of Forest Plan revision. On November 29, 2004, a second list was submitted via e-mail to USDI FWS for review, including 4 additional species to consider. On December 1, 2004, USDI FWS replied via e-mail that the new list was complete and those 15 species should be considered in the programmatic Biological Assessment. On April 20, 2005 the USDI FWS and USDA Forest Service discussed the proposed list and agreed to drop the candidate species from consideration in this assessment, leaving eleven federally listed species to consider.

Limiting Factors for Federal Species: Limiting factors are well-known for some species and are uncertain for other species. However, major factors that are known or suspected include:

Table BA-2: Limiting Factors

Limiting Factor	Species Affected
Threats to water quality	Hine's emerald dragonfly, Tumbling Creek cavesnail Pink mucket pearly mussel, Scaleshell mussel, , Topeka shiner, Bald eagle, Gray bat, Indiana bat
Conversion of habitat to urban/agricultural/industrial uses	All species
Human disturbance at caves	Tumbling Creek cavesnail, Gray bat, Indiana bat
Lack of fire and encroachment of woody vegetation	Mead's milkweed, Indiana bat
Pesticide contamination	Bald eagle, gray bat, Indiana bat
Non-native invasive species	Mead's milkweed, Virginia sneezeweed, Running buffalo clover, HIne's emerald dragonfly, Pink mucket pearly mussel, Scaleshell mussel, Indiana bat
Climate change	Tumbling Creek cavesnail; Indiana bat

Summary of Existing Conditions on MTNF:

Species Occurrences

- There are no known sites on MTNF for Virginia sneezeweed, running buffalo clover, Topeka shiner, or pink mucket pearly mussel.
- Tumbling Creek cavesnail has one known location in the world, and although not on MTNF lands, about 24% of the cave recharge area is comprised of MTNF lands.
- There is one known site for Mead's milkweed on MTNF.
- There is one inactive bald eagle nest known to occur on MTNF lands along the Eleven Point National Scenic River, and an additional 4 active nests adjacent to or very near MTNF lands (St. Francis River, Black River, Eleven Point National Scenic River, Big Piney River).
- There are 9 known locations for Hine's emerald dragonfly, with other sites possible.

- There are 4 known Indiana bat hibernacula, and capture sites for 5 Indiana bats on MTNF. There is one known maternity colony on MTNF lands. The extent of summer use on MTNF is unknown, although surveying data indicate that use is very low.
- There are 18 known occupied gray bat caves on MTNF, and gray bats forage along several MTNF streams and rivers.

The existing condition of MTNF lands in relation to limiting factors for the eleven federally listed species discussed is as follows:

- ***Water quality***

Water quality is generally considered good in streams and rivers that dissect MTNF lands with relatively low rates of soil loss and sedimentation. Point and non-point pollution sources are found primarily on other ownerships. MTNF lands comprise 0.2% to 57% of the 5th level watersheds in which MTNF lands lie.

- ***Conversion of habitat***

Permanent conversion of native habitats to urban/agricultural/industrial land uses still occurs on private lands in and around MTNF. No MTNF lands are converted permanently to urban or industrial uses.

- ***Cave disturbance***

Two of the four known Indiana bat caves have been gated and are locked shut during the time the bats are there. Populations of Indiana bats have fluctuated in a similar manner in 3 of the 4 caves over the past 25 years, indicating that human disturbance has not played a major role in caves on MTNF. Five of the 19 gray bat caves (26%) have been gated to prevent human entry when the bats occupy those caves.

Other than structures to prevent human entry, no physical alteration of caves or cave entrances is done on MTNF. A buffer has been established around each known bat cave within which forest cover is maintained.

- ***Lack fire/woody encroachment***

Currently MTNF uses prescribed fire on about 1% or less of MTNF lands per year. The majority of natural communities on MTNF are fire-adapted, and without fire, many are degraded as woody vegetation increases in density, decreasing the diversity of ground cover. This is particularly the case with glade habitats, such as Bell Mountain Wilderness (Mead's milkweed site) and fen habitats (HIne's emerald dragonfly sites). Lack of fire also decreases habitat suitability for Indiana bat which prefers to forage in forest or woodland with more open understories.

- ***Non-native invasive species***

There are a number of non-native invasive plant and animal species known to occur on MTNF. Some of these may have impacts on federally listed species. Kudzu and honeysuckle vine on trees, making dead trees unacceptable as Indiana bat roost trees. Fescue, multiflora rose, and garlic mustard, among others, crowd out native plants, simplifying ecological systems, and reducing plant hosts for the terrestrial insects eaten by Indiana bats. Feral hogs root and wallow, potentially digging up the three federally listed plants, as well as potentially destroying crayfish burrows which Hine's emerald dragonfly larvae use. Both Asian clams and zebra mussels have been found in the Missouri and Mississippi Rivers. Bald eagles eat introduced rainbow and brown trout

from southern Missouri rivers during the winter. Whether or not introduced trout have had an influence on native fishes that are mussel hosts is unknown.

- ***Climate change***

While the Ozarks climate has appeared to be stable over the past several thousand years, there are some indications that climate changes are responsible for the warming of interior cave/mine temperatures, leading to reduced suitability for hibernating Indiana bats.

Summary of Potential Effects to Listed Species: There is no designated critical habitat on MTNF for any of the eleven listed species, and therefore no destruction or adverse modification of critical habitat from implementation of the Revised Forest Plan.

The following table summarizes potential impacts to species from implementation of the Revised Forest Plan.

Table BA-3: Summary of Potential Effects to Species

Species	No Effects	Potential Negative Effects	Potential Beneficial Effects	Unknown Effects
Mead's milkweed		Lack of fire & encroachment of woody vegetation	Prescribed fire; removal of woody vegetation	
Virginia sneezeweed	No known locations on MTNF			
Running buffalo clover	No known locations on MTNF			
Hine's emerald dragonfly		Encroachment of woody vegetation; Prescribed fire; Herbicide application; Altered hydrologic systems; Illegal ATV activity; feral hogs	Removal of woody vegetation; Prescribed fire; Herbicide application; Restoration of hydrologic systems; Control access to fens	Prescribed fire effects on aquatic larvae
Tumbling Creek cavesnail	All activities outside cave recharge area	Sedimentation of cave stream; Decline in water quality of cave stream	Removal of cattle from glades in recharge area; Restoration of natural communities	
Pink mucket pearly mussel	All activities outside Black River watershed	Physical alteration of substrate; Sedimentation; Decrease in water quality; Non-native invasive species; Pesticide use	Prohibit channelization, impoundment; Protect water quality & minimize soil movement; Restore natural communities	Recreational use of rivers
Scaleshell mussel	All activities outside Gasconade River watershed	Physical alteration of substrate; Sedimentation; Decrease in water quality; Non-native invasive species; Pesticide use	Prohibit channelization, impoundment; Protect water quality & minimize soil movement; Restore natural communities	Recreational use of rivers
Topeka shiner	No known locations on MTNF			
Bald eagle		Human disturbance of nests or roosts; Sedimentation of waterways; Smoke; Pesticide use; Illegal ATV use	Protect nest and roost sites; Protect riparian corridors; Minimize soil movement; Restore natural communities	Mercury in waterways
Gray bat		Human disturbance in caves; Smoke in cave; Physical alteration of caves; Sedimentation of waterways; Pesticide use	Protect occupied caves; Provide travel corridors & foraging habitat; Protect water quality; Restore natural communities	Illegal ATV use
Indiana bat	Change from 3.5 Management Area to other management area allocations	Human disturbance in caves; Smoke from prescribed burning; Physical alteration of caves; Roost tree removal; Alteration of foraging habitat; Sedimentation of waterways;	Protect occupied caves, roost trees & foraging areas; Provide roost trees & foraging areas; Protect water quality; Restore natural communities	Landscape effects of forest management; Pesticide use;

Determination of Effects to Listed Species:

Table BA-4: Determinations by Species

Species	Determination
Mead's milkweed	May Affect – Likely to Adversely Affect
Virginia sneezeweed	No Effect
Running buffalo clover	No Effect
Hine's emerald dragonfly	May Affect - Not Likely to Adversely Affect
Tumbling Creek cavesnail	May Affect - Not Likely to Adversely Affect
Pink mucket	May Affect - Not Likely to Adversely Affect
Scaleshell	May Affect - Not Likely to Adversely Affect
Topeka shiner	No Effect
Bald eagle	May Affect - Not Likely to Adversely Affect
Gray bat	May Affect - Not Likely to Adversely Affect
Indiana bat	May Affect –Likely to Adversely Affect

Request for Formal Consultation:

Mark Twain National Forest requests initiation of formal consultation on Mead's milkweed and Indiana bat. The Forest also requests concurrence from US Fish and Wildlife Service on determinations of No Effect and May Affect – Not Likely to Adversely Affect for gray bat, bald eagle, Hine's emerald dragonfly, scaleshell, pink mucket, Tumbling Creek cavesnail, Topeka shiner, running buffalo clover, and Virginia sneezeweed.

Acronyms Used

ACOE	Army Corps of Engineers
AOI	Area of Influence (Indiana bat)
ATV	All Terrain Vehicle
BA	Biological Assessment
DNR	Missouri Department of Natural Resources
EAM	Even-aged management
ELT	Ecological Land Type
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
FS	Forest Service
FWS	Fish and Wildlife Service
HED	Hine's emerald dragonfly
LWCF	Land and Water Conservation Fund
MDC	Missouri Department of Conservation
MTNF	Mark Twain National Forest
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFSL	National Forest System land
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
OHV	Off Highway Vehicle
ONSR	Ozark National Scenic Riverways
ORV	Off-road Vehicle
RFSS	Regional Forester Sensitive Species
ROW	Right-of-way
SAF	Society of American Foresters
TCC	Tumbling Creek cavesnail
TE	Threatened/Endangered
TNC	The Nature Conservancy
TSI	Timber Stand Improvement
UE	Union Electric Power Company
UEAM	Uneven-aged management
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USGS	United States Geological Survey

Purpose and Need

The National Forest Management Act (NFMA) requires that national forests revise forest plans at least every 15 years (U.S.C. 1604[f][5]). Other indicators that the current plan needs revision include:

- Land conditions and public demands have changed;
- Agency policies and strategic priorities have changed;
- Monitoring and evaluation results suggest changes are needed;
- New information is available

In April 2002 the Forest prepared an Assessment of the Need for Change for the Mark Twain National Forest Land and Resource Management Plan. The Need for Change discusses the process and information used to develop proposed changes to the 1986 Forest Plan. A Notice of Intent to Revise the Forest Plan was published in the Federal Register on April 16, 2002. Both these documents identified the central issues and public concerns resulting in the identification of the revision topics, which are the focus of the revision process. The revised Forest Plan was developed to answer questions raised by these revision topics.

The eight major revision topics, some with sub-topics are summarized here.

Revision Topic 1 – **Vegetation and Timber Management** – Concerns about vegetation management, particularly timber management, have evolved over the last 15 years around harvest levels, cutting methods, cost efficiency and maintaining or restoring forest health through the application of vegetation treatments. It has also been suggested that MTNF should restrict or prohibit commercial development of natural resources. For this topic there is a need to:

- Revisit suitable land determination, revise demand estimations, and rebuild allowable sale quantity (ASQ) determination based on those changes.
- Provide for adaptive management and greater flexibility of silvicultural techniques in order to maintain oak-hickory, shortleaf pine, and oak-pine communities.

Revision Topic 2 – Ecological Sustainability and Ecosystem Health – Sustainability consists of ecological, social, and economic components. By managing for ecological sustainability, forest ecosystems will be healthy and resilient in the long term, and will provide a lasting flow of goods and services that help sustain the economy and local communities. Managing for ecological sustainability requires an integrated management approach that considers natural processes such as fire, insect and disease outbreaks, and catastrophic wind events, along with forest management activities that mimic those natural events. For this topic there is a need to:

- Develop management direction for restoring and maintaining healthy forest ecosystems in response to oak decline; providing a healthier balance of shortleaf pine and white oak in what is now a predominately black and red oak forest; and restoring some of the more open woodland habitats encountered by early settlers.

- Change management direction to allow pine and oak reforestation and stand improvement in a wider variety of situations, so as to encourage natural vegetation most suited to Missouri's natural communities.
- Provide a wide diversity of natural communities and wildlife habitat conditions based on differing landscape capabilities and advanced ecological knowledge.
- Revise the list of Management Indicator Species

Revision Topic 3 – Fire Management – The topic of fire management focuses on the concept of using fire as a management tool. Fire management includes two aspects: 1) the use of fire to meet resource and land management goals; and 2) all activities required to protect property and natural resources from fire. For this topic, there is a need to:

- Develop management direction guiding the use of prescribed fire to restore ecosystems, maintain healthy forests, provide wildlife habitat, and reduce hazardous fuels.
- Improve management direction for managing wildland fires to protect life, property, and communities.

Revision Topic 4 – Management Areas – Management areas define which management prescriptions apply to various parts of the Forest. Management area boundaries are determined by ecological characteristics, social considerations, and on-the-ground practicality of differentiating one management area from another. New ecological principles and changes in social expectations may necessitate revision of some of the 1986 management area boundaries. For this topic there is a need to:

- Adjust management area boundaries as needed to incorporate ecological landtypes, current social demands, and management practicalities.
- Review management direction to insure protection of Roadless, wilderness, wild, and scenic river values and other "special areas".
- Evaluate inventoried roadless areas for their potential for Wilderness designation and determine the most appropriate use and management for inventoried roadless areas not recommended to Congress for Wilderness designation.
- Determine eligibility and highest potential classification for any rivers identified with potential for inclusion in the Nation's wild and scenic river system.

Revision Topic 5 – Riparian Areas and Water Quality – Knowledge of the important functions of riparian areas and their effects on the biological and hydrologic integrity of streams has increased since the 1986 Forest Plan was approved. Criteria for riparian area definition and delineation are not clear or quantifiable in the current Forest Plan. Inconsistent identification of riparian areas in project planning and implementation has led to inconsistent application of management direction. Management direction for protection of groundwater and karst systems is generally lacking in the 1986 Forest Plan. For this topic there is a need to:

- Provide for the restoration and maintenance of the ecological function of riparian areas, emphasizing the ecological processes that riparian areas play in supporting aquatic systems and water quality.
- Develop clearer definitions and criteria for delineating riparian areas and aquatic ecosystems, based on plant community, soil and hydrologic criteria.

- Develop management direction to protect water quality and ecological processes associated with karst terrain and karst features.

Revision Topic 6 – Threatened, Endangered, and Sensitive Species Viability – This was a topic not originally identified as a need for change. However, several species' status have changed since the 1986 Forest Plan was approved, and even since subsequent amendments to address new information. For this topic, there is a need to:

- Examine and revise management direction to protect and provide for threatened, endangered, and sensitive species.

Revision Topic 7 – Access and Transportation Management – Roads are needed in the Forest for recreational access, management, and access to private property. Roads and access they provide have remained controversial. Concerns exist about the effect of roads on natural resources such as water quality and wildlife habitat. Traffic volumes have increased and recreational use of Forest roads has changed. Forest managers are concerned about costs of road construction and maintenance. The 2003 Mark Twain National Forest roads analysis results are incorporated into this topic. For this topic, there is a need to:

- Clarify, modify or eliminate road density standards.
- Eliminate the term "woods road" and assign those roads a standard maintenance level.
- Eliminate the Forest Plan Transportation Map. Clarify that changes to the road system are project level decisions.
- Clearly state the existing Forest direction for OHV and ATV use of "closed unless posted open". Clarify the relationship among the Forest Plan direction, State law, and the Forest Supervisor's closure order.

Revision Topic 8 – Monitoring and Evaluation – Through implementation of current monitoring and evaluation direction, we have found that some requirements cannot be fully implemented, do not yield meaningful results, are not measurable or scientifically supported, or are not reasonably affordable. In addition, new information about ecosystem management and ecological sustainability concepts are not well reflected in the current monitoring and evaluation requirements. For this topic, there is a need to:

Revise and improve the strategy for monitoring and evaluation to reflect ecosystem management and sustainability concepts and approaches.
Focus the monitoring strategy on information that will (1) enhance understanding of resource management issues' (2) is measurable and scientifically supported; and (3) is feasible given probable budgets.

Proposed Action

The Forest Service proposes to revise the 1986 Land and Resource Management Plan (1986 Forest Plan) for the Mark Twain National Forest. The revised Forest Plan would be used to guide all natural resource management activities on the Forest to meet the objectives of federal law, regulations, and policy.

Forest Plans make **six key decisions** for managing a National Forest on a landscape scale in the long term:

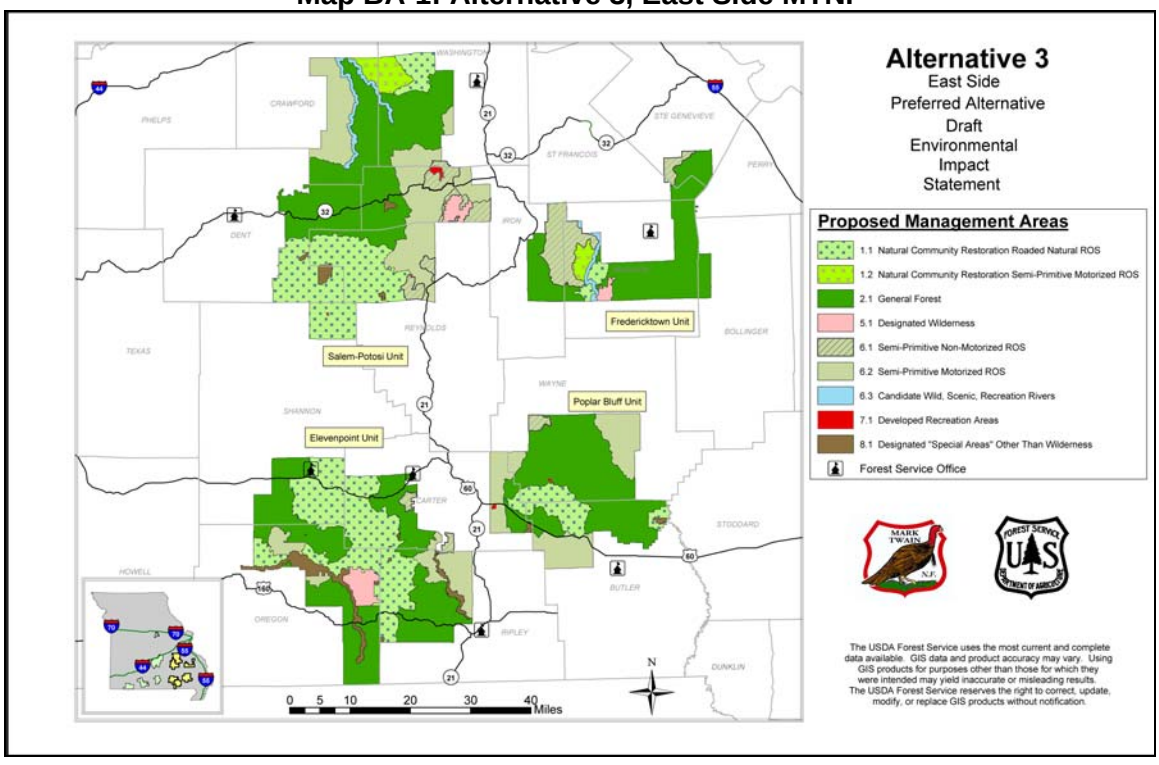
- Forest-wide multiple use goals and objectives
- Forest-wide management requirements for protecting resources (standards and guidelines)
- Management area direction
- Land suited and not suited for timber production
- Monitoring and evaluation requirements
- Recommendations to Congress, such as Wilderness designation.

No project-level decisions are considered or made during the revision process.

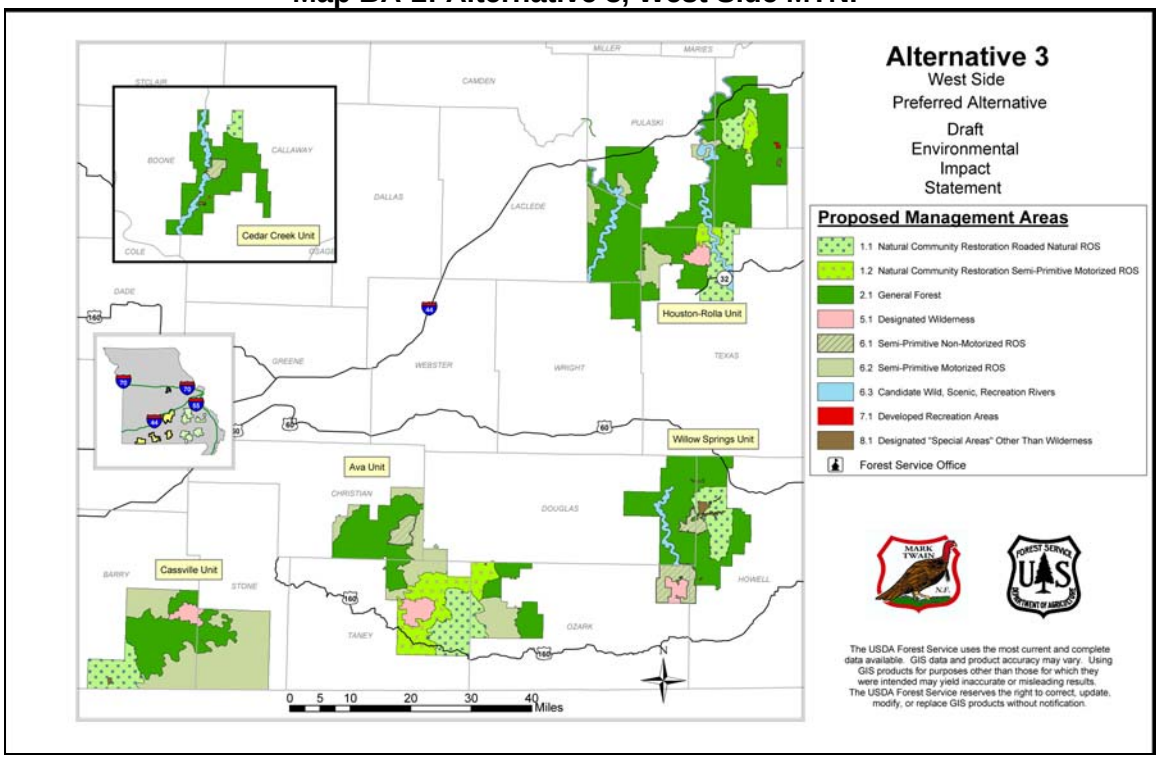
The proposed action is to implement a program of ecological restoration and resource management activities on MTNF that will insure the perpetuation of healthy natural communities through time on MTNF and provide a variety of goods and services through time. Alternative 3 is the preferred alternative.

Maps BA-1 and BA-2 show how lands would be allocated to the various Management Prescriptions in Alternative 3.

Map BA-1: Alternative 3, East Side MTNF



Map BA-2: Alternative 3, West Side MTNF



This alternative was designed to balance restoration of natural communities with management and production of more traditional forest commodities. The emphasis is on improvement of forest health conditions, production of forest products and other multiple use benefits, and enhancement of ecological communities. Restoration efforts will be focused in areas identified as biologically rich. Management activities, such as timber harvest and prescribed fire, are used to mimic ecological processes to attain and sustain a high diversity of habitats and species. A wide range of wildlife habitat is provided by restoring and enhancing ecological communities and emulating their historical distribution patterns. A broad range of settings for a variety of recreational opportunities are provided, including both developed recreation sites and areas for dispersed recreation such as backpacking, hunting, floating, and off-road vehicle use.

A Forest Plan does not make site-specific decisions regarding specific actions to be taken on the land. However, we can anticipate that certain actions would be needed to implement the revised Forest Plan. Effects analysis for this document will describe general changes in the Forest landscape as a result of implementing Alternative 3, the preferred alternative. It will also describe, in general terms, the potential effects of the actions we anticipate will be taken to move the Forest from its current condition to the desired conditions described in the revised Plan.

Table BA-5: Summary of Projected Management Activities under the Revised Plan as compared to the Current Plan as implemented (numbers rounded to nearest 100)

Projected Management Activities	Unit of Measure	Current Plan as Implemented	% MTNF	Revised Plan Alternative 3	% MTNF
Suitable Lands					
Timber	Acres	1,282,500	86	997,100	67
Grazing	Acres	Not calculated		23,719	1.5
Timber Harvest					
Allowable Sale Quantity (ASQ)	MMBF	105		103	
Regeneration	Acres/decade	82,460	6	112,700	7
Commercial Thin	Acres/decade	52,730	3.5	99,800	7
Salvage/Sanitation	Acres/decade	25,730	2	Included in regen & thin totals above	
Vegetation Management					
Pre-commercial thin & release	Acres/decade	35,000	2	40,200	3
Non-commercial thin	Acres/decade	0	0	8,400	0.6
Red cedar reduction	Acres/decade	1,500	0.1	12,600	0.8
Prescribed burning					
Ecological restoration/enhancement	Acres/decade	20,000	1	94,800	6
Hazard fuel treatment	Acres/decade	87,000	6	593,200	40
Hazard fuel reduction - mechanical	Acres/decade	30,000	2	149,200	10
Roads Managed					
System roads	Miles	2,366		2,366	
Temporary roads	Miles	2,800		1,500	
Skid Trails	Acres/decade	7,500	0.5	4,000	0.3
Wildlife Habitat					
Early successional	Acres	37,000	3	112,700	7
Old growth*	Acres	275,550	18	164,200 - 247,600	11-17
Grasslands	Acres	45,000	3		
Water sources	Number	3000+	92% w/in 1/4 mile	3000+	92% w/in 1/4 mile
Grazing					
Allotments	Number	112		Unknown	
Acres available	Acres	46,685	3	17,525	1
AUM's	Number	20,405		19,220	

Vegetation and Timber Management

Various methods of timber harvest and vegetation management techniques would be used to reach multiple objectives. Timber harvest may be done to achieve structural or species objectives, to provide wood products, to enhance the health of natural

communities, to increase growth rates on remaining trees, and to provide early successional or multi-storied wildlife habitat.

Based on land capabilities and demand projections, the amount of land suitable for timber production on the Mark Twain National Forest has been determined to be:

Table BA-6. Classification of national forest land for timber production.

Classification	Acres
Total National Forest System land	1,495,747
Non-forest and water	107,261
Legally withdrawn (Wilderness)	69,981
Land not physically suited for timber production (e.g., low site index, regeneration not assured)	1,964
Land not appropriate for timber production due to other resource Management (e.g., riparian areas, campgrounds, unique areas)	319,829
Land suitable for timber management	996,712

This compares to almost 1.3 million acres classified as suitable under the existing Forest Plan (USDA Forest Service 1986, page IV-6).

The allowable sale quantity of timber (ASQ) is the maximum amount of volume that may be offered and sold during a given decade of Forest Plan implementation from land identified as suitable for timber management. For the first decade, the average annual ASQ is 103 million board feet.

The average annual ASQ under the current Forest Plan is 105 million board feet (USDA Forest Service 1986, page IV-8).

Table BA-7. Estimate of acres of timber harvest by treatment method (Forestwide)

	Decade 1 (Proposed)		Decade 2 (Probable)	
Treatment Method	Acres	Percent	Acres	Percent
Thinning	99,800	57%	99,800	57%
Regeneration	112,700	53%	112,700	53%
Totals	212,500	100%	140,230	100%

Under the current Forest Plan, with average annual ASQ of 105 million board feet and projected annual harvest of 30,400 acres (USDA Forest Service 1986, page IV-5), average annual harvest of all types of products has averaged about 50 million board feet per year over the past 18 years.

Other vegetation management, including non-commercial thinning and pre-commercial thinning and release would be done to achieve species or structural objectives and to increase growth on remaining trees. Associated with timber harvest and vegetation management would be the construction of temporary roads and skid trails to remove wood materials.

Table BA-8. Projected vegetation management activities for Decades 1 and 2 (numbers rounded to nearest 100).

Projected Management Activities Decades 1 and 2	Unit	MP 1.1 and 1.2 Ecosystem Restoration	MP 2.1 General Forest	MP 5.1 Wilderness	MP 6.1 Semi Primitive Non Motorized	MP 6.2 Semi Primitive Motorized	Total
Pre-commercial thinning and release	acres	7,500	30,000	0	250	2,400	40,200
Non-commercial thinning	acres	8,400	0	0	0	0	8,400
Temporary roads	miles	500	800	0	20	200	1,500
Skid Trails (1mile = .96 acres)	acres	1,300	2,200	0	50	500	4,000

Ecological Sustainability and Ecosystem Health

One of the major goals of the Revised Forest Plan is to promote ecosystem health and sustainability by restoring and maintaining site-appropriate natural communities, with the full range of vegetation diversity, structure and composition typical of those communities (USDA Forest Service 2005, page 1-1). A major component of ecological health is the presence of native wildlife, and the Revised Plan goals include providing a range of habitats necessary to support populations of existing native plant and animal species; to restore and maintain natural communities that support these populations; to support recovery of federal and state listed species, and provide specialized habitats (USDA Forest Service 2005, page 1-3).

The primary methods to restore and enhance natural community attributes such as structure, species composition, and ground cover diversity and abundance. will be timber harvest, non-commercial thinning, and prescribed fire (see Tables BA-7, BA-8 and BA-11). Other restoration and enhancement activities, such as red cedar reduction, may be conducted on specific natural communities (i.e. glades and open woodlands).

Table BA-9. Projected ecosystem restoration activities for Decades 1 and 2 (numbers rounded to nearest 100).

Projected Management Activities Decades 1 and 2	Unit	MP 1.1 and 1.2 Ecosystem Restoration	MP 2.1 General Forest	MP 5.1 Wilderness	MP 6.1 Semi Primitive Non Motorized	MP 6.2 Semi Primitive Motorized	Total
Red Cedar Reduction	acres	10,600	2,000	0	0	0	12,600

Table BA-10. Estimated Acres in MP 1.1 and 1.2 to be treated for restoration in Decade 1 based on Forest Plan objectives.

Natural Community Type	Minimum	Maximum
Prairie	100	500
Savanna	5,300	13,400
Open Woodland	36,300	45,300
Closed Woodland	41,800	50,400
Forest	0	19,300
Glade	13,900	19,400
Fens	11	889
Total	97,411	149,189

In the 1986 Plan, there were no specific objectives for amount of natural communities to be restored or enhanced. Desired future conditions were based on age-class, structure, and wildlife habitat needs more than landscape capabilities. There were eight specific wildlife habitats to be provided in varying amounts depending on the LandType Association and Management Prescription. Under the Revised Forest Plan, particularly in Management Prescriptions 1.1 and 1.2, the natural range of variability in natural communities will determine the amount and type of various habitat conditions (i.e. early successional, multi-storied, old growth, etc.). There are specific objectives for the amount of early successional and old growth habitats to be provided in Management Prescriptions other than 1.1 and 1.2.

Openland habitats would also be provided through the natural range of variability inherent in savanna and open woodland communities in Management Prescriptions 1.1 and 1.2. In the remainder of the Forest, emphasis would be on managing natural openlands and native vegetation. Artificial openlands, such as fescue pastures and food plots, would only be maintained where conversion to native vegetation is not feasible, project-specific analysis shows a need for that habitat, or other resource needs (i.e. forage or pastoral scenes) are being met.

There are currently over 3000 constructed waterholes, ponds, and lakes on MTNF. Approximately 92% of the Forest is within ¼ mile of a National Forest water source. All of the Forest would be within ¼ mile of a water source if private ponds and large lakes were considered. Under the Revised Plan, existing waterholes may be maintained, but new waterholes would only be constructed where natural or man-made water sources are limited.

Grazing is used on MTNF to manage grassland vegetation and to provide forage for livestock. Under the current Plan, in 2004, there were 52,000 acres in 112 allotments on MTNF which supported about 24, 705 Animal Unit Months (AUM's). Under the Revised Plan, approximately 17,525 acres of existing allotments would be available for grazing which could support about 19,220 AUM's. Grazing of glades and associated woodlands would be discontinued under the Revised Plan.

Fire Management

In the current Forest Plan, there was little direction on prescribed burning or hazardous fuel treatment. The Revised Plan has added standards and guidelines for prescribed burning to emulate historic fire regimes and hazardous fuel treatments to reduce the potential for catastrophic wildfires, particularly near the wildland/urban or wildland/rural interface where property and lives may be at risk.

Table BA-11. Projected management activities for Decades 1 and 2 (numbers rounded to nearest 100).

Projected Management Activities Decades 1 and 2	Unit	MP 1.1 and 1.2 Ecosystem Restoration	MP 2.1 General Forest	MP 5.1 Wilderness	MP 6.1 Semi Primitive Non Motorized	MP 6.2 Semi Primitive Motorized	Total
Prescribed Burning Areas subject to Multiple Burns	acres	79,800	15,000	0	0	0	94,800 (9,480 ac/year)
Hazard Fuels Treatment - Mechanical	acres	78,400	127,600	21,500	8,000	21,800	257,300 (25,730 ac/year)
Hazard Fuels Treatment -Prescribed Burning	acres	156,800	255,300	42,900	32,100	87,300	574,400 (57,440 ac/year)

Under the current Forest Plan, MTNF has conducted an average of about 11,000 acres of prescribed burning annually over the past 7 years (USDA Forest Service 2005, page 3-167). The Revised Plan projects a considerable increase in the annual acres of prescribed burning for ecosystem restoration and enhancement as well as for hazard fuel treatment.

Management Areas

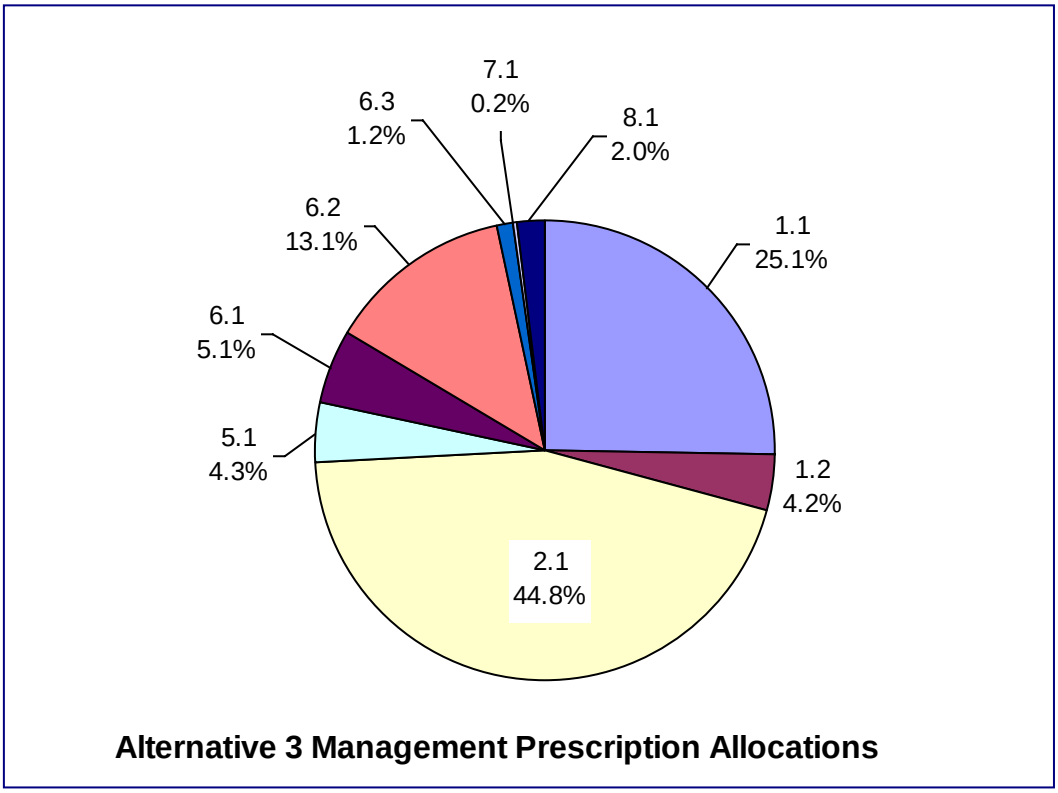
Management prescriptions 5.1 (Wilderness), 6.1 (Semi-primitive non-motorized recreation), 6.2 (Semi-primitive motorized recreation), 6.3 (Candidate areas), 7.1 (Developed recreation areas), and 8.1 (Designated special areas other than Wilderness) have not changed substantially from the 1986 Plan. The allocation of lands to these prescriptions is essentially the same in the Revised Plan as in the current Plan (USDA Forest Service 2005, page 2-3).

Seven Management Prescriptions included in the 1986 Plan (2.1, 3.1, 3.2, 3.3, 3.4, 3.5 and 4.1) have been combined into three new Management Prescriptions in the Revised Plan. These new prescriptions emphasize ecosystem restoration (1.1), ecosystem and semi-primitive dispersed recreation opportunities (1.2), and enhancement of natural communities while providing a variety of goods and services (2.1).

In Alternative 3, Management Prescriptions 1.1 and 1.2 (which emphasize restoration of ecological communities) make up about 29% of NFS lands. Management Prescriptions for Wilderness (5.1), Semi-primitive non-motorized recreation (6.1), Semi-primitive motorized recreation (6.2), candidate rivers (6.3), developed recreation areas (7.1) and designated special areas (8.1) would remain essentially the same as under the 1986

Forest Plan. All other areas, about 45% of NFS lands, would be allocated to Management Prescription 2.1 (emphasizing multiple use resource objectives).

Figure BA-1 – Management Prescription Allocations



The potential effects of changing Management Prescription 3.5 (Areas of Influence for Indiana bat hibernacula and maternity areas) to other Management Prescriptions is discussed in the Indiana bat section of this Assessment.

Riparian Areas and Water Quality

The major change from the current plan is the recognition that headwater, intermittent streams are an integral part of watershed health, and the establishment of the Watercourse Protection Zone (WPZ), within which management activities are limited or modified to minimize soil movement and protect water quality. The definition of riparian areas has been modified from the 1986 Plan, and a Riparian Management Zone (RMZ) has been established to protect the integrity of the riparian system, including the associated aquatic, lowland and upland portions. In the Revised Plan, about 84,500 acres would be included in the RMZ and WPZ. In the current Plan, about 65,000 acres are included in riparian ELT's (USDA Forest Service 2005, page 3-181).

Threatened, Endangered, and Sensitive Species Viability

In the Revised Plan, management direction has been added for several species not known to occur on MTNF when the 1986 Plan was developed. Management direction for other federal and RFSS species has been updated to reflect current knowledge of limiting factors and habitat needs.

Standards and guidelines for specialized habitats have been updated, and direction for restoration and enhancement of natural communities was developed to provide the natural range of variability of habitat conditions across the landscape. See Appendix D for a listing of all standards and guidelines applicable to the federally listed species evaluated in this Assessment.

Changes from the current Plan for specific species are described in those sections of this Assessment.

Access and Transportation Management

There are currently about 2,366 miles of National Forest System road on MTNF (USDA Forest Service 2005, page 3-239). Most of these are gravel or dirt roads maintained to provide vehicle access for management and administrative needs. The transportation system identified in the 1986 Plan is largely in place, and very little new construction of roads is anticipated in the next decade (USDA Forest Service 2005, page 3-240).

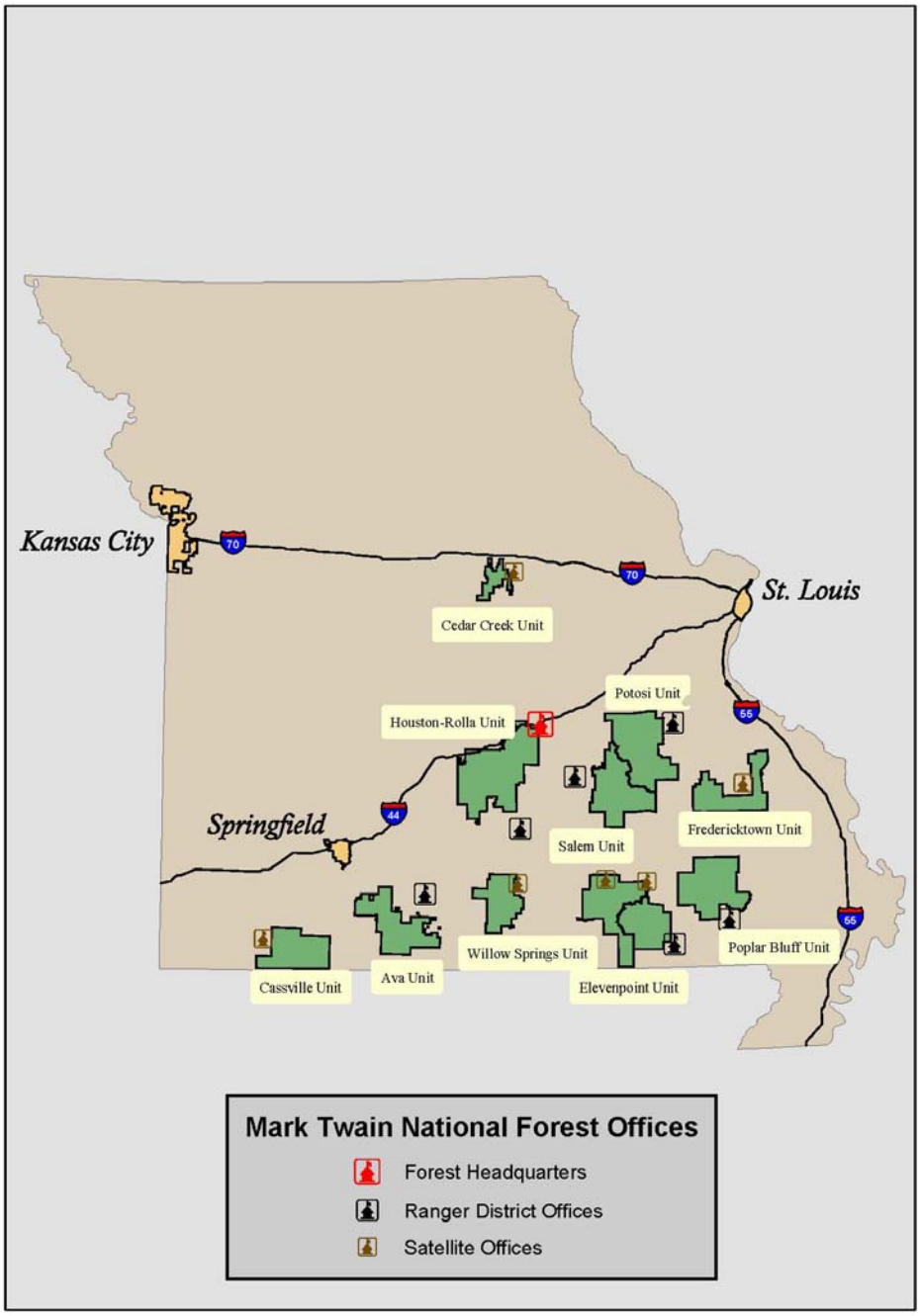
Under the Revised Plan, National Forest System roads will be maintained and reconstructed as needed to provide access, and protect and manage resources. Existing roads which are not on the system will be decommissioned. Changes to the existing road system will be based on site-specific proposals.

Description of Affected Area

The Mark Twain National Forest is comprised of about 1,496,100 acres in 29 Missouri counties. All of the Forest, with the exception of about 16,000 acres of the Cedar Creek Unit, is south of the Missouri River.

Mark Twain National Forest is characterized by three distinct geological areas. The extreme northern portion of the Forest consists of glacial till. The majority of the Forest has sedimentary surface material consisting of cherty dolomites and sandstones. In the eastern part of the Forest the St. Francois Mountains are composed of exposed igneous rocks. Elevations forest-wide range from 350 to 1,700 feet above sea level.

Map BA-3: Mark Twain National Forest Vicinity Map



Mark Twain National Forest is found primarily in the Ozark Highlands Section of the Ozark Broadleaf Forest Province. The Ozark Highlands Section is a geologically, ecologically and culturally distinct area of North America. Historically, the region was a diverse blend of forests, woodlands, savannas, glades, wetlands, caves, riparian and aquatic natural communities. High levels of geologic, soil, topographic, and hydrologic diversity result in a wide range of habitat types. Sixty five terrestrial and 67 aquatic

natural communities are home to more than 5,000 plant and at least 20,000 animal species in the Ozarks.

The Ozark Highlands Section is divided into sixteen subsections, with the 1.5 million acres of MTNF touching or including 10 of those 16 subsections. Subsections are distinguished by differences in topography, relief, the relative occurrence and patterns of natural communities, geology and hydrology. These differences play an important role in determining natural community, plant and animal distribution across the Forest. Each presents special conservation challenges because their distinctive characteristics and historical natural conditions have dramatically changed since the time of European settlement.

Species Occurrences

- There are no known sites on MTNF for Virginia sneezeweed, running buffalo clover, Topeka shiner, or pink mucket pearly mussel.
- There is one known site for Mead's milkweed on MTNF.
- Tumbling Creek cavesnail has one known location in the world, and although not on MTNF lands, about 24% of the cave recharge area is comprised of MTNF lands.
- There is one inactive bald eagle nest known to occur on MTNF lands along the Eleven Point National Scenic River, and an additional 4 active nests adjacent to or very near MTNF lands (St. Francis River, Black River, Eleven Point National Scenic River, Big Piney River).
- There are 9 known locations for Hine's emerald dragonfly, with other sites possible.
- There are 4 known Indiana bat hibernacula, and one known maternity colony on MTNF lands. There are also capture sites for 5 Indiana bats on MTNF. The extent of summer use on MTNF is unknown, although surveying data indicate that use is very low.
- There are 18 known occupied gray bat caves on MTNF, and gray bats forage along several MTNF streams and rivers.

The existing condition of MTNF lands in relation to limiting factors for the eleven federally listed species discussed is as follows:

- ***Water quality***

Water quality is generally considered good in streams and rivers that dissect MTNF lands (MDC Watershed Assessments for White, North Fork, Eleven Point, Current, Black, Meramec, St. Francis and Big Rivers). Rates of soil loss and sedimentation are relatively low in most Ozark rivers. Point and non-point pollution sources are found primarily on other ownerships. MTNF lands comprise 0.2% to 57% of the 5th level watersheds in which MTNF lands lie.

- ***Conversion of habitat***

Permanent conversion of native habitats to urban/agricultural/industrial land uses still occurs on private lands in and around MTNF. No MTNF lands are converted permanently to urban or industrial uses. Some MTNF lands have been converted from forest cover to food plots, grass fields, or wildlife openings. However, only about 5% of MTNF is in openland habitats, compared to 95% in forest cover of varying successional stages.

» ***Cave disturbance***

Two of the four known Indiana bat caves have been gated and are locked shut during the time the bats are there. Populations of Indiana bats have fluctuated in a similar manner in 3 of the 4 caves (2 gated, 2 not gated) over the past 25 years, indicating that human disturbance has not played a major role in caves on MTNF. Five of the 19 gray bat caves (26%) have been gated to prevent human entry when the bats occupy those caves. Ungated caves are subject to varying degrees of human entry, from almost none to heavy, depending on their location, ease of access and discovery, entrance configuration, and passage configuration. Several caves are protected by the difficulty of finding them, and then the technical difficulties presented in negotiating dangerous passages.

Other than structures to prevent human entry, no physical alteration of caves or cave entrances is done on MTNF. A buffer has been established around each known bat cave within which forest cover is maintained.

» ***Lack fire/woody encroachment***

Currently MTNF uses prescribed fire on about 1% or less of MTNF lands per year. The majority of natural communities on MTNF are fire-adapted, and without fire, many are degraded as woody vegetation increases in density, decreasing the diversity of ground cover. This is particularly the case with glade habitats, such as Bell Mountain Wilderness which is the site for the only known location of Mead's milkweed on the Forest. Lack of fire and increase density of trees is also a problem for HIne's emerald dragonfly which requires open, grassy fens, and for Indiana bat which prefers to forage in forest or woodland with more open understories. The Revised Forest Plan anticipates prescribed burning would be done on up to about 4% of MTNF acres per year, and would be targeted to areas with a high potential for restoration of natural community diversity and structure.

» ***Non-native invasive species***

There are a number of non-native invasive plant and animal species known to occur on MTNF. Some of these may have impacts on federally listed species. Kudzu and honeysuckle vine on trees, making dead trees unacceptable as Indiana bat roost trees. Fescue, multiflora rose, and garlic mustard, among others, crowd out native plants, simplifying ecological systems, and reducing plant hosts for the terrestrial insects eaten by Indiana bats. Feral hogs root and wallow, potentially digging up the three federally listed plants, as well as potentially destroying crayfish burrows which Hine's emerald dragonfly larvae use. Both Asian clams and zebra mussels have been found in the Missouri and Mississippi Rivers. Bald eagles eat introduced rainbow and brown trout from southern Missouri rivers during the winter. Whether or not introduced trout have had an influence on native fishes that are mussel hosts is unknown.

» ***Climate change***

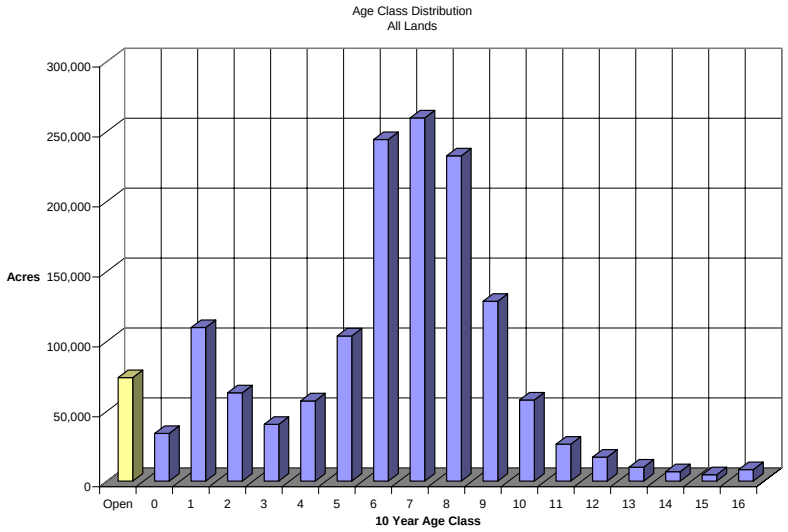
While the Ozarks climate has appeared to be stable over the past several thousand years, there are some indications that climate changes are responsible for the warming of interior cave/mine temperatures, leading to reduced suitability for hibernating Indiana bats.

» ***General Forest Conditions***

Between 1977 and 2003, the amount of black and scarlet oak on MTNF has increased by almost 29% to become by far the most prevalent forest type on MTNF. In the same time period, white oak decreased almost 61% to less than 10% of MTNF. The amount of sawtimber on MTNF has increased about 39% from 1977 to 2003. The density of trees across the Forest has also dramatically increased, with almost half of the Forest in fully to over-stocked condition in 2003, as compared to about half of the Forest in moderately stocked class in 1977.

The age class distribution of MTNF in 2003 shows the majority of the Forest is between 60-90 years old.

Figure BA-1: Current Age Class Distribution for MTNF

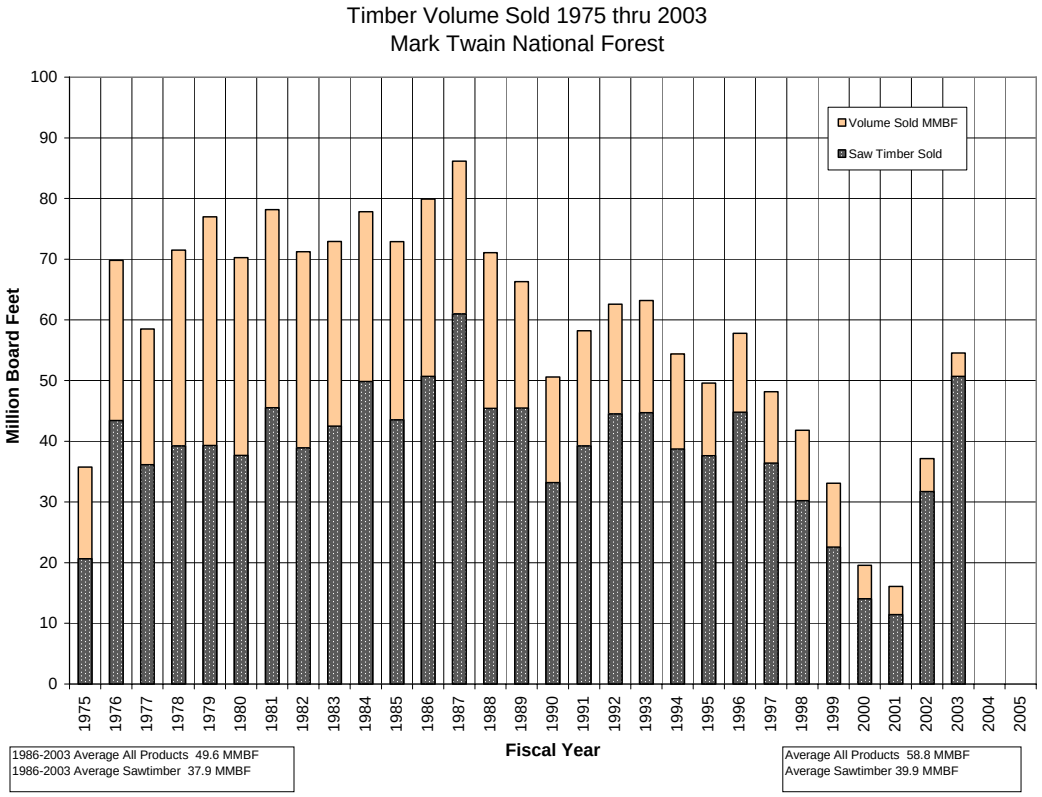


MTNF has prescribed burned about 10,000-20,000 acres per year primarily for hazardous fuel reduction and wildlife habitat improvement. The average size of a prescribed burn unit has increased over the past 10 years, and less fireline is being constructed as roads, trails, drainages, and other natural fuel breaks are being used as firelines.

The transportation system on MTNF is primarily in place, and MTNF manages about 2,366 miles of National Forest system roads, most of which are gravel or dirt-surfaced. Roads are maintained or reconstructed as needed, and as budgets allow.

Since 1975, MTNF has sold from 15-87 million board feet of timber each year. Most timber sold since about 1984 has been sawtimber.

Figure BA-2: Timber Volume Sold on MTNF



Chapter 3 of the Draft Environmental Impact Statement further describes the current condition of other natural resources on MTNF.

Critical Habitat

There is no designated critical habitat on Mark Twain National Forest for any of the species considered in this evaluation/assessment.

Species Information

For each of the eleven federally listed species considered in this assessment, the following information will be presented:

- Life History summary
- Population status range-wide, in Missouri, and on MTNF
- Causes of past and/or current declines and Limiting Factors
- Causes of past and/or current recovery
- Surveys for Species
- Occurrence on MTNF, existing and potential habitat
- Consistency of Revised Forest Plan with applicable Recovery Plan Actions
- Effects of implementation of the proposed action
- Additional measures needed for species conservation and recovery recovery
- Effects of additional measures
- Determination

Determinations

Section 7(a)(2) of the Endangered Species Act requires federal agencies to insure that their actions are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. A Biological Assessment is the means by which federal agencies gather information and evaluate their actions to determine whether or not the proposed action is likely to adversely affect listed species or designated critical habitat.

A Biological Evaluation is the documented Forest Service review of a proposed action in sufficient detail to determine how that action may affect any listed species (FSM 2670.5 (3)). Adverse effects are defined in the Forest Service manual as any action that has an apparent direct or indirect adverse effect on the conservation and recovery of a listed species. Such actions include, but are not limited to:

a) Any action that directly alters, modifies, or destroys critical habitat or essential habitats or renders occupied habitat unsuitable for use by a listed species, or that otherwise affects its productivity, survival, or mortality.
b) Any action the directly results in the taking of a listed species.
c) Any action involving the disposal of land that is essential to achieving recovery objectives.

The Forest Service manual states “Unless there is clear rationale of no effect documented in the biological evaluation (FSM 2671.44), or a letter from FWS or NMFS indicating they to not wish to consult on the Plan, or prefer to consult at the project implementation level, the Forest Service shall formally consult on Forest Plan. (FSM 2671.45c (1)).

Biological evaluations shall include a “determination of no effect, beneficial effect, or “may” effect on the species and the process and rationale for the determination” (FSM 2672.42(5.)).

Determinations are defined by the FWS as follows:

No Effect – the appropriate conclusion when the agency determines its proposed action will not affect a listed species or designated critical habitat, either positively or negatively.
May Affect – the appropriate conclusion when a proposed action may pose **any** effects on listed species or designated critical habitat. This determination requires either the initiation of formal consultation (Likely to adversely affect) or concurrence that the action is "Not likely to adversely affect" listed species.
Is Likely to Adversely Affect – the appropriate conclusion when the agency determines its proposed action may have any adverse effect to listed species, and the adverse effect(s) is not discountable, insignificant or entirely beneficial. If incidental take is anticipated to occur as a result of the proposed action, the determination should be "Likely to adversely affect". This determination requires the initiation of formal consultation.
Is Not Likely to Adversely Affect – the appropriate conclusion when anticipated effects on listed species are expected to be discountable, insignificant, or completely beneficial.

- Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- Insignificant effects relate to the size of the impact and should never reach the scale where take occurs.

Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. [ESA 3(19)]. **Harm** is further defined by FWS to include significant habitat modification or degradation that results in death or injury to listed species *by significantly impairing behavioral patterns* such as breeding, feeding, or sheltering (emphasis added). **Harass** is further defined by FWS as actions that create the likelihood of injury to listed species to such an extent as to *significantly disrupt normal behavior patterns* which include, but are not limited to, breeding, feeding or sheltering [50 CFR 17.3]." (emphasis added).

Incidental take is take of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by a Federal agency or its applicant [50 CFR 402.2].

Mead's milkweed (*Asclepias meadii*)

» Life History summary

Mead's milkweed is a long-live perennial rhizomatous herb that has low reproductive rates and may take 15 years or more to reach sexual maturity (U.S. Fish and Wildlife Service. 2003). Plants can persist indefinitely unless destroyed by animals, pathogens, or mechanical disturbance (U.S. Fish and Wildlife Service. 2003). The plant's longevity is an important strategy for survival and has allowed populations to sustain themselves through years of haying where mowing removes the fruits before they can mature and release seeds (several authors in U.S. Fish and Wildlife Service. 2003). Mead's milkweed can also spread vegetatively.

Environmental stresses can result in sterile plants, loss of flowers, or die-back of entire plants (U.S. Fish and Wildlife Service. 2003). Mead's milkweed usually does not produce seeds when self-pollinated and can experience inbreeding depression (U.S. Fish and Wildlife Service. 2003). Pollinators for this species are small bumblebees and miner bees that are strong flyers and may retain Mead's milkweed pollen sacs for up to 6 hours. Long-distance pollen transfers may occur (U.S. Fish and Wildlife Service. 2003). Seeds are wind-dispersed.

The species is genetically diverse with about 74% of genetic variation retained within populations and only 26% genetic difference between populations; characteristics of outcrossing breeding systems and wind-dispersed seeds (U.S. Fish and Wildlife Service. 2003). Because of this reproductive system, large natural populations have high reproductive potential, while populations that are small, clonal, or with few genotypes appear to have low reproductive potential (U.S. Fish and Wildlife Service. 2003).

"Mead's milkweed populations exhibit minor annual fluctuations in ramet numbers" (Betz and Hohn 1978; Freeman 1988; Betz 1989 in U.S. Fish and Wildlife Service. 2003). Individuals may be flowering, non-flowering, or absent above-ground in any given year and these differences may be caused by environmental factors or land use changes (U.S. Fish and Wildlife Service. 2003). More flowering plants occur in sites that are burned rather than mowed, but ramet densities are higher in mowed sites (U.S. Fish and Wildlife Service. 2003). Burning appears to promote sexual reproduction by flowering and is essential to maintain a population's viability (U.S. Fish and Wildlife Service. 2003).

Plants are susceptible to damage from a variety of insects, but the effects on survival and mortality are not well known (U.S. Fish and Wildlife Service. 2003). Most of the insects probably cause little harm to healthy populations if not present in excessive numbers (U.S. Fish and Wildlife Service. 2003). Milkweed cerambycid beetles and milkweed weevils feed on leaves, flowers and roots and can kill host plants or prevent seed production (U.S. Fish and Wildlife Service. 2003).

» **Population status range-wide, in Missouri, and on MTNF**

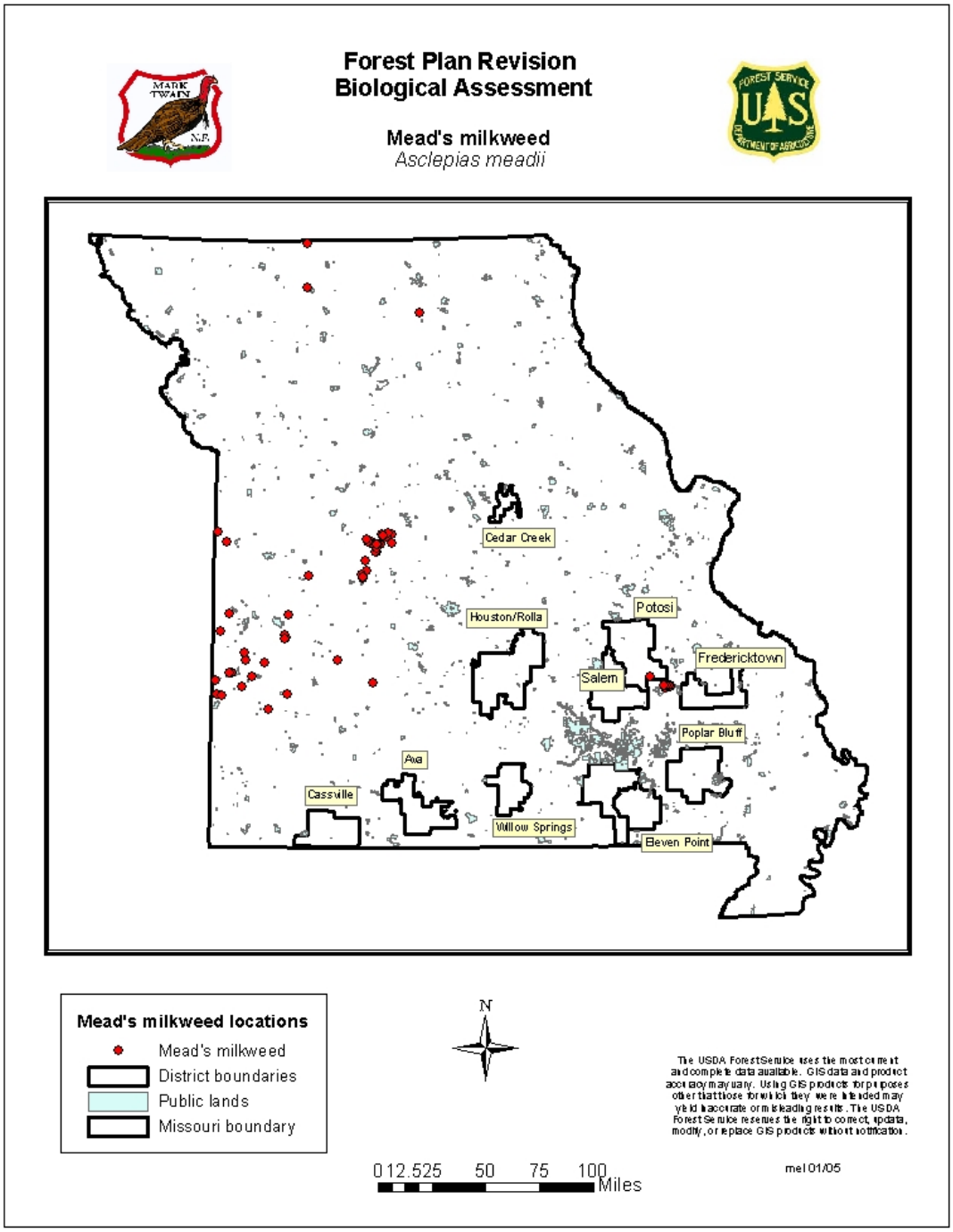
Mead's milkweed is currently found on 171 sites in 34 counties in eastern Kansas, Missouri, south-central Iowa, and southern Illinois (U.S. Fish and Wildlife Service. 2003). The majority of populations are located within a 125 square mile area of eastern Kansas and southwest Missouri (U.S. Fish and Wildlife Service. 2003). All other populations are widely dispersed across 11 counties of northern and southeast Missouri, southwest Iowa and southern Illinois. (U.S. Fish and Wildlife Service. 2003). The species has been extirpated from Wisconsin and Indiana (U.S. Fish and Wildlife Service. 2003).

The Missouri sites for Mead's milkweed are primarily on private land and in southwest Missouri (Horner 2001 in U.S. Fish and Wildlife Service. 2003). Other Missouri sites are scattered in the Unglaciated Ozark Border, Unglaciated Ozark-St. Francois Mountains, and Glaciated Plains (Horner 2001 in U.S. Fish and Wildlife Service. 2003). The long-term viability of Missouri populations is questionable since most sites lack sexual reproduction (Horner 2001 in U.S. Fish and Wildlife Service. 2003).

There is only one known occurrence of Mead's milkweed on the Mark Twain National Forest. This site is a large rhyolite glade within Bell Mountain Wilderness in Iron County. The Mead's milkweed site is about 10' X 10" in size and contained 24 ramets on 5/24/2001. In a 1993 survey, eight plants were found on the site. This population was ranked using Table 6 in the Recovery Plan, resulting in a score of 0.4 or low viability.

Mead's milkweed flower – MOFWIS photo

Figure MM-1: Mead's milkweed locations in Missouri



» **Causes of past and/or current declines and Limiting factors**

Mead's milkweed was listed as a threatened species on September 1, 1988 because of the widespread loss of prairie and glade habitat (U.S. Fish and Wildlife Service 1988). There is no critical habitat designated for this species.

Mead's milkweed is listed as endangered by the Missouri Conservation Commission (Missouri Department of Conservation 2005).

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range*** lists elimination of tallgrass prairie habitat due to urban expansion, agricultural development & practices as a threat to the species (Fed Register Vol. 53, No. 170, pg. 33993). In addition, the curtailment or elimination of fire has led to the decline of the species in southwestern Missouri, where its primary habitat is igneous glades. Mead's milkweed is a tallgrass prairie plant, and habitat loss and modification is a primary cause of past and present declines (U.S. Fish and Wildlife Service. 2003). Other factors that may threaten small, isolated populations of this species include predation, pathogens, unpredicted catastrophes, and sexual incompatibility (U.S. Fish and Wildlife Service. 2003).

Because there is a limited amount of high-quality tallgrass prairie remaining in the Midwest, available habitat size may be a limiting factor in the recovery of this species (U.S. Fish and Wildlife Service. 2003). In addition, habitat fragmentation has reproductively isolated most populations of Mead's milkweed (U.S. Fish and Wildlife Service. 2003), leading to loss of genetic material and failure to sexually reproduce.

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes*** is not considered to be a current threat to the species, but collection could stress or reduce populations in easily accessible areas (Fed Register Vol. 53, No. 170, pg. 33993).

Listing Factor C. ***Disease or predation****.* Individual plants are known to be affected by beetle larvae and weevils. The extent or severity of this as a threat to the species is not stated. (Fed Register Vol. 53, No. 170, pg. 33994).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms*** is a factor in the decision to list Mead's milkweed as threatened. Several states list the plant as threatened or endangered, but protection is variable, and enforcement difficult. Also, the majority of known populations of this species are located on private lands, and are unprotected (Fed Register Vol. 53, No. 170, pg. 33994).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. This species takes about 5-8 years to reach maturity from seed, and there are relatively low numbers of plants at each site, making it difficult to attract pollinators . In addition, numbers of individual plants at one site fluctuate over time. Seed production, germination and survival rates are low for this plant (Fed Register Vol. 53, No. 170, pg. 33994). All these factors make reproduction problematic.

With the destruction or modification of its habitat and a low reproductive rate, it is difficult for this plant to adapt to changing circumstances or colonize new sites.

Historic populations are unknown for the Mark Twain National Forest. Because the Mark Twain National Forest is composed of acquired lands (i.e. they were in private ownership, not public domain, before becoming a part of the Forest), in the southern part of the state and on lands primarily forest or woodland, alteration of glade habitats through open-range grazing is probably the primary cause of loss of habitat suitability for this species on the Forest.

At the Mark Twain National Forest site, a current threat to the known Mead's milkweed population is the lack of active management. The site is located within a Congressionally designated Wilderness, where evidence of man's work will be substantially unnoticeable and biological diversity depends entirely on the forces of nature. Woody vegetation is encroaching on the Mead's milkweed site, and there has been no fire on the site for decades.

- **Causes of past and/or current recovery**

Restoration attempts are being made in Wisconsin, Indiana and Illinois where the species is otherwise extinct (U.S. Fish and Wildlife Service. 2003). However, the current status of the species is much the same as it was in 1988 when it was listed (U.S. Fish and Wildlife Service. 2003).

- **Surveys for Mead's Milkweed**

About 550 acres of potential habitat on MTNF have been searched for additional populations of Mead's milkweed, but none have been found. An additional 150,000 acres have been surveyed for all TES/RFSS plants, and no Mead's milkweed was found during those surveys.

- **Occurrence on MTNF, existing and potential habitat**

There is no designated critical habitat for Mead's Milkweed on MTNF.

The one known site for Mead's milkweed on Mark Twain National Forest is a rhyolite glade in Bell Mountain Wilderness. The plants are located in a space of about 10 feet by 10 feet with rocky ledges on one side and encroaching red cedar on the other. Sumac stems are present across the site. Ground cover is a mat of little bluestem and sedges.

In 1993 when the population was first discovered, seven of the eight plants had inflorescences and were in healthy condition (U.S. Fish and Wildlife Service 1999). In 2001, there were 24 mature ramets. Surveys in 2004 also showed 24 ramets, and all were depauperate. Although only a fraction of the known US sites and about 2% of Missouri sites, this population represents about 8% of those populations in the country that exhibit signs of sexual reproduction, and is therefore important to the recovery of the species (U.S. Fish and Wildlife Service 1999).

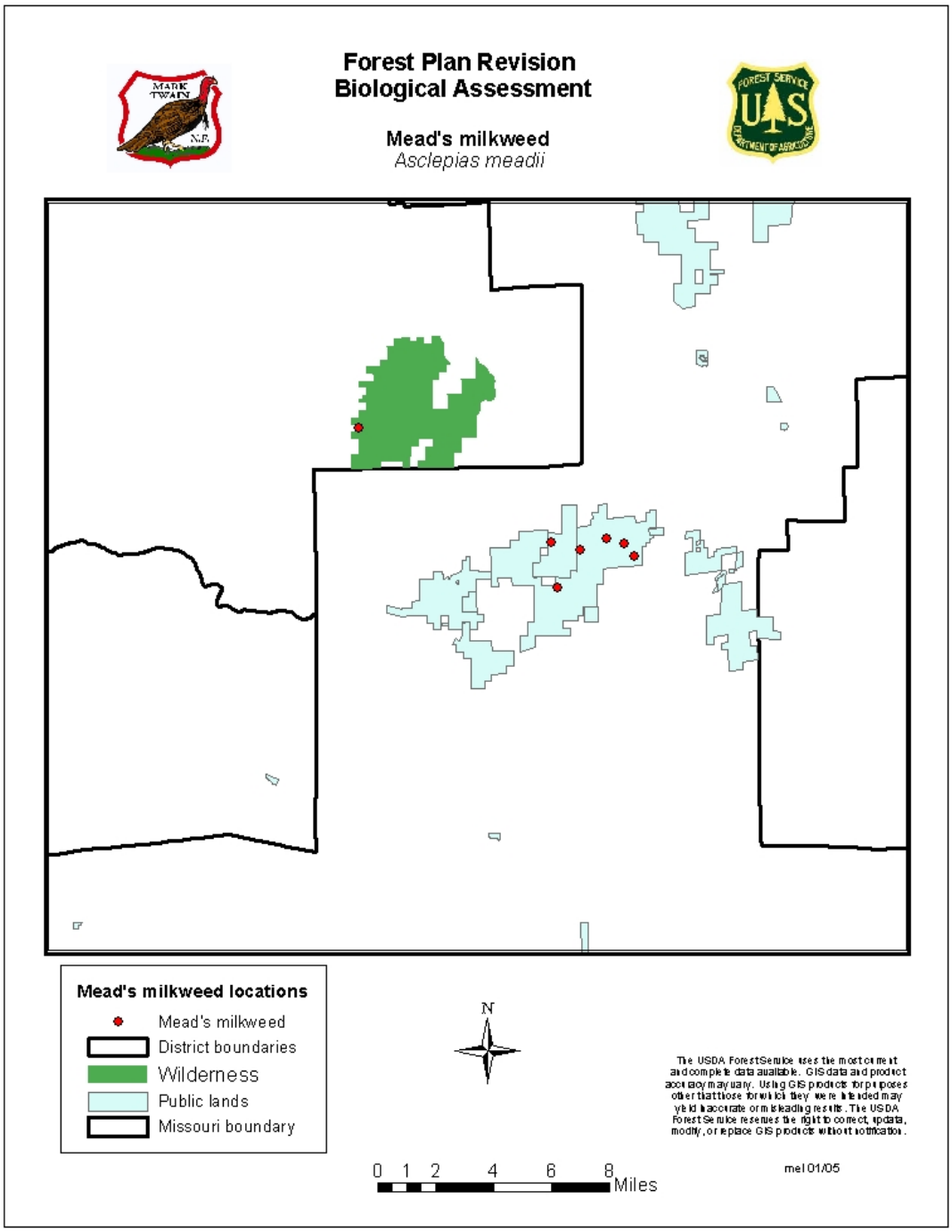
Once a population has been protected, active habitat management is a critical factor in recovery (U.S. Fish and Wildlife Service. 2003). Prescribed fire and woody vegetation removal are management actions that should be used to improve habitat quality (U.S.

Fish and Wildlife Service. 2003). At the Bell Mountain site, management is constrained by Wilderness legislation. Using prescribed fire requires permission from the Regional Forester (FSM 2324.04b(2)).

Other potential habitat for this species on Mark Twain National Forest would be open glades in southeast Missouri on the Potosi/Fredericktown Springs District. About 38,000 acres of glade habitat exists on MTNF, in varying stages of openness.

Bell Mountain Wilderness
Mead's Milkweed site
USDA Forest Service photo

Figure MM-2: Mead's milkweed locations in and near MTNF



» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

Specific management objectives of the Recovery Plan that are applicable to MTNF include a) using management techniques that mimic natural processes and prevent invasions of non-native plants; and b) recovering extant populations to viable levels.

As of 2003, there were only 7 extant populations in the Ozark-St. Francois Mountains Physiographic Region, and the Recovery Criteria is for 1 highly viable population. Currently, the population at Bell Mountain on MTNF does not meet that criteria. The Recovery Plan does state however, that "Protection of peripheral populations, even small ones, may be important in preserving the genetic variability of the species." (U.S. Fish and Wildlife Service. 2003).

Recovery Actions that are applicable to MTNF include:

1.1 Assess the viability of each population: Using the Determination of population viability index (PVI) shown on Table 6, page 22 of the Mead's Milkweed Recovery Plan, the Bell Mountain population has a PVI of 0.4 which is considered a Low viability (Bowles and Bell 1998 in U.S. Fish and Wildlife Service. 2003).

Table MM-1: Recovery Plan Table 6 – Population Viability
Bell Mountain Wilderness Site – Mark Twain National Forest
12/10/04

Variable	Current Condition	Ranking
A. Population size	24 mature ramets	1
B. Population growth trend	Increase in # from 1993 to 2001; no flowering	2
C. Effective population size/# of genotypes	24 mature ramets	1
D. Habitat size	Large glade complex, but <1 hectare inhabited	0
E. Habitat condition/successional stage	In Wilderness – no human disturbance for decades	2
F. Protection status	On federal land	3
G. Management condition	In Wilderness – no human manipulation – Badly needs fire and reduction of woody invasion	0
	TOTAL	**9**

PVI = 9/21 = 0.4 Low Viability <=0.50

2.1 Conduct management assessment of public and private lands to identify management needs. In 2001, Wildlife Biologist Dennis Heape, Wildlife Biologist Mary Lane, Forest Ecologist Paul Nelson and Alan Brant (a private contractor) visited the site and determined that a combination of prescribed fire and removal of woody species was needed at the Bell Mountain Wilderness site. Continued assessment is consistent with the revised Forest Plan.

2.2 Perform prescribed burns on a regular basis in Mead's milkweed habitat between the end of October and end of March to stimulate flowering. This action also includes removal of woody vegetation on sites that have been fire-free and are being shaded.

And

2.3 Control invasive species in habitat with extant populations of Mead's milkweed with herbicide application, biological control, and manual and mechanical brush removal between the end of October and the end of March. Management actions are not

normally performed in Wilderness, and require additional plans and approvals. The revised Forest Plan makes no changes in Wilderness standards and guidelines. While not incompatible with these Recovery Actions, it will be difficult to implement these Recovery Actions under the revised Forest Plan.

4.5 Conduct field surveys for new population occurrences or potential habitat for introduction in Southeast Missouri – Ozark-St. Francois Mountains Physiographic Region. MTNF has already conducted surveys on about 550 acres of potential habitat in this area on National Forest lands. There is nothing in the revised Forest Plan that would prohibit us from carrying out additional surveys.

» **Effects of implementation of the proposed action**

In all of the alternatives, Wilderness management is the same.

Direct Effects

Potential Negative Effects

Recreation activities which may occur in the Wilderness include hiking, horseback riding, hunting, and camping. People engaged in any of these activities might travel across the Mead's milkweed site, trampling the plants if not in the dormant season. The Mead's milkweed site is located about ¾ mile from the nearest trailhead and about 100 feet downslope from the nearest trail. Bell Mountain Wilderness is 9,027 acres. Use levels for hiking, horseback riding, hunting and camping have historically been low. Considering the site location in relation to the trail, the low levels of use, and the small area covered by the plant, I consider it only a remote possibility that recreationists would walk over the Mead's milkweed site.

Feral hogs are present on MTNF lands. Hikers reported seeing feral hog sign within Bell Mountain Wilderness in winter 2005 (Larry Furniss, pers. comm. 2/14/05). Feral hogs root and wallow and can do considerable damage to soil and vegetation (Missouri Department of Conservation 2005(a)). The Forest Service, in cooperation with APHIS and MDC, is making a concerted effort to eliminate feral hog populations, but continuing illegal releases make it a losing proposition. It is possible that feral hogs could root up and harm or destroy the Mead's milkweed population on Bell Mountain in search of roots to eat. I consider this possibility to be small, but present.

Arson is a problem on the forest and a wildfire that occurred during the growing season might damage or destroy some or all of the plants. Most arson fires occur in the fall (after leaf-fall) and in the late winter or early spring (through early April). There was one arson fire on the east side of Bell Mountain Wilderness in 2003. Prior to that, the last known arson fires were several small sets on the northeast side of the Wilderness in the late 1980's. Both these fires were far from the Mead's milkweed site. I consider the potential for an arson fire to affect the site to be a fairly remote possibility.

Collecting could be a threat to this population if unscrupulous botanists, nursery owners, or herb dealers knew the site existed. This plant is not known for any medicinal properties, is not showy, and would not be a particularly good target species. Therefore, I consider this to be a remote possibility.

Potential Beneficial Effects

On the other hand, a wildfire that occurred in the dormant season could actually benefit the plants by top-killing encroaching woody vegetation. Again, however, this would be a remote possibility.

Indirect Effects

Potential Negative Effects

With no prescribed fire and no cutting of encroaching woody vegetation, it is likely that habitat quality at the Bell Mountain Wilderness site will decline. Woody vegetation will eventually take over the site, shading the plants. It has been suggested that Mead's milkweed plants may remain dormant several years in response to environmental factors; a theory supported by observations of populations that fluctuate widely from year to year and may be absent completely for a few years (U.S. Fish and Wildlife Service 1999).

So, even with no active management, the plants at Bell Mountain Wilderness may persist for many years. However, Missouri Department of Natural Resources has found that Mead's milkweed will disappear from glades if fire is not used on a regular basis (U.S. Fish and Wildlife Service 1999). With no active management, I believe the plants will eventually disappear from this site, thus losing a genetic component that might otherwise help in recovery of this species. "A small proportion of unique alleles also occurs among different populations, making small populations important genetic resources." (U.S. Fish and Wildlife Service. 2003).

The Bell Mountain Wilderness site constitutes about 0.67% of the known extant sites in the United States and about 2% of known sites in Missouri. With no active management, it is reasonably foreseeable that the population on MTNF will decline in vigor and health, and eventually disappear from the site.

Potential Beneficial Effects

Glades that are not within Wilderness may be managed as part of natural community restoration or enhancement in any of the alternatives. Prescribed fire and control of encroaching woody vegetation would provide conditions suitable for Mead's milkweed (i.e. grass/forb ground cover with little accumulated mat and few to no woody stems) across the Ozark-St. Francois Mountains Physiographic Region. The more acres treated in this way, the more habitat would be potentially suitable for this species. Fewer acres treated would result in less potentially suitable habitat.

- Alternative 1 would have the least acres treated since there would be no commercial method to harvest woody vegetation, and thus the least amount of potentially suitable habitat maintained.
- Alternative 2 would have the most acres treated since it maximizes the restoration of natural communities, and thus the most potentially suitable habitat maintained.
- Alternative 3 (the Proposed Alternative) would have a moderate amount of glade treatment, which would be somewhat more potentially suitable habitat than is available currently.
- Alternative 4 would be similar to Alternative 1.

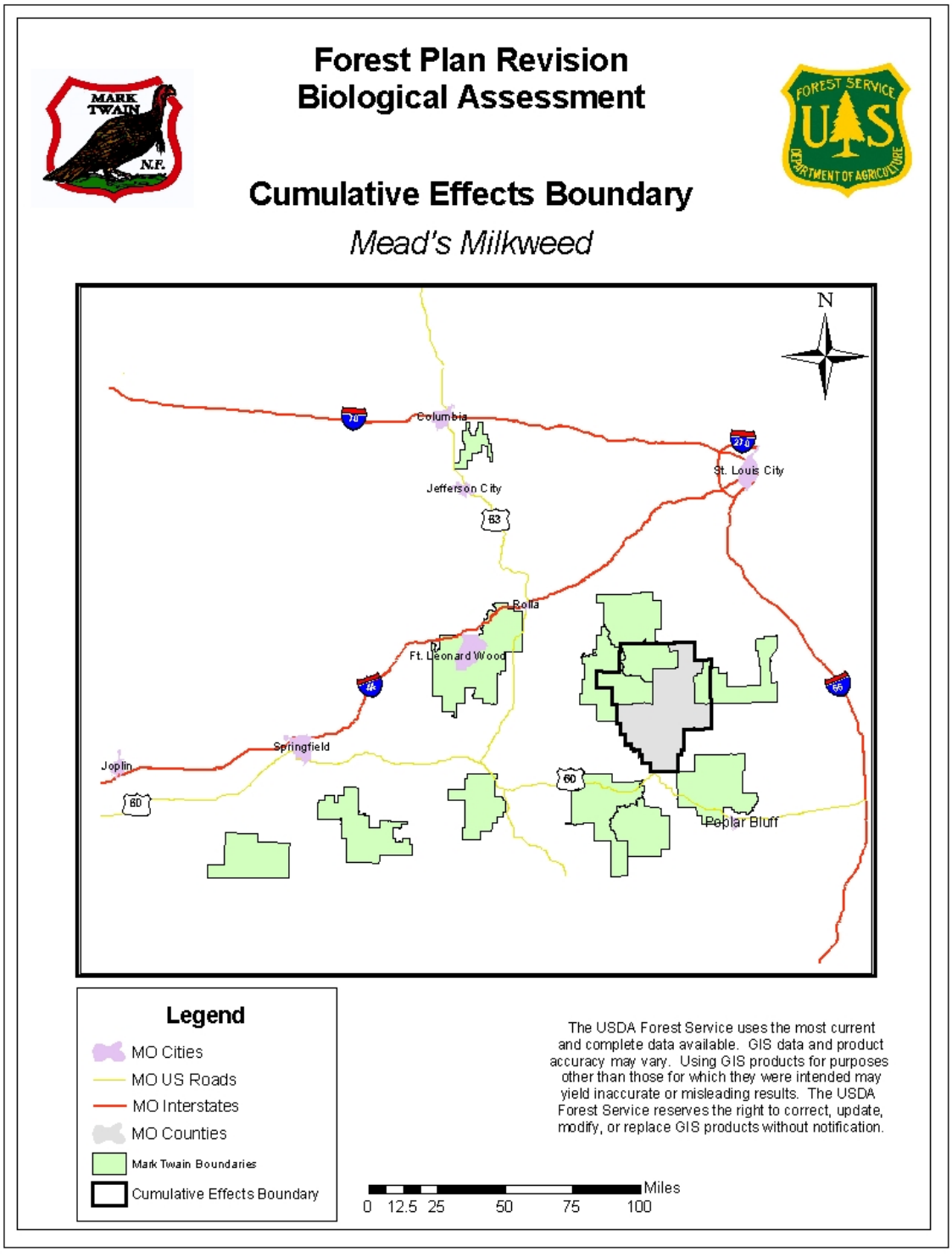
While suitable habitat may exist, it is unclear whether or not that habitat would be occupied by Mead's milkweed even if available. Mead's milkweed has low reproductive rates and may require 15 years or more to reach maturity (U.S. Fish and Wildlife Service. 2003). Seeds are wind-dispersed and could travel for some distance (U.S. Fish and Wildlife Service. 2003). However, Mead's milkweed does not usually produce seeds when self-pollinated (U.S. Fish and Wildlife Service. 2003). Cross-pollination between the 7 populations in the Ozark-St. Francois Mountain Physiographic Region would have to occur for seeds to be produced and potentially spread to unoccupied suitable habitat in the region. This is possible since the bee pollinators are strong flyers and Mead's milkweed pollen can be retained on the bees for up to 6 hours (U.S. Fish and Wildlife Service. 2003).

Cumulative Effects

Boundaries:

The one known site for Mead's milkweed in Missouri is in Iron County with only six other locations known to occur within 5 miles of the National Forest boundary. All other known locations for Mead's milkweed are in prairie habitat in the extreme north and west counties of Missouri. The two counties which contain the glade habitats for Mead's milkweed (Iron and Reynolds) are the spatial boundary for cumulative effects analysis for Mead's milkweed because all effects to this population in Missouri would occur in that area.

Figure MM-3: Cumulative Effects Boundary for Mead's Milkweed



The temporal boundary for cumulative effects analysis for Mead's milkweed is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years beyond the anticipated Plan life was selected

because any potential beneficial impacts from improvement of glade natural communities would have been realized by then.

Past and Present Actions

Past and present actions on National Forest lands in these two counties are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. In the case of Mead's milkweed, past and present actions have resulted in a deteriorating condition of the glade habitat in which the one population is found. The lack of fire and encroachment of cedar and other woody vegetation makes the current habitat marginal and getting worse.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, many glades were overgrazed, and invaded by woody species or non-native invasive species (U.S. Forest Service 2005b, page 3-46). Some of these glades were later acquired by the Forest Service and some are still on other ownerships.

Reasonably Forseeable Actions

On National Forest lands within the two counties, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,

- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Since the other known locations of Mead's milkweed within the two counties are all on lands owned by the state of Missouri (Missouri Department of Natural Resources and Missouri Department of Conservation), reasonably foreseeable actions on these ownerships can be predicted based on past trends. Each of these agencies has a different purpose and objectives for management of their lands, but both agencies are conservation-based and subject to state laws.

Both agencies have managed their lands to maintain or improve glade habitats through prescribed burning, various types of timber harvest, and limited herbicide use. Both also provide recreational experiences. Neither agency has changed its management emphasis recently, and it is reasonable to assume these types of activities would continue into the foreseeable future.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the two county area. However, none of the known locations for Mead's milkweed in these two counties is on private land.

Effects Analysis

There is nothing in the Revised Forest Plan which would prohibit the Forest Service from carrying out the actions needed to manage the one population of Mead's milkweed on National Forest lands.

It is reasonable to assume that the MDNR and MDC will continue to manage their Mead's milkweed sites to perpetuate open glade communities that would provide appropriate habitat for the species. These two agencies will also likely continue efforts to control or eradicate feral hogs from their ownerships. Therefore, it is reasonable to assume that habitat would continue to be available for this species on these ownerships.

If the Forest Service does not reintroduce fire and control woody vegetation at the Bell Mountain site, it is likely that this population would eventually disappear. If the Forest Service does reintroduce fire and control woody vegetation at the site, it is likely that the population would respond with more vigorous growth. Whether or not the plants would eventually reproduce sexually is uncertain.

Conclusions:
In the short-term, loss of 0.67% of the known sites for Mead's milkweed would not appear to have an impact on viability of the species. However, while the known population on MTNF is a small fraction of Missouri's population and an even smaller fraction of the range-wide population, its genetic material may be important in cross-pollinating other genets to achieve sexual reproduction. This may, in turn, contribute to the recovery of the species in the long-term. It is impossible to say whether or not the existence of the Bell Mountain Wilderness population is critical to the species' survival.

» **Additional measures needed for species conservation and recovery**

The Recovery Plan (pages 32-34 and 65) lists conducting field surveys for new populations as a Priority 3 recovery action (on a scale of 1-3 with 1 being required to prevent species' extinction or irreversible decline in the foreseeable future and 3 being all other recovery actions). The area most relevant to the MTNF is the Ozark-St. Francois Mountains Physiographic Region (Item 4.5 on page 33-34) which includes parts of the Potosi/Fredericktown District. As of October 2004, about 550 acres of potential habitat on MTNF have been searched for additional populations of Mead's milkweed, but none have been found. An additional 150,000 acres have been surveyed for all TES/RFSS plants, and no Mead's milkweed were found during those surveys.

Glades that could provide potential habitat for Mead's milkweed should be evaluated for potential habitat and searches done as appropriate to attempt to locate new populations. Should additional populations be discovered on National Forest lands outside Wilderness, a management plan should be developed to protect and manage the site(s) to maintain or improve habitat. Prescribed burning on the site(s) should only occur in the dormant season for Mead's milkweed, i.e. burning could occur from the end of October through the end of March.

Control or eradication of feral hog populations is needed.

» **Effects of additional measures**

Surveys of potential glade habitat in the Ozark-St. Francois Mountains Physiographic Region may turn up additional populations of Mead's milkweed. If outside Bell Mountain Wilderness, those populations would be subject to the standards and guidelines of the management prescription area in which they were found. Prescribed fire and removal of encroaching woody vegetation are possible in all other management prescriptions, and could be beneficial to the species. With the provision that ***any prescribed burning be done in the plant's dormant season***, there would be no adverse impacts to the species, and long-term beneficial effects by maintaining the suitability of habitat.

Control or eradication of feral hog populations would eliminate the potential for hogs rooting up or wallowing on Mead's milkweed sites.

» **Determination - May Affect – Likely to Adversely Affect**

Rationale: With no prescribed fire and no cutting of encroaching woody vegetation, the health and vigor of the Bell Mountain population is likely to decline. The plant may persist for some years, but is likely to disappear in the future, resulting in a loss of valuable genetic material. Missouri Department of Natural Resources has found that Mead's milkweed will disappear from glades if fire is not used on a regular basis (U.S. Fish and Wildlife Service 1999).

Running buffalo clover (*Trifolium stoloniferum*)

» Life History summary

Running buffalo clover is a perennial, growing 4-20 inches tall. It forms long stolons that root at the nodes. The white, round flower heads are borne on erect stems from 3-6 inches tall with two leaves near the top. Flowering takes place from mid-April through July, and is induced by exposure to temperatures which vary between 30-40 degrees Fahrenheit or less (Campbell et al. 1988 in NatureServe). Insect pollinators are unknown and have not been studied. This species is easily propagated from cuttings.

The plant is believed to be self-fertile, with good seed production. Scarification is evidently necessary for germination. Historically, scarification would have occurred as the seeds passed through the digestive system of large and small herbivores, from bison and deer to rabbit (Cusick 1988a, Thurman 1988, Campbell et al. 1988 all in NatureServe). This process was also an important method of seed dispersal. Today, cattle have replaced bison throughout the plant's range, but it is unclear whether cattle and bison are ecologically equivalent (Vincent, pers. comm., Windus, pers. comm., Harmon, pers comm. in NatureServe).

Unlike most other legumes, running buffalo clover does not have rhizobial infections. There are two hypotheses to explain this – one that extant populations are small remnants of larger populations that have either lost the Rhizobium as a result of declining population, or that the loss of Rhizobium contributed to the species decline (Leblanc and Aldrich 1988 in NatureServe). The second hypothesis is that this species never required rhizobial infection to remain healthy or propagate.

Running buffalo clover occurs primarily in mesic habitats with filtered sunlight, in areas with periodic moderate soil disturbance. The extant sites are found in a variety of habitats, including savannas, floodplains, stream banks, lawns, grazed woodlots, mowed paths, old logging roads, jeep and skid trails, mowed wildlife openings within mature forest, and steep, weedy ravines (Serena Selbo, USFWS, pers. comm.. 5/6/04). Running buffalo clover is thought to be dependent on bison or other large ungulates to scarify and spread seed, and to provide the moderate soil disturbance necessary for proliferation and spreading.

» Population status range-wide, in Missouri, and on MTNF

Until 1985, when 2 small populations were discovered in West Virginia, this species was thought to be extinct. Since then, extant populations have been discovered at 164 sites in West Virginia, southern Ohio, Kentucky, Indiana, and Missouri. Historic range included these five states, along with Arkansas, Illinois, Kansas, and Nebraska.

The largest number of sites occurs in Kentucky with 98 sites, followed by West Virginia with 29, Ohio with 16, Indiana with 5 sites and Missouri with 3 sites, (Serena Selbo, USFWS pers. comm..5/6/04). Most populations are small, C- or D-ranked sites of less

than 100 rooted crowns, but there are several A-ranked occurrences with more than 1000 rooted crowns per site (primarily on the Monongahela National Forest in West Virginia) and B-ranked occurrences with 101-999 rooted crowns. (NatureServe, no date).

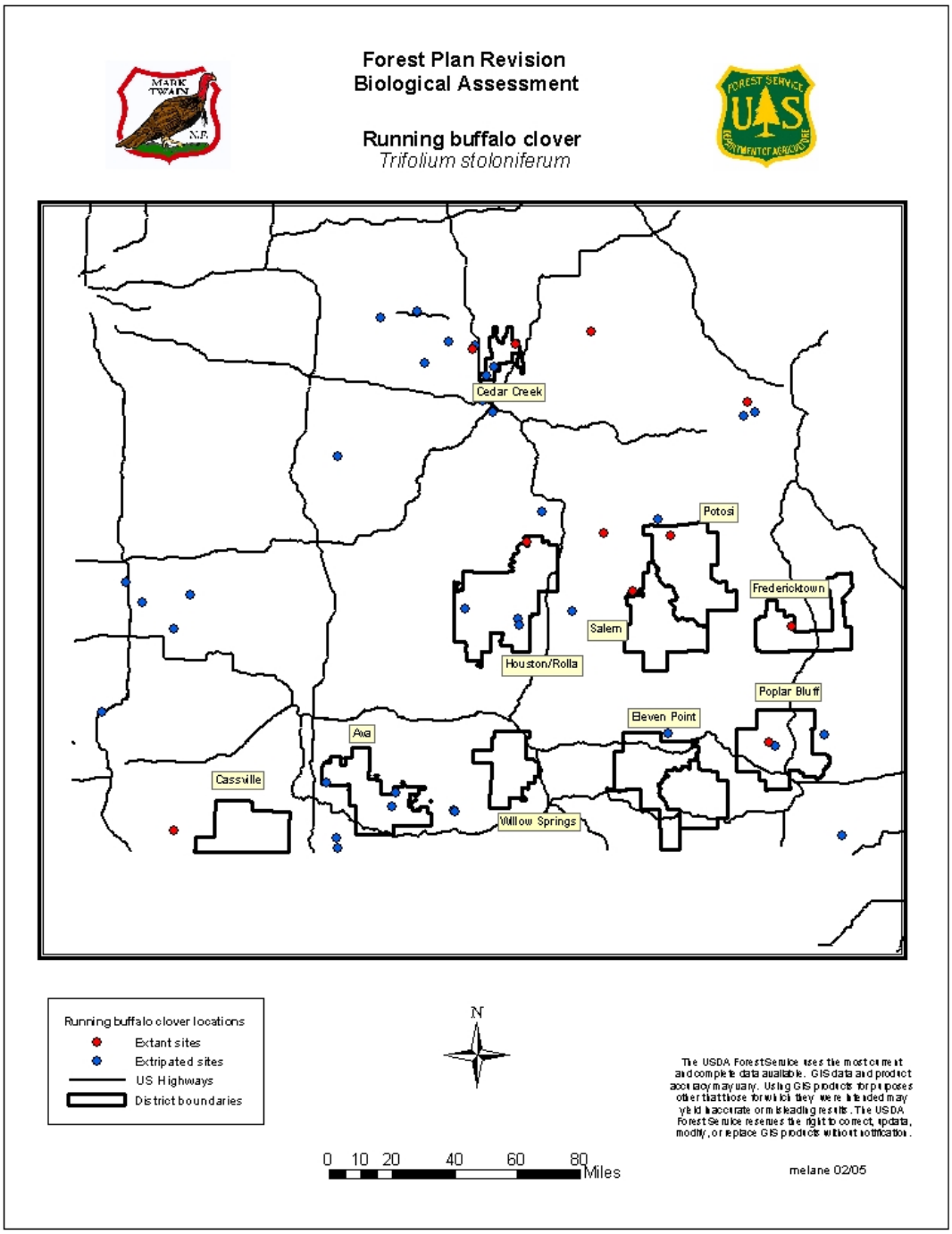
Running buffalo clover formerly occurred in the southern 2/3 of Missouri. Historical collections are recorded from St. Louis, Cooper, Jasper and Wayne Counties, Missouri (Hickey 1994). By 1907, the plant was considered extirpated from the state (Missouri Department of Conservation .1998). The re-discovery of running buffalo clover in Missouri occurred in 1990, when a load of topsoil delivered to a botanist's home contained seeds that sprouted into running buffalo clover plants. In a subsequent search of the area from which the topsoil came, no running buffalo clover plants were found. The newly discovered plants were propagated at Missouri Botanical Garden for use in re-introduction efforts (Center for Plant Conservation, no date). Since then, four other populations have been found in Missouri. The first was in 1994 on private land in Madison County, the second was discovered in 1998 in Maries County (Missouri Department of Conservation. 1998), the third in Phelps County in 1999, and the fourth in Montgomery County in 2003.

The populations in Phelps and Maries County have declined and are presumed gone (Smith, pers. comm.. 2004). The Phelps County population had been sprayed with herbicide when it was found, and subsequently did not re-appear. The population in Maries County disappeared from its discovery in 1998 to 2001, despite the fact that habitat appeared unchanged and there was no apparent physical disturbance (Smith, pers. comm. 2004). The population in Madison County has declined from 199 nodes in two subpopulations to 9 nodes in a single population (Smith, pers. comm. 2004).

There are no known naturally occurring populations of running buffalo clover on MTNF. Over the past 15 years, approximately 150,000 acres of MTNF have been surveyed for all TES/RFSS plants. These surveys were primarily done through contracts with Universities or private botanists. All habitats were surveyed, with particular attention given to those habitats known to support TES in other areas. As of October 2004, no running buffalo clover populations have been found during these field surveys.

Running buffalo clover
Photo by Missouri Department of Conservation

Figure RBC-1: Running buffalo clover locations in Missouri



» **Causes of past and/or current declines and Limiting Factors**

Running buffalo clover was listed as an Endangered Species on July 6, 1987 (50 FR 21478-21480) because of widespread habitat loss and competition with introduced

clover species (Missouri Department of Conservation 1998). There is no critical habitat designated for this species.

Running buffalo clover is listed as endangered by the Missouri Conservation Commission (Missouri Department of Conservation 2004).

The range-wide cause of the original decline has not been determined, but may be a result of the disappearance of large herbivores, particularly bison (U.S. Fish and Wildlife Service. 1989). Herbivores functioned as a seed dispersal mechanism, as well as providing physical disturbance necessary to the plant's survival.

Other possible causes for the continued decline include competition from other plants, particularly non-native invasives and other clovers; herbivory by rabbits and deer, overgrazing, and no grazing at all (Serena Selbo, pers. comm.. 5/6/04).

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** Land development for urban expansion is a serious threat to running buffalo clover habitat. Much of the area near extant sites is composed of non-native vegetation (Serena Selbo, pers. comm. 5/6/04). Non-native clovers may have also contributed to decline of running buffalo clover by invading habitat and outcompeting the native plant. Other non-native invasive plants may also affect running buffalo clover habitat.

Original habitat for running buffalo clover is thought to be canopy gaps in old growth forest in the eastern United States and areas where bison removed or suppressed other vegetation to provide open understories and light gaps necessary for running buffalo clover to thrive. Current harvest practices may create the canopy gaps and moderate ground disturbance required by this species. A study which compared running buffalo clover populations before and after logging showed an initial decrease, but a rebound to higher than pre-disturbance population (Madarish and Schuler 2002).

Today, overgrazing can be a threat to extant populations, as can no grazing at all, which results in heavy shading and no ground disturbance.

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** There is no known commercial or recreational use for running buffalo clover. Collection of this plant for scientific or educational purposes is limited and poses only a minimal threat to the species. However, individual populations of small size may be subject to overutilization. (Serena Selbo, pers. comm. 5/6/04).

Listing Factor C. ***Disease or predation***. It has been suggested that a pathogen introduced from the non-native white clover may be partially responsible for the decline of running buffalo clover. However, no specific disease has been identified (Serena Selbo, pers. comm. 5/6/04).

Herbivory has also been suggested as a cause of decline. In Missouri, running buffalo clover plants have been continually gnawed to the ground by rabbits, slugs and rodents; while similar events have been reported in West Virginia and Kentucky with groundhogs and deer. In a West Virginia incidence, the affected plants had more than a dozen rooted crowns the following year, and palatable greens may be an evolutionary advantage as an attractant for seed dispersal (Serena Selbo, pers. comm. 5/6/04).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms***. Most state laws currently provide little additional protection for federally listed plants. Running buffalo clover is listed as Endangered in Missouri (Missouri Department of Conservation 2004), prohibiting the exportation, transportation or sale, or possession with intent to sell, of any part of the species.

Sites on National Forest or other federal ownerships are afforded some protection, since federal agencies are required to avoid jeopardizing the species under the Endangered Species Act. However, since running buffalo clover requires periodic disturbance, management is many times lacking.

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Poor seed dispersal mechanisms may be a problem in the continued existence of this species. Seed quality may also play a part in the decline of the species.

The small size of most existing populations is also a concern for several reasons. Major disturbances, viral infections, or heavy predation could easily wipe out entire sites. Inbreeding within small populations with little genetic diversity may lead to reduced vigor and declining numbers.

» **Causes of past and/or current recovery**

Between 1990 and 1994, 27 experimental plantings were established on MDC lands with plants propagated at Missouri Botanical Garden from the seed collected from topsoil delivered to a homeowner in St. Louis. Of these plantings, ten still had rooted crowns as of 1998. By 2002, twenty of the sites were considered extirpated, and the largest of the four surviving populations had 35 nodes in 2002. As of 2004, none of the populations had persisted.

In 1992, MTNF entered into a Challenge Cost Share agreement with the Missouri Botanical Garden and Northeast Missouri University – Kirksville to establish experimental populations of running buffalo clover on MTNF. The Forest hired botanist Ethel Hickey to spearhead the effort. From 1992 – 1994, plants were established at eleven sites on the Cedar Creek, Rolla-Houston, Ava-Cassville, and Poplar Bluff districts of MTNF, mirroring the distribution of the 4 known historical sites. Several different natural divisions, natural communities, light intensities, and disturbance factors were represented in the selected sites (Hickey. 1994 page 3).

Results of this project were not particularly encouraging. Viral symptoms were noticed in the first year in eight of the first nine plantings (Hickey. 1994). Seven of these eight sites were eliminated as a reintroduction site because they had less than 4 individuals, all with signs of viral infection (Hickey. 1994). Some of these sites were also subject to extreme flooding which caused loss of some of the plants.

» **Occurrence on MTNF, existing and potential habitat**

There are no known natural occurrences of running buffalo clover on MTNF.

Potential habitat occurs on MTNF in the Ozark Border and Ozark Natural Divisions of Missouri in the form of mesic upland and bottomland woodlands with filtered light and nutrient rich soils. This type of habitat occurs on about 10,000 acres of MTNF (about 7% of MTNF).

» Surveys for Running Buffalo Clover

About 150,000 acres of MTNF have been surveyed for all TES/RFSS plants, and no running buffalo clover was found during those surveys.

» Consistency of Revised Forest Plan with applicable Recovery Plan Actions

The 1989 Recovery Plan has two Recovery Plan Narrative items that are applicable to MTNF.

- Item 122. Surveys in western part of range (including Missouri) states that surveys should continue and be focused on surveying disturbed woodlands near streams. It further states that "If extant populations are not found in this region in three years, these surveys should be deemphasized and done opportunistically." (U.S. Fish and Wildlife Service 1989, page 13). Three years from the date of the Recovery Plan would have been 1992. Surveys to locate sensitive, threatened, and endangered plants have covered about 150,000 acres of Mark Twain National Forest lands in the past 15 years. Botanical surveys continue to be conducted on MTNF, and running buffalo clover is one of the target species. There is nothing in the revised Forest Plan that would prohibit the Forest Service from continuing survey efforts.

- Item 23. Develop methods for enlarging population sizes, "such as planting from cultivated stock" (U.S. Fish and Wildlife Service 1989, page 16). Mark Twain National Forest initiated a study in 1992 to propagate and reintroduce running buffalo clover to National Forest lands in Missouri. From 1992 – 1994, plants were established at eleven sites on MTNF, mirroring the distribution of the 4 known historical sites. These plantings did not result in successful reestablishment. There is nothing in the revised Forest Plan that would prevent MTNF from participating in other reestablishment efforts in the future.

» Effects of implementation of the proposed action

Direct Effects - Because there are no known populations of running buffalo clover on MTNF, there would be no direct effects. If populations of running buffalo clover are discovered in the future on MTNF, the Forest Service would reinitiate consultation with USFWS on this species.

Indirect Effects – While some suitable habitat exists on MTNF, botanical surveys of more than 150.000 acres of MTNF lands have found no populations of running buffalo clover. In addition, the populations introduced on MTNF have not successfully persisted.

Until such time as there is evidence that running buffalo clover may actually occur on MTNF, there would be no indirect effects on potential habitat.

Cumulative Effects - Since there are no direct or indirect effects, there are no cumulative effects.

- **Additional measures needed for species conservation and recovery**

Continue opportunistic surveys to try and locate new populations of this species

- **Effects of additional measures**

New sites could be found on MTNF. If new sites are located, consultation with USFWS would be reinitiated.

- **Determination – No Effect**

Virginia Sneezeweed (*Helenium virginicum*)

» Life History summary

Helenium virginicum (Virginia Sneezeweed) is a perennial plant and a member of the aster family (Asteraceae) known only from Augusta and Rockingham counties, Virginia and 43 sites in Missouri. *Helenium virginicum* stems grow to a height of 4 to 11 decimeters (1.5 to 3.5 feet) above a rosette of basal leaves. Coarse hairs are visible on the basal and lower stem leaves. The basal leaves may be broad in the middle tapering toward the ends, but otherwise may appear oblong. Stem leaves are lance-shaped, and become progressively smaller from the base to the tip of the stem. The stems are winged, the wings being continuous with the base of the stem leaves. The flower ray petals are yellow, and wedge-shaped with three lobes at the ends. The central disk of the flower is nearly ball-shaped. Flowering occurs from July to October (Virginia Department of Conservation and Recreation 1995).

Helenium virginicum is similar to Common Sneezeweed (Helenium autumnale), but differs in having a sparsely-leaved stem, larger basal leaves, and longer pappus scales (appendages which crown the ovary or fruit). It is also differentiated by leaf shape, stem and leaf hairs, and habitat requirements. Comparison of morphological and ecological characters with plants in common gardens and transplant sites (Knox et al. 1995) clearly demonstrated that *Helenium virginicum* and *Helenium autumnale* were two distinct species.

S.F. Blake first described *Helenium virginicum* in 1936 from specimens collected near Stuart's Draft, Virginia. In Virginia, the species is a wetland plant found on the shores of shallow, seasonally flooded ponds in Virginia's Shenandoah Valley. In Missouri it occurs in a variety of habitats that exhibit a seasonal hydroperiod and occur in full sunlight. These habitats include are sinkhole ponds, wet swales, farm ponds and roadside ditches.

From 1985 through 1995, extensive status survey work was conducted for *Helenium virginicum* in over 100 limestone sinkhole ponds along the western edge of the Blue Ridge Mountains in the Shenandoah Valley of Virginia. A total of 28 separate populations were located during these surveys. In addition, one Helenium population with similarities to *Helenium virginicum* was found near Pomona, Missouri. This population was originally described as a hybrid between Helenium autumnale and Helenium flexuosum (Steyermark 1960). Its taxonomic status was regarded with uncertainity until and Internal Transcribed Spacer Region (ITS) sequence demonstrated that there was no significant genetic difference between the Missouri and Virginia populations (Simurda and Knox 2000)

The ponds supporting *Helenium virginicum* range in size from less than 0.04 hectare (ha) (0.1 acre (ac)) to 3 ha (8 ac) and are seasonally flooded or semi-permanent bodies of water. These ponds have poorly drained, acidic, silty loam soils, and are typically flooded from January through July.

Helenium virginicum is adapted to survive the water level fluctuations of the seasonal ponds, giving it a competitive advantage in this habitat. From year to year, the number of *Helenium virginicum* plants at any given site may vary greatly. A high water level one year may leave the ponds flooded, resulting in less shoreline for plants to become established or to survive. However, a high water level also eliminates the invading shrubs and trees that may compete with *Helenium virginicum* on the pond shores. When the water level is lower, more pond shore is exposed and the surviving plants and the seeds stored in the soil enable the *Helenium virginicum* populations to rebound (Virginia Department of Conservation and Recreation 1995).

Helenium virginicum disperses seeds in late fall and winter; the seeds germinate in late summer or early fall of the following year if conditions are suitable. Seeds will not germinate in the dark or under a standing column of water. In the first year of growth, the plant exists as a basal rosette with a diffuse root system. Plants seem to grow year-round, even while submerged. Flowering usually does not occur until the plant is more than 1 year old. *Helenium virginicum* forms one aerial stem bearing several flower heads during the first flowering season; in subsequent years it may form several flowering stems in a season.

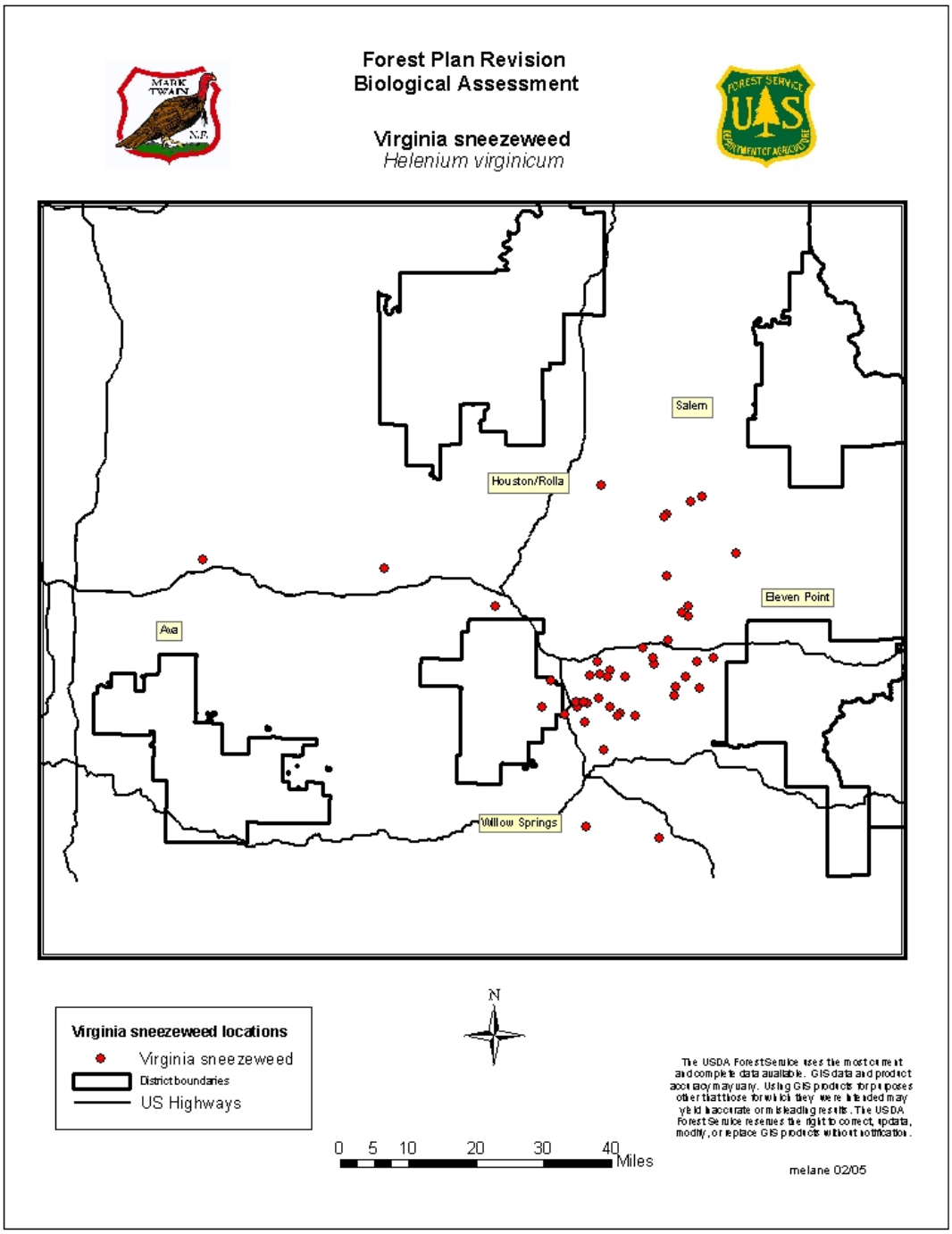
- **Population status range-wide, in Missouri, and on the Forest**

Virginia Sneezeweed was first described in 1936 by S.F. Blake on a collection made from a site discovered in Augusta County, Virginia in that same year. For 21 years Virginia was the only state in which Virginia Sneezeweed was known to occur. Then, in 1957, Julian Steyermark collected a specimen of Helenium from the edge of a sinkhole pond near Pomona, Missouri (Steyermark 1960).

Steyermark initially thought this specimen was a hybrid between *Helenium flexuosum* and *Helenium autumnale*, and specimens were deposited in the Gray Herbarium of Harvard University and in the University of Missouri Herbarium in Columbia, Missouri. The taxonomic status of the Pomona, Missouri population remained in doubt until 1999, when ITS sequencing concluded that the Missouri and Virginia populations were the same species (Simurda and Knox 2000).

In 2003, the Missouri Department of Conservation inititated surveys for Virginia Sneezeweed in an effort to determine the status of the species in Missouri. Since 2003, 42 additional populations have been discovered. Furthermore, reintroduction efforts by the Missouri Department of Conservation have resulted in the establishment of two more populations. Including the original population discovered by Steyermark in 1957, there are presently 45 populations in Missouri. It is expected that further surveys will yield more populations of this species.

Figure VS-1: Virginia Sneezeweed locations in Missouri



» **Causes of past and/or current declines and Limiting factors**

Virginia Sneezeweed was federally listed as threatened on December 3, 1998, because of the limited numbers of populations discovered after extensive survey efforts,.and is state-listed in both Missouri and Virginia – the two states in which it is known to occur.

Section 4 of the Endangered Species Act (16 U.S.C. 1513) and regulations (50 CFR part 424) were promulgated to implement the listing provisions of the Act set forth the procedures for adding species to the Federal lists. The Act determines a species to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1). These factors and their application to *Helenium virginicum* (Virginia Sneezeweed) are as follows:

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** Habitat modification is the principal threat to *Helenium virginicum*. The species is threatened by residential development, incompatible agricultural practices, filling and ditching of wetland habitats, groundwater withdrawal, and other disruptions of hydrology. Because the survival and maintenance of *Helenium virginicum* populations depend on seasonal water level fluctuations, either wetland drainage or increases in the time of inundation may cause high levels of mortality.

Of the 18 Virginia populations visited in 1995, eight were located in relatively undisturbed wetlands, while the remaining ten were in wetlands altered by ditching, mowing, grazing or filling (Van Alstine 1996). At least four of the sites where the species has dramatically declined in recent years have modified hydrology (Van Alstine and Ludwig 1991). Three of these sites have been either ditched or filled, thereby shortening or eliminating the wet phase.

Cattle grazing and mowing affect in a positive manner many of the sites supporting the species. In general, moderate levels of grazing and mowing appear to be beneficial, since populations at several regularly grazed or mowed sites are among the largest and best established. Nonetheless, there is a potential that frequent, or poorly timed mowing (and perhaps overgrazing) could have a long-term adverse effect on the species by interfering with flowering and seed production (Van Alstine and Ludwig 1991).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes*****:** Other species in the genus Helenium have been shown to contain compounds with antitumor properties. However, there is no information to show that *Helenium virginicum* is in commercial trade for these compounds. Overcollection has not been documented as a problem for the species. Most collections, to date, have been for scientific purposes; scientists have collected specimens from locally large populations which can tolerate these low levels of collection.

Listing Factor C. ***Disease or predation***. Disease and predation currently are not factors affecting the continued existence of *Helenium virginicum*. The effects of grazing on the species are mostly positive, because most grazers appear to feed preferentially on competing vegetation while avoiding *Helenium virginicum*. The effects of long-term heavy grazing on this species are not known.

Listing Factor D. ***The inadequacy of existing regulatory mechanisms****.* Both the States of Missouri and Virginia currently list *Helenium virginicum* as an endangered species. State law prohibits the taking of this species from State or private lands without consent of the landowner but does not protect the species' habitat. Section 404 of the Clean Water Act provides some regulation of the species' wetland habitats. These

regulations have not prevented draining and filling of sites supporting the species. Therefore, existing regulations appear to be inadequate to protect the species.

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Invasion of an exotic species, purple loosestrife (Lythrum salicaria), is a potential threat to *Helenium virginicum*. Purple loosestrife is slowly extending its range throughout freshwater wetland areas in Virginia and may one day invade *Helenium virginicum* habitats in Missouri. Climate changes (either natural or human-caused) are also a potential threat to the species. Several consecutive years of unusually wet or unusually dry weather can dramatically lower population numbers. Based on his long-term demographic study of one *Helenium virginicum* site, Knox (1997) suggests that *Helenium virginicum* is naturally at high risk of local extinction as a result of such events. *Helenium virginicum* is not self-fertilizing, and small populations are at risk of extirpation due to limited availability of compatible mates (Messmore and Knox 1997).

- **Causes of past and/or current recovery**

Restoration attempts are being made in Wisconsin, Indiana and Illinois where the species is otherwise extinct (U.S. Fish and Wildlife Service 2003), as well as in Missouri. The current status of the species is much the same as it was in 1988 when it was listed (U.S. Fish and Wildlife Service 2003).

- **Occurrence on the Forest, existing and potential habitat**

There are presently no known occurrences of Virginia Sneezeweed on the Mark Twain National Forest (Forest). However, surveys by the Missouri Department of Conservation have resulted in the discovery of 42 new populations mainly in Howell County. Two of the occurrences are within the proclamation boundary of the Willow Springs Unit of the Ava/Cassville/Willow Springs Ranger District. In areas where it is known to occur, the number of individuals is as high 200 or more.

Habitats for Virginia Sneezeweed in Missouri include natural and modified sinkhole ponds, man-made (dug) ponds, wet roadside ditches, upland swales (in hayfields and flatwoods), open ravines under powerline rights-of-way, and freshwater marshes (some associated with sinkhole basins while others may be low wet areas in open fields). The common factor with each of these habitats is direct sunlight for a majority of the day and a seasonal hydro-period. The exact number of sites or acres of habitat is difficult to ascertain, but there are potentially thousands of sites that can be suitable habitat for this species on the Forest.

- **Surveys for Virginia Sneezeweed**

Twenty sites on the Eleven Point Ranger District were searched in 2004. Each of these were negative searches. In addition, several sites on the Forest in Howell County were checked opportunistically. These were also negative searches.

» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

Not applicable since no final recovery plan has been completed.

» **Effects of implementation of the proposed action**

Direct Effects - Because there are no known populations of Virginia Sneezeweed on the Forest, there would be no direct effects. If populations of Virginia Sneezeweed are discovered in the future on the Forest, the Forest Service would reinitiate consultation with the United States Fish and Wildlife Service (USFWS) on this species.

Indirect Effects – While some suitable habitat exists on the Forest, initial botanical surveys have found no populations of Virginia Sneezeweed. Until such time as there is evidence that Virginia Sneezeweed may actually occur on the Forest, there would be no indirect effects on potential habitat.

Cumulative Effects - Since there are no direct or indirect effects, there are no cumulative effects.

» **Additional measures needed for species conservation and recovery**

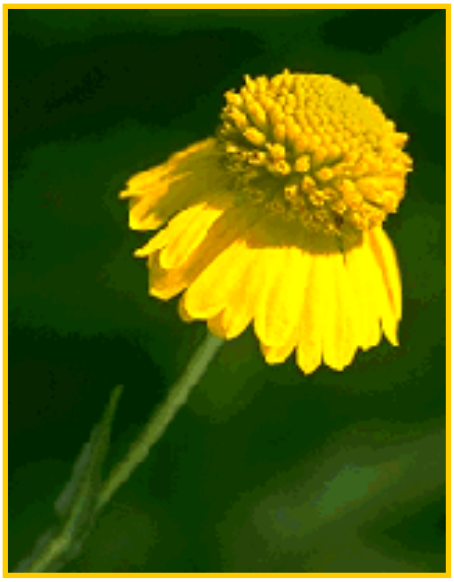
Continue surveys for new populations of this species

» **Effects of additional measures**

Potential location of new sites on the Forest. If new sites are located, consultation with USFWS would be reinitiated.

» **Determination – No Effect**

Virginia sneezeweed
Virginia Natural History photo
http://www.dcr.state.va.us/dnh/helenium.htm



Hine's emerald dragonfly (*Somatochlora hineana*)

» Life History summary

Hine's emerald dragonfly is similar to other dragonflies in having three basic life stages; aquatic egg, aquatic larva, and terrestrial/aerial adult. Hine's larvae spend 2-4 years foraging and molting, and emerge as adults starting in late May (U.S. Fish and Wildlife Service 2001). Adults live 2-6 weeks, feeding, establishing territories, mating and laying eggs. Adults are general predators, feeding primarily on insects they capture in flight.

Adults forage primarily during the day over herbaceous vegetation, often near shrubs or forest edges (U.S. Fish and Wildlife Service 2001). Males establish territorial patrols near aquatic habitat which they defend from intrusion by other dragonflies. Hine's emerald dragonflies have been documented dispersing between habitats up to 3.4 miles (U.S. Fish and Wildlife Service 2001).

Females may lay over 500 eggs during their lifetime. Females oviposit in shallow water or possibly muck or mud during the summer. Larvae are active mostly at night and feed opportunistically on other small insect larva, worms, small fish and snails (U.S. Fish and Wildlife Service 2001).

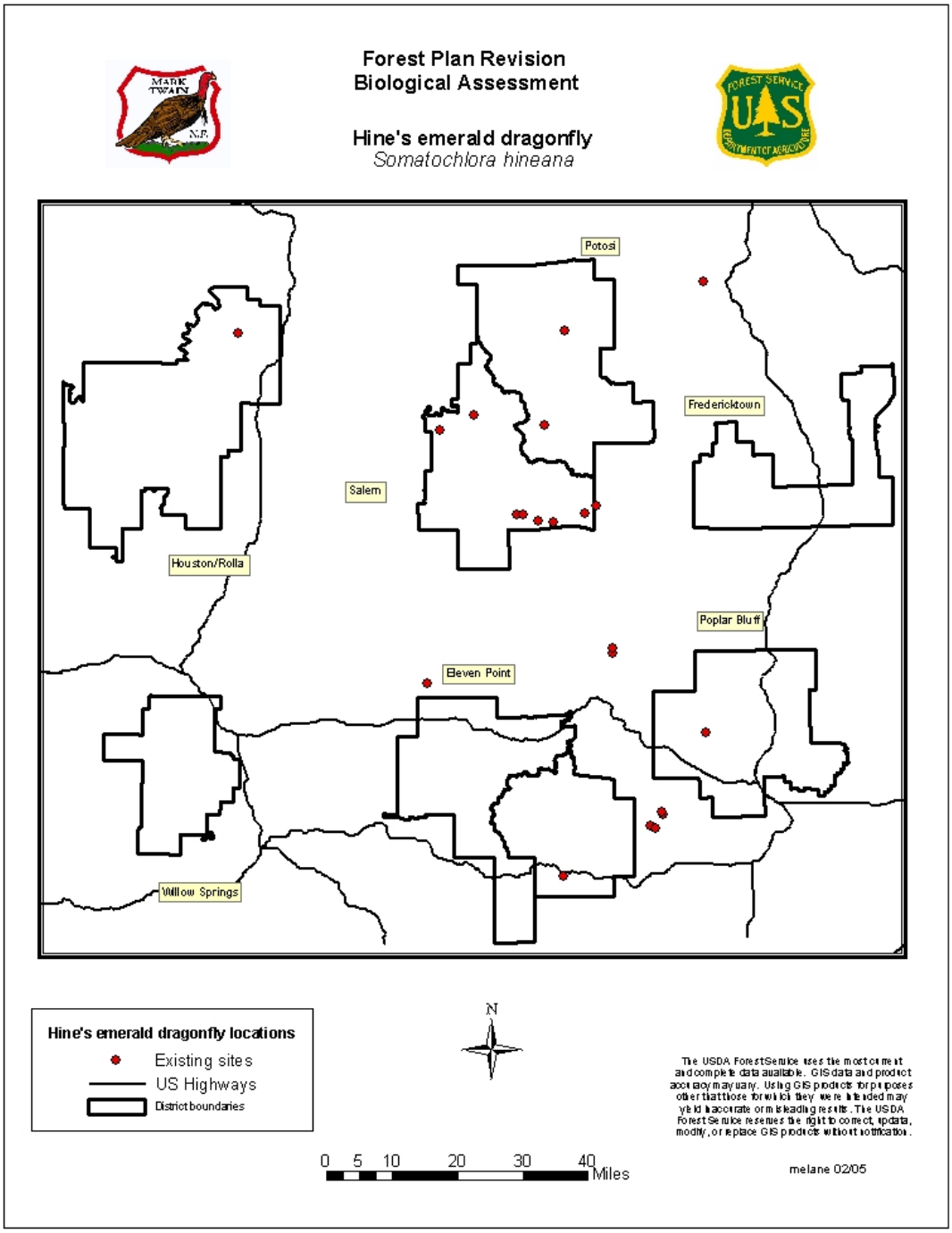
» Population status range-wide, in Missouri, and on MTNF

Hine's emerald dragonfly is currently known to occur in Illinois, Wisconsin, Michigan and Missouri (U.S. Fish and Wildlife Service 2001). This species is apparently extirpated from historic range in Ohio and Indiana. Habitats in Illinois and Wisconsin are restricted and fragmented (Federal Register Vol. 60, No. 17, 1/26//95), with the Illinois population being most genetically diverse and the Wisconsin populations the largest and presumably the most secure (U. S. Fish and Wildlife Service 2001).

There are 21 known sites for Hine's emerald dragonfly in Missouri as of January 2005 (Illinois State Museum 2005). Future searches of appropriate sites may discover additional locations for this species. Total documented population at these sites less than 100 individuals, including both adults and larva.

There are 9 known sites for Hine's emerald dragonfly on MTNF as of January 2005 (Illinois State Museum 2005, pers. comm. Dr. Paul McKenzie 1/31/05). Total documented population at these sites is about 40 individuals, including both adults and larva.

Figure HED-1: Hine's emerald dragonfly locations in and near MTNF



» Causes of past and/or current declines and Limiting factors

Hine's emerald dragonfly was listed as Endangered January 26, 1995. There is no critical habitat designated for this species.

Loss and degradation of marsh, fen and sedge meadow habitat from agriculture, commercial and industrial development is the primary cause of the species' decline (U.S. Fish and Wildlife Service 2001). Continued habitat loss, as well as disruption of ecological and hydrological processes, are continuing threats to the surviving populations.

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range:*** Habitat destruction and degradation is the greatest threat to this species' survival (Federal Register Vol. 60, No. 17, 1/26/95). Agricultural, urban, and industrial development in northern Illinois and southern Wisconsin permanently remove habitat as well as posing threats to groundwater quality through pesticide drift, agricultural and industrial run-off, and gypsy moth control measures (Federal Register Vol. 60, No. 17, 1/26//95). Disruption of groundwater hydrology is also a serious threat to habitat.

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes*** is not currently believed to be a factor in the decline of this species. Federal protection which prohibits unauthorized collection may be important in the future as collectors may become interested in collecting this species (Federal Register Vol. 60, No. 17, 1/26//95).

Listing Factor C. ***Disease or predation***. The importance of these factors has not yet been determined (Federal Register Vol. 60, No. 17, 1/26/95).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms.*** Aquatic habitats of Hine's emerald dragonfly are within the jurisdiction of the Clean Water Act with its various regulatory mechanisms to protect surface and groundwater from point and non-point pollution (Federal Register Vol. 60, NO. 17, 1/26/95). This species is listed as Endangered in Missouri (Missouri Department of Conservation 2005) which protects it from direct taking. In spite of federal and state regulations, aquatic habitat for this species has been only partially protected.

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. The threat of impacts with vehicles where sites occur near roadways is a concern (Federal Register Vol. 60, No. 17, 1/26/95).

- **Causes of past and/or current recovery**

While new sites continue to be discovered in Missouri, the species does not appear to be in the process of recovery yet.

- **Occurrence on MTNF, existing and potential habitat**

All of the nine known MTNF sites for Hine's emerald dragonfly are open fens with some standing or sheet flow water and crayfish burrows. They range in size from very small (<1 acre) to moderate (~ 10 acres). These sites are primarily in the eastern part of the Forest and most sites are on the Salem-Potosi Unit of the Forest.

There are several other known fens on MTNF that have potential as Hine's emerald dragonfly sites. Those sites are scheduled for survey in the summer of 2005.

» Surveys for Hine's emerald dragonfly

Hine's emerald dragonfly was described as a species in 1931 from Ohio specimens. Survey information throughout the range is found in Appendix 2 of the Recovery Plan.

Surveys for Hine's emerald dragonfly began in Missouri in 1999 when a specimen was collected from Grasshopper Hollow in Reynolds County. Surveys of National Forest fens have been conducted in 2001, 2002, 2003, and 2004, with additional surveys planned for summer 2005. (Vogt, 2005, Walker 2004; Vogt 2004;.Landwer 2003; Walker and Smentowski 2003; Vogt 2001)

» Consistency of Revised Forest Plan with applicable Recovery Plan Actions

Missouri is included in the Southern Recovery Unit, along with Alabama (U.S. Fish and Wildlife Service 2001).

The Mark Twain National Forest is not listed as a Responsible Party for any of the Recovery Tasks listed in the Implementation Schedule on pages 73-79 of the Recovery Plan. However, the Recovery Plan was completed prior to the discovery of extant sites on National Forest lands in Missouri. The following recovery actions are those that MTNF can contribute to.

Actions 1.1, "Protect extant populations", 1.1.4, "Long-term watershed habitat protection" and 1.1.1 "Review Federal, state, and private activities". All Hine's emerald dragonfly sites on MTNF are subject to specific standards and guidelines which provide for appropriate habitat management to keep habitats suitable (U.S. Forest Service 2005, page 2-7). In addition, there are standards and guidelines to minimize impacts to wetland habitats from management activities (U.S. Forest Service 2005, page 2-12 through 2-13). Grasshopper Hollow and Wells Branch fens are both designated State Natural Areas and Kaintuck Hollow, Barton, Bates Hollow, and Blue Flag fens are all listed as Forest Special Areas (U.S. Forest Service 2005, page 3-40 through 3-41). All these fens are included in Management Prescription 8.1 which protects the unique characteristics of those sites.

In 2004 and 2005, illegal ATV use has resulted in damage to known Hine's emerald dragonfly sites on MTNF. The Forest Service has taken immediate action to repair damage and prevent future occurrences by limiting access through fencing and road closures.

All site-specific projects involving actions on National Forest land are subject to Section 7 consultation with the U.S. Fish and Wildlife Service. One such consultation has led to habitat management at Barton Fen to restore fen hydrology throughout the fen recharge area.

Actions 1.2 "Monitor extant populations" and 1.2.1.1 "Presence/absence surveys" MTNF cooperates with U.S. Fish and Wildlife Service to monitor known sites on National

Forest lands. Chapter 4 of the Revised Forest Plan directs monitoring of TES species population status and trends, as well as monitoring the contribution of forest management to the conservation and recovery of TES species (U.S. Forest Service 2005, page 4-11).

Actions 1.3 "Manage habitat" and 1.3.4.1 "Grasshopper Hollow, Reynolds County" There are standards and guidelines in the Revised Forest Plan to guide management of Hine's emerald dragonfly habitat to maintain or restore hydrologic functioning, control non-native invasive species or undesirable woody vegetation, and protect water quality (U.S. Forest Service 2005, page 2-7). These standards and guidelines would apply to the part of Grasshopper Hollow that is on National Forest lands.

Action 2.3.4 Conduct hydrologic studies in Missouri. Chapter 4 of the Revised Forest Plan includes a monitoring item which addresses the question of how Forest management affects water quality, quantity and physical features of aquatic, riparian and wetlands ecosystems (U.S. Forest Service 2005, page 4-13).

» **Effects of implementation of the proposed action**

Effects analysis will

A). identify actions which may affect Hine's emerald dragonfly individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
- a) identifying how many individuals would be exposed
- b) which populations are represented by those individuals
- c) identifying specific stressors associated with exposure to the action
- d) identifying where and when exposure would occur
- e) identifying the duration and extent of exposure

C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of Hine's emerald dragonfly individuals, groups, or habitat.
E) estimate the risk posed to Hine's emerald dragonfly by the action.

There are no known studies or published research on the effects of forest management practices on Hine's emerald dragonfly (U.S. Fish and Wildlife Service 2003b).

Direct Effects

Because most vegetative management activities are prohibited within or near fens (U.S. Forest Service 2005, pages 2-12 through 2-13), the primary avenue of direct effects to Hine's emerald dragonfly would be habitat management activities designed to maintain or increase suitability of habitat for Hine's emerald dragonflies in occupied fens. Habitat management would include control of invading woody species or non-native invasive species through hand-cutting, appropriate herbicide, and/or prescribed fire. Habitat management may also include restoring hydrologic functioning of fens by removing old drainage ditches or other water diversion structures within the fen or that affect fen

hydrology, and prescribed burning or timber harvest within the fen recharge area, but outside of the fen itself.

Potential Negative Effects

Prescribed burning can only occur from November through April on fens that harbor known or suspected populations of Hine's emerald dragonfly (U.S. Forest Service 2005, page 2-7). Each prescribed burn occurs over a period of 1-3 days, depending on the size of the burn and fuel and weather conditions. Most fen burns would be easily completed in one day. Therefore, all prescribed burning would be completed prior to emergence of adults in May-June and there would be no direct effects on adults.

Most prescribed burns are low intensity and fast moving, which would limit the amount of heat experienced during the burn at any one location. In particular, where fire reaches moist or wet areas that could harbor larvae, fire would be put out or burn slowly and spotty. The probability of heat being enough to affect larvae behavior or survival is so extremely low that it is considered insignificant and discountable.

In addition, mechanical fireline construction is prohibited within 100 feet of a fen (U.S. Forest Service 2005, page 2-15) and hand-constructed lines are encouraged for all prescribed burns where feasible and practical (U.S. Forest Service 2005, page 2-14). All firelines have standards and guidelines for erosion control measures, including drainage features and revegetation where necessary (U.S. Forest Service 2005, page 2-14). This means that there would be no direct impact to fens or Hine's emerald dragonfly habitat from construction of firelines.

Herbicide application would only occur when it was the most effective means to meet the objective of species control (U.S. Forest Service 2005, page 2-18). All herbicide application would comply with the product label, and if used within a fen would have to be labeled for use in or near aquatic systems (U.S. Forest Service 2005, page 2-18 through 2-19). Hand application or individual stem application are normally the only methods to be used in a fen (U.S. Forest Service 2005, page 2-19). There is no restriction in the Revised Forest Plan on the season or time of day in which herbicide activities could occur. Adult Hine's emerald dragonflies are normally active during the day, when herbicide application would be done. Depending on the type of herbicide used, herbicide application is normally most effective when done during the plant's active growing season, which is also when the adults would be active. There is no evidence that the mere presence of people in the vicinity of adult dragonflies would change their behavior or activity level. And, since most fens on National Forest lands are small, and treatment could be completed within 1-3 days, the impact on individual dragonfly behavior and reproductive success is likely to be minimal. With these measures in place, it is unlikely that there would be any direct adverse impact to Hine's emerald dragonfly individuals or populations.

Hand-cutting or removal of non-native invasive species or undesirable woody species could occur at any time of the year. It is easiest to accomplish during leaf-off period, but the most effective time to actually kill plants by hand-cutting is at the beginning of the active growing season when root reserves are low, and when adults would be flying. Because most of the occupied fens on MTNF are small (<10 acres), hand-cutting or removal could be completed within 1-5 days. A few of the larger fens may take several weeks of hand-cutting to complete. There is no restriction in the Revised Forest Plan on

when hand-cutting activities could occur. Adult Hine's emerald dragonflies are normally active during the day, when hand-cutting work would be done. There is no evidence that the mere presence of people in the vicinity of adult dragonflies would change their behavior or activity level. Because most treatment could be completed within 1-5 days, the direct impact on individual dragonfly behavior and reproductive success is likely to be minimal.

Restoring hydrologic flows may be as easy as hand raking to restore topographic contours (as at Blue Flag Fen), or may involve alteration of the area with heavy equipment, or the installation of flow levelers (as at Barton Fen). All these activities could occur at any time of year and may take from one day to several months of work, depending on the severity of the condition being addressed. The only activity which would have potential to cause direct adverse impacts to individuals or a population would be work with heavy equipment. Any such proposal would have to be evaluated by the Forest Service and U.S. Fish and Wildlife Service on a site-specific basis to determine the relative importance of restoring the hydrology against the relative probability of impacting individuals. The Revised Forest Plan includes a standard and guideline encouraging restoration of local hydrology but only "if such activities would not result in a loss of habitat." (U.S. Forest Service 2005, page 2-7).

We do not know the population of each of the occupied fens on National Forest land, so we do not know how many individuals may be affected by habitat management activities on each fen or all occupied fens in total. However, surveys to date have only found 6 adults and 31 larvae on MTNF fens. Regardless, management activities in occupied fens would be conducted to minimize potential direct impacts on individuals, including crayfish burrows which may harbor larvae.

It is slightly possible that an occupied fen could be damaged (i.e. burrows crushed, hydrology changed, soil compacted) by activities associated with wildfire suppression, particularly from mechanical construction of firelines. Forest Plan standards and guidelines prohibit mechanical construction of firelines within 100 feet of fens unless necessary to protect life, structures, private property or to maintain safety of firefighters or the public (U.S. Forest Service 2005, page 2-17). With this measure in place, the likelihood of such damage is so low as to be considered insignificant and discountable.

Other potential direct impacts to Hine's emerald dragonfly could occur through illegal activities which occur on National Forest lands. The Forest has already had several occurrences where illegal ATV use has damaged or destroyed soils, crayfish burrows, and hydrologic functioning of fens known to be occupied by Hine's emerald dragonfly. We are also concerned about the potential damage which may be done by the rooting and wallowing of feral hogs that are illegally released on National Forest lands.

Indirect Effects

Potential Negative Effects

Illegal dumping of household and other waste products on National Forest lands is fairly common in rural counties which have no widespread waste disposal system. Waste is usually dumped on the side of roads, or in sinkholes. Until each county has some sort of trash pick-up that is convenient and inexpensive for county residents, trash will continue

to be dumped on National Forest lands. The Forest Service has worked on cleaning these up and preventing further dumping for decades. In addition, illegal methamphetamine labs are set up on and near National Forest lands, and the materials used in the manufacture of meth are dumped on public lands. The Revised Forest Plan requires that any "suspected uncontrolled or abandoned hazardous materials, sites, or contamination found on or near National Forest lands shall be reported promptly to the Forest Service Law Enforcement and Investigation personnel." (U.S. Forest Service 2005a).

Leakage from these dumps can enter the groundwater system, where it may end up flowing through fens. If waste products did enter occupied fens from illegal dumps on National Forest lands, effects on Hine's emerald dragonfly are unknown, although contaminants in the water system may cause adverse impacts up to and including mortality of individuals (U.S. Fish and Wildlife Service 2001, page 20).

While there are no standards and guidelines directing cleanup of these dumps, the Forest Service has traditionally identified them and worked to clean them up. Law enforcement officers investigate and pursue legal action, when possible, against persons responsible for illegal dumping.

Several of the known Hine's emerald dragonfly sites on MTNF are near lead tailings disposal sites on private ownerships in the Viburnum Trend. Winter winds may blow lead mine tailings dust from one such area toward Grasshopper Hollow (U.S. Fish and Wildlife Service 2001, page 20). Whether or not this is detrimental to either individuals or the population of Hine's emerald dragonfly at this site is unknown

Potential Beneficial Effects

Prescribed burning and/or removal of invading species by herbicide or hand-cutting would result in an increase in herbaceous vegetation as more nutrients and water are made available by reducing the amount of woody species occupying the site. Habitat for Hine's emerald dragonfly is wetlands dominated by grass or grass-like plants (U.S. Fish and Wildlife Service 2001, page 15). Another element that is identified as an important component of Hine's emerald dragonfly habitat is "Areas of open vegetation" that "serve as places to forage" (U.S. Fish and Wildlife Service, 2001, page 15-16). By eliminating or reducing the area covered by woody species or non-native invasive species, additional foraging habitat would be made available. This may also make more habitat available for the crayfish whose burrows are used by Hine's emerald dragonfly larvae. Whether or not this would result in more successful reproduction is uncertain.

Prescribed burning and timber harvest within the watershed and/or recharge area of fens to restore terrestrial natural communities representative of the site should also have a positive effect on the water retention capacity of the area. This in turn would help restore the landscape-scale functioning of the hydrologic connection between the uplands and fen. In other words, water falling within the recharge area of the fen would be held and released in a pattern resembling the historic pattern that created the fen. Since the "hydrology of these wetlands may be one of the most critical components of the larval habitat" (U.S. Fish and Wildlife Service 2001, page 16), restoring the natural hydrologic cycle should improve long-term habitat conditions at these sites.

Restriction of forest management activities which can take place within 100 feet of the edge of small fens or within the buffer zone associated with large fens (U.S. Forest

Service 2005, page 2-12) would insure that forest habitat is available near occupied fens. Nearby or adjacent forest edges that provide protected, shaded areas for perching and roosting are identified as one of two important habitat components (U.S. Fish and Wildlife Service 2001, page 16).

The Revised Forest Plan contains a standards and guideline that discourages modification of beaver-created impoundments within riparian management zones and watercourse protection zones (U.S. Forest Service 2005, page 2-4 through 2-5). However, in the case of at least one fen on MTNF, a beaver dam has altered the historic flow patterns of an occupied fen (Barton Fen). The Forest Service is currently working in cooperation with Missouri Department of Conservation to install a flow-leveling device at the beaver dam to restore historic water levels in the most efficient and effective way possible. This will reduce the water level in the upper part of the fen, making additional habitat available for crayfish and thus, for Hine's emerald dragonfly larvae.

Other efforts to restore hydrology at specific sites would also result in more or higher quality habitat for Hine's emerald dragonfly at that specific site. Whether this would result in higher numbers of dragonflies or more successful reproduction is uncertain.

No Effects

Over the past 2-3 years, Forest personnel have been involved in efforts to control feral hogs on National Forest lands. The Revised Forest Plan directs that treatment of non-native invasive species be prioritized based on threats to resources, size of infestation, potential for further spread, effectiveness of available control measures, species status, and relationship to Forest boundaries (U.S. Forest Service, 2005, page 2-2). Every hog or group of hogs that is removed from National Forest lands reduces the potential for adverse impacts to occupied fen habitats. However, illegal releases of feral hogs continue to occur, diluting the effectiveness of control efforts.

Implementation of standards and guidelines for fireline construction, erosion control, and revegetation (U.S. Forest Service 2005, pages 2-14 through 2-15) would reduce or eliminate the potential for sediment to reach occupied fens as a result of fireline construction for prescribed burning.

Unknown or Questionable Effects

Since larvae are aquatic, water quality is an important habitat component. The Revised Forest Plan has many standards and guidelines to minimize or eliminate the potential for soil movement off-site, including many related to prescribed burning. However, when conducting prescribed burns around and through occupied fens, there will be a layer of ash remaining when the burn is completed. Depending on the topography and weather immediately following the prescribed burn, some of this ash could wash into the adjacent waters occupied by larvae. What, if any, effect this may have on larvae is unknown. If there was any effect, it would most likely be short-term and temporary as new vegetation grows and helps absorb or hold the ash in place.

Cumulative Effects

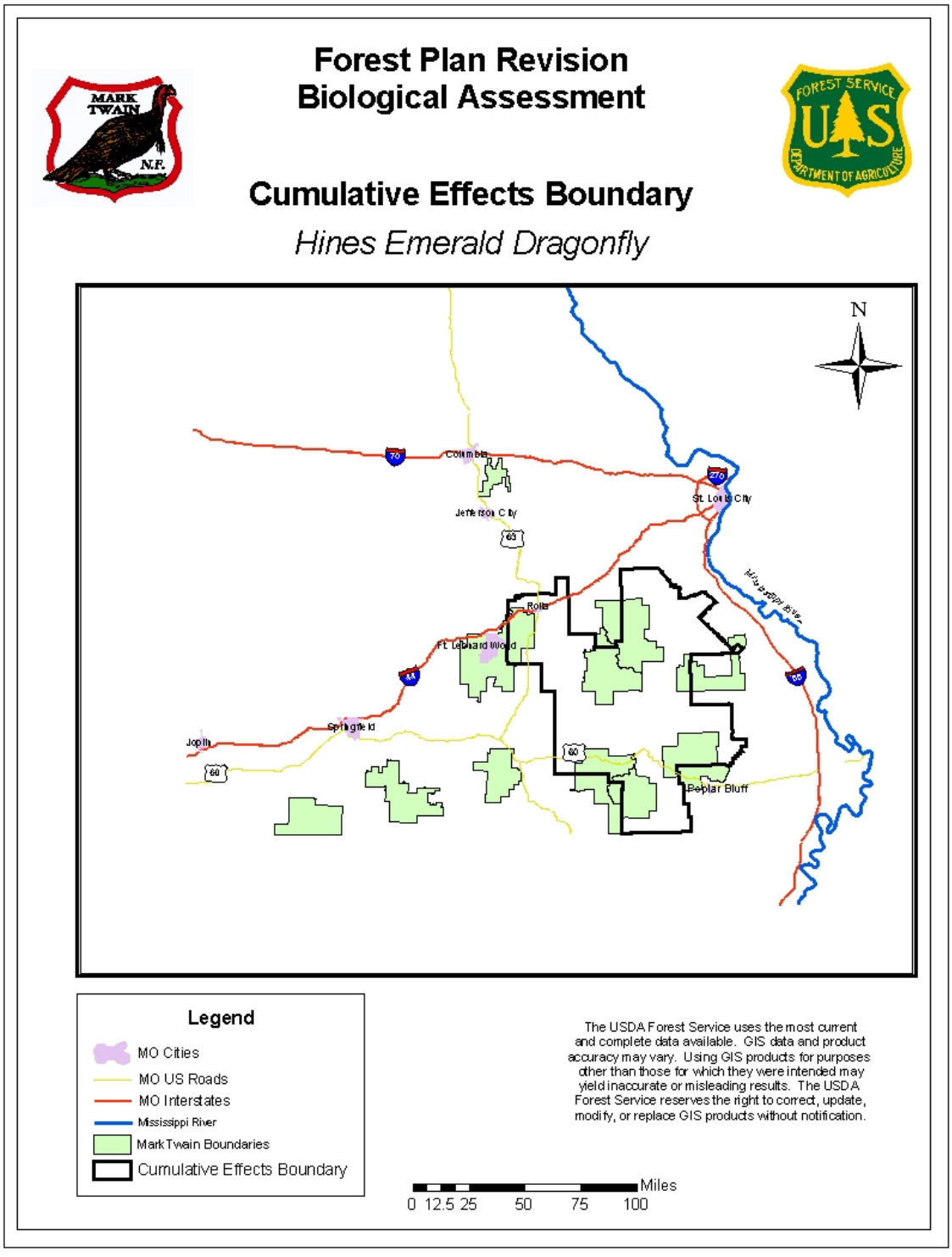
Boundaries:

All known sites for Hine's emerald dragonfly in Missouri are located in a nine county area in east-central and southeast Missouri (Phelps, Wayne, Iron, Dent, Ripley, Reynolds, Washington, Shannon, and St. Francois). Carter County has been added to the cumulative effects boundary because of its location between the nine counties known to have HED. This is the spatial boundary for cumulative effects analysis for Hine's emerald dragonfly because all effects to Hine's emerald dragonfly in Missouri would occur in that area.

Hine's emerald dragonfly adult
MOFWIS photo

Welker Fen – possible Hine's emerald dragonfly site
Photo by Lynda Mills

Figure HED-2: Cumulative Effects Boundary for Hine's Emerald Dragonfly



The temporal boundary for cumulative effects analysis for Hine's emerald dragonfly is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected because any potential effects of sedimentation would be through the system by at least that time, and any potential

beneficial impacts from improvement of fen natural communities and their hydrology would have been realized by then.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, many fens and other wetlands were drained or altered by early settlers, then were overgrazed, farmed, and invaded by woody species or non-native invasive species (U.S. Forest Service 2005b, page 3-46). Some of these fens were later acquired by the Forest Service and some are still on other ownerships.

Reasonably Forseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;

- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the proclamation boundary of MTNF. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can reasonably be predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section 7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the proclamation boundary of MTNF. However, past trends on private properties within the 29 counties that contain National Forest lands are some indication of reasonably foreseeable trends for the future.

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on Hine's emerald dragonflies or their habitat include:

- Continued population growth (particularly in southwest Missouri counties and counties south and west of St. Louis) resulting in habitat destruction or alteration;
- Wetland conversion to agriculture/commercial/industrial/residential uses resulting in habitat loss;
- Highway construction/relocation/improvement/maintenance potentially resulting in direct adult mortality where roads are near occupied habitat;
- Inadequate waste disposal, including dumping of household waste on private lands which may result in waste materials leaching into groundwater, leading to poor water quality or contamination – reactions of HED to toxic chemicals is unknown;

- Pesticide/insecticide use for control of gypsy moths or insect vectors of West Nile virus – resulting in unknown effects to HED.

These are the types of activities identified in the Hine's Emerald Dragonfly Recovery Plan as significant threats to the existence of the species (U.S. Fish and Wildlife Service 2001, page 19-23).

Effects Analysis

There are only 21 known sites for Hine's emerald dragonfly in Missouri after approximately 5 years of searching appropriate habitats. Of these, 4 are managed by the Missouri Department of Conservation (19%), 1 is managed by The Nature Conservancy (5%), 8 are managed by the Forest Service (38%), and 8 are located on private ownerships (38%) (Missouri Heritage Database 2004). Two thirds of the known locations are on ownerships whose objectives include appropriate management of these areas and protection of endangered species. One third is on ownerships where management objectives may or may not be compatible with appropriate management of fen habitat.

Of the 29 counties which have some land within MTNF proclamation boundary, all have experienced population growth ranging from 7% to 38% from the 1990 to 2000 census, with the exception of two counties that lost less than 1% of their population growth over that 10 year period (U.S. Forest Service 2005b, page 3-277). The fastest growing counties are near Branson and Columbia, Missouri. Average population growth for the 29 counties over the 10 year period was about 19%. These trends are likely to continue into the reasonably foreseeable future. It is reasonably certain that some land development as a result of population growth will destroy, damage, or alter wetlands to some degree. Whether or not these are occupied Hine's emerald dragonfly habitat is unknown, but current sites are concentrated in the east central part of MTNF, with none known to occur near Branson or Columbia, Missouri (Missouri Heritage Database 2004).

Several highway projects are proposed within the 29 county area for the foreseeable future. Missouri Department of Transportation website shows projects planned over the next decade (http://www.modot.state.mo.us/plansandprojects/construction_program/stip5year.htm). None of these are adjacent to known sites on MTNF or on private lands, and therefore should not be a significant source of mortality for the species in Missouri.

Many of the rural counties in which MTNF lands are located do not have county-wide waste disposal systems. Residents must dispose of their own waste, and some dump it on their own property, or on public lands nearby. These dumps have potential to leach waste materials directly into the groundwater systems that feed occupied Hine's emerald dragonfly sites. Landfills and industrial/commercial waste sites may also leach waste materials into the groundwater system. While MTNF does not permit dumping on National Forest lands, and cleans up illegal dumps when and where possible, dumps within the recharge area of National Forest occupied fens do have potential to contaminate fen groundwater. Whether or not there would be adverse impacts to Hine's emerald dragonfly is unknown (U.S. Fish and Wildlife Service 2001, page 20-21).

Gypsy moths have not yet been a serious problem in Missouri, although it is anticipated that they will occupy the state by about 2025 unless control efforts are successful in slowing the spread (http://www.fs.fed.us/ne/morgantown/4557/gmoth/spread/). No

widespread control measures have yet been instituted in Missouri. The Forest Service does not anticipate needing to use any form of chemical gypsy moth control in the foreseeable future. West Nile virus caused concern in Missouri for several years, but the Forest Service does not propose to use mosquito control measures in the Revised Forest Plan. The small amount of insecticide used by the Forest Service to control wasps and bees in developed recreation areas is not likely to have any cumulative impact on Hine's emerald dragonfly since none of the occupied fens are near developed recreation areas.

Conclusions:

With 38% of the known sites, MTNF is a significant contributor to the survival of Hine's emerald dragonfly in Missouri. Under the Revised Forest Plan, all known and suspected sites for this species would be protected from inappropriate disturbance, and would be managed to maintain or restore the components that make them suitable habitat for Hine's emerald dragonfly. There would be no conversion of occupied or potential Hine's emerald dragonfly habitat to other uses. There would be site-specific analysis of potential effects of proposed management activities prior to implementing any activity to insure proper timing, methods, and minimization of risk to both larvae and adults. The probability of forest management activities adversely affecting adult or larvae behavior or survival is so extremely low that it is considered insignificant and discountable. There would be little or no cumulative adverse effects from implementing the Revised Forest Plan.

Beneficial effects from habitat management on National Forest lands include an increase in both quantity and quality of available habitat. Whether this translates into increased survival or reproduction for the species is unknown. With 38% of known sites, MTNF would be likely to have cumulative beneficial effects on the species through maintenance of suitable habitat.

» **Additional measures needed for species conservation and recovery**

Additional measures which are needed for species conservation and recovery include:

- Increased vigilance by law enforcement to reduce impacts to fen habitats from illegal use of ATV's, and successful prosecution of violators.
- Increased efforts to control or eradicate feral hogs, particularly in locations where there are known Hine's emerald dragonfly habitats.
- Physical protection of occupied fens where necessary to discourage entry by vehicles or feral hogs.

» **Effects of additional measures**

Increased patrols by law enforcement officers will be difficult to achieve, since MTNF has only 7 officers currently stationed on Districts, with potentially one more officer to be added. In addition to enforcing federal laws on National Forest lands (especially related to theft of timber and arson), these officers spend time cooperating with other state and federal officers, particularly in regards to drug interdiction and enforcement. Missouri is the number one state in the nation for production of methamphetemine, much of which takes place in the rural counties which contain National Forest lands. Illegal off-road

activities of recreationists necessarily take a back seat to the more serious concerns of drugs and other felonies.

Feral hogs are notoriously difficult to hunt, kill or trap. Efforts by state, federal, and local agencies, as well as hunting by private individuals have failed to keep up with the increasing numbers of feral hogs in the state. Feral hog numbers and distribution have increased dramatically over the past decade. Budgets have not allowed for additional control efforts, and some federal monies are not being continued past FY 2005. It appears as if feral hogs are going to be a part of the Missouri landscape into the future.

Physical protection of fens occupied by Hine's emerald dragonfly has been used in the past year to reduce illegal vehicle use, and to prevent additional damage from occurring. This is not a very practical solution, particularly for the larger fens with numerous avenues of entry. However, this method does afford some measure of protection and will be used when necessary to reduce potential or actual impacts.

» **Determination– May Affect, Not Likely to Adversely Affect**

Rationale: There is limited potential for adverse impacts to adults, larvae and habitat through direct habitat manipulation or fireline construction for wildfire suppression. However, the potential for these to occur is so remote that it is considered insignificant and discountable. Beneficial effects are anticipated by increasing the quantity and quality of available habitat for Hine's emerald dragonfly through control of invasive species, restoration of hydrologic functions, and restoration of terrestrial natural communities within fen recharge areas.

Tumbling Creek cavesnail (*Antrobia culveri*)

» Life History summary

Tumbling Creek Cavesnail is a small, blind, aquatic snail found in only one cave, on private ownership, in Taney County, Missouri (Federal Register Vol. 67, No. 157, 8/14/02). It was first described as a species in 1971. Habitat for the species is the gravel and rock substrate of the cave stream running through Tumbling Creek Cave. Little is known about the biology of the species. Nothing is known of the longevity, reproductive behavior or movements of the species. It is postulated that this cavesnail feeds on aquatic microfauna and may be indirectly dependent on large deposits of gray bat guano found in the cave (Federal Register Vol. 67, No. 157, 8/14/02).

» Population status range-wide, in Missouri, and on MTN

The population in Tumbling Creek Cave is the only known population of this species in the world. The cave is not located on MTNF, but approximately 23% of the cave recharge area is located on MTNF lands north of the cave (U.S. Fish and Wildlife Service 2003b). Current population is estimated to be about 40 individuals (U.S. Fish and Wildlife Service 2003a). The estimated population in 1973 was 15,118 cavesnails (U.S. Fish and Wildlife Service 2003b). In 1996 a rigorous sampling protocol was designed, and subsequent surveys of the cave stream have followed that protocol. Between September 1997 and April 2003, twenty-five separate monitoring trips were made (U.S. Fish and Wildlife Service 2003b). Populations of the cavesnail fluctuated seasonally and annually from a high of 1,166 individuals in September 1997 to zero individuals in 2001 (U.S. Fish and Wildlife Service 2003b). Between January 2001 and April 2003, no individuals were found at established monitoring stations, but a small population was discovered in March 2001 upstream of the sampling stations (U.S. Fish and Wildlife Service 2003b). Using snails per plot for the various surveys made from 1973 through 2003, the species has experienced a decline in density of about 88% between 1974 and 1995. Distribution within the cave has decreased by 90% since surveys began (U.S. Fish and Wildlife Service 2003b). In addition, studies of cavesnail shell lengths indicate a reduction in recruitment of younger age classes between 1997 and 2000 (Ashley 2000 as cited in U.S. Fish and Wildlife Service 2003b).

» Causes of past and/or current declines and Limiting factor

Tumbling Creek Cavesnail was listed as endangered on August 14, 2002 (Federal Register/Vol. 67, No. 157, 50 CFR Part 17), after having been emergency listed in December 2001 after a sharp drop in the population was noted (USFWS 2002). There is no critical habitat designated for Tumbling Creek cavesnail.

Tumbling Creek cavesnail is listed as Endangered in Missouri (Missouri Department of Conservation 2005).

The primary cause of decline is believed to be decreased water quality in the cave

stream, but this hypothesis needs research to be confirmed (U.S. Fish and Wildlife Service 2003b).

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** The recharge area for Tumbling Creek Cave is approximately 9.07 square miles. Of that, approximately 23% is in National Forest ownership. About 72% of the recharge area is in ownerships that could be expected to manage the land to benefit the species (Federal Register Vol. 67, No. 157, 8/14/02). However, most of the land recently purchased by the cave owner has been impacted by overgrazing, excessive land clearing, and a failed earthen dam, all potentially causing silt to enter the cave stream (Federal Register Vol. 67, No. 157, 8/14/02). The number and distribution of this species has declined dramatically since it was first described as a species, probably due to degraded water quality (U.S. Fish and Wildlife Service 2003b).

The cave owners have noticed an increase in water turbidity and cementing of rocks together and to the stream bottom. This decreases available habitat since the cave snails are generally restricted to the underside of gravel and rock surfaces (U.S. Fish and Wildlife Service 2003b). Increases in silt could also increase potential impacts of bacteria and viruses that enter the cave in livestock waste (U.S. Fish and Wildlife Service 2003b). However, the actual effects of siltation on the species have yet to be determined.

Several potential sources of silt have been identified on tracts of land recently purchased by the cave owners. Mechanically constructed firebreaks on National Forest lands are also identified as a potential source of silt "if not properly designed and revegetated." (U.S. Fish and Wildlife Service 2003b). Feral hogs are identified as a potential source of sedimentation, as well as direct impact to cavesnails by using the cave for shelter.

Other sources of potential water quality degradation include nutrient enrichment from livestock feedlots or fertilizers (which reduce dissolved oxygen in streams and may be toxic to organisms at high levels); accidental spills or chemicals used for highway maintenance; contaminants from waste materials dumped in sinkholes, ravines or depressions; and possibly hormones, antibiotics, disinfectants, or other chemicals found in human or animal wastes. (U.S. Fish and Wildlife Service 2003b).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** Access to Tumbling Creek Cave is strictly controlled by the owner and there is no evidence, and little likelihood, that overutilization for any purpose could or would occur. There is also no evidence to suggest that the carefully controlled surveys have adversely affected the species (Federal Register Vol. 67, No. 157, 8/14/02).

Listing Factor C. ***Disease or predation***. Effects of disease, predation or competition on Tumbling Creek cavesnail are unknown. Because this species occurs in only one known location, there is high potential for disease to be a significant threat to the species' survival (Federal Register Vol. 67, No. 157, 8/14/02).

Other species of salamanders and aquatic invertebrates have shown increased susceptibility to infection or disease when exposed to high levels of nitrogen caused by overgrazing or agricultural/urban runoff (Federal Register Vol. 67, No. 157, 8/14/02).

In 1997, an unknown species of limpet was discovered using the same substrates as does Tumbling Creek cavesnail. After 2001, limpet numbers increased explosively and showed evidence of reproduction. How and why this species appeared in the cave are unknown, and it is not known if they actually compete with Tumbling Creek cavesnail for food, substrate or other resources (Federal Register Vol. 67, No. 157, 8/14/02).

Interspecific competition with other aquatic invertebrates may result in reduced availability of important habitats, but whether this occurs or what the extent may be are unknown.

Listing Factor D. ***The inadequacy of existing regulatory mechanisms.*** Existing "Federal, State, and local laws have not been sufficient to prevent past and ongoing impacts to areas within the cave's delineated recharge area." (Federal Register Vol. 67, No. 157, 8/14/02).

Tumbling Creek cavesnail is listed as Endangered in Missouri (Missouri Department of Conservation 2005), prohibiting the exportation, transportation or sale, or possession with intent to sell, of any part of the species. General prohibitions in Chapter 4 of the Wildlife Code 3CSR10-4.110 include protection for individuals of a species as well as its homes, dens, nests, eggs. In addition aquatic species are further protected by a prohibition against placing or allowing any substance to be placed into "waters of this State in quantities sufficient to injure, stupefy or kill fish or other wildlife which may inhabit such waters." (Missouri Department of Conservation 2005).

Missouri also has a Cave Resources Act which, under Section 578.215, prohibits any substance from being purposely introduced into caves, cave systems, sinkholes, or subsurface waters that could violate the Missouri clean water law (Federal Register Vol. 67, No. 157, 8/14/02). However, violation of this measure is only a Class A misdemeanor.

Sites on National Forest or other federal ownerships are afforded some protection, since federal agencies are required to avoid jeopardizing the species under the Endangered Species Act.

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. There are several factors that could be contributing to the decline of Tumbling Creek cavesnail. However, all are suspected or possible causes, but none are proven causes.

Tumbling Creek Cave is located in one of the fastest growing areas of the state, near Branson and Bull Shoals Lake. Residential, urban, and commercial development within the cave recharge area may contribute to siltation and point or non-point pollution that enters the cavestream. Current land uses within the recharge area may also contribute to point or non-point pollution, such as barnyard or feedlot waste drainage and the discharge of solid or liquid waste into sinkholes. Accidental spills of material being transported on State or local highways within the recharge area could also contribute harmful materials to the cavestream. Water from Bull Shoals Lake occasionally backs up into Tumbling Creek Cave, and a proposal to raise the conservation pool of the lake would likely increase the frequency of that occurring (Federal Register Vol. 67, No. 157, 8/14/02).

The cave owner, Tom Aley, postulated that cavesnail declines may be related to the depletion of dissolved oxygen in the cave stream due to excessive amounts of gray bat guano, particularly in times of decreased flow (Federal Register Vol. 67, No. 157, 8/14/02).

Climate change, particularly in the form of extended periods of drought, may have contributed to the decline of this species. There have been four periods when the Palmer Drought Index was below normal for 6 months or longer, and indicated a moderate to severe drought for at least part of those time periods (Federal Register Vol. 67, No. 157, 8/14/02). Normally in the Ozarks, extended drought periods result in lower flows of cave streams. Low flows in Tumbling Creek cave, combined with other potential threats such as less flushing of guano or contaminants from the stream, higher water temperatures, lower dissolved oxygen, could create an environment where the cavesnails are outcompeted by other species (Federal Register Vol. 67, No. 157, 8/14/02).

- **Causes of past and/or current recovery**

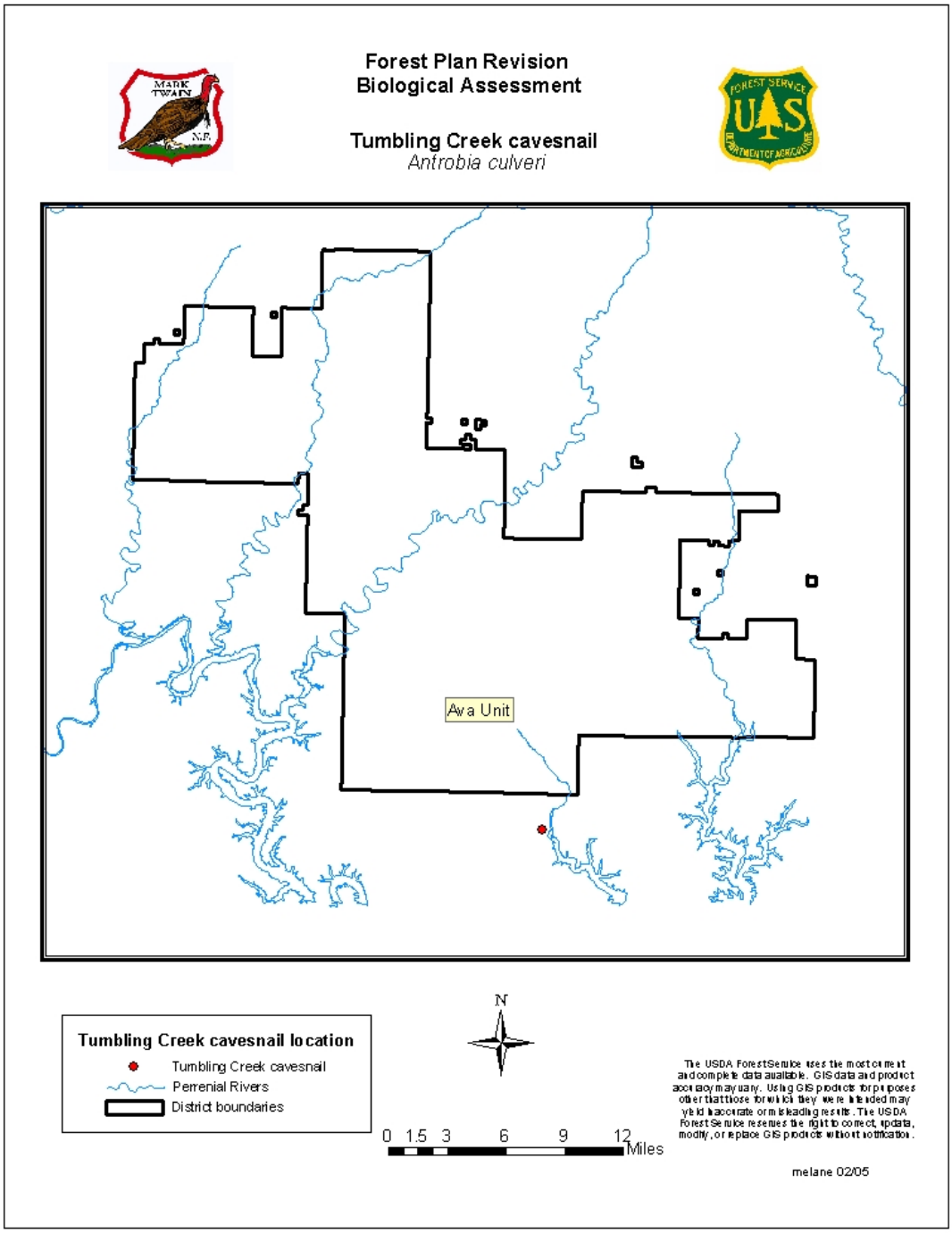
At the present time, the species appears to be in decline, with little indication of recovery.

- **Occurrence on MTNF, existing and potential habitat**

Tumbling Creek cavesnail does not occur on MTNF lands. However, MTNF lands comprise about 23% of the cave recharge area (Federal Register Vol. 67, No. 157, 8/14/02). Therefore, activities which occur on these lands have the potential to affect water quality in the cavestream.

There are caves with cave streams located on MTNF lands, which may be potential habitat. However, there is very little known about the habitat needs of this species, so even other cave streams may not be suitable habitat. To date, biological inventories of caves on MTNF lands have not discovered any additional populations of Tumbling Creek cavesnail.

Figure TCC-1: Tumbling Creek Cavesnail location in Missouri



» Surveys for Tumbling Creek cavesnail

Biological surveys of public and privately owned caves in Missouri have been conducted for decades. Specific surveys to look for additional Tumbling Creek cavesnail sites in caves and springs close to Tumbling Creek Cave were conducted by Dr. David Ashley of

Missouri Western State College (U.S. Fish and Wildlife Service 2003b). No additional sites were discovered.

The Cave Research Foundation (CRF) conducts biological inventories of MTNF caves each year under a Challenge Cost Share agreement with the Forest. To date, they have not found any other caves on MTNF which harbor Tumbling Creek cavesnail.

Within Tumbling Creek Cave, surveys have been conducted since the early 1970's, and an area of the cave was identified as Tumbling Creek cavesnail habitat (U.S. Fish and Wildlife Service 2003b). Updated survey protocols were designed and put in place in 1996 and at least 25 separate surveying trips were made using that protocol between 1996 and 2002. When no individuals were located at the established stations, surveyors expanded their efforts and found additional individuals in another area of the cave stream (U.S. Fish and Wildlife Service 2003b).

» Consistency of Revised Forest Plan with applicable Recovery Plan Actions

The September 2003 Tumbling Creek Cavesnail Recovery Plan (Table 3, page 65) includes the Forest Service as a potential partner in no Priority 1 Actions, in one Priority 2 Action and three Priority 3 Actions. Priority 1 Actions are those that must be taken to prevent extinction or prevent irreversible decline in the foreseeable future. Priority 2 Actions are those that must be taken to prevent a significant decline in population or habitat quality short of extinction. Priority 3 Actions are necessary to meet recovery objectives.

The Priority 2 Action identified is Action **2.2.2 "Recommend improved livestock grazing systems and practices.**" (U. S. Fish and Wildlife Service 2003b). In the preferred alternative, MTNF lands within the Tumbling Creek Cave recharge area are included in Management Prescription 1.1 which emphasizes restoration of natural communities (U.S. Forest Service 2005a). Within this prescription, grazing would only be permitted on existing improved pastures. All currently grazed areas that contain glade or woodland communities, including the areas within the Tumbling Creek Cave recharge area, would be closed to grazing when the current permit(s) expires (U.S. Forest Service 2005a). Until then, timing, duration, and intensity of livestock grazing would be controlled to "achieve desired structure and species composition objectives." (U.S. Forest Service 2005a).

One of the Priority 3 Actions is Action **2.5.1"Where appropriate and logistically feasible, recommend that the Forest Service establish a demonstration area that will highlight proper grazing techniques and riparian zone management."** (U.S. Fish and Wildlife Service 2003b). In the preferred alternative, a demonstration area could only be established in the cave recharge area where there are existing improved pastures, since those are the only areas within Management Prescription 1.1 where grazing would be permitted in the long-term. There are a limited number of improved pastures within the recharge area that may or may not lend themselves to a demonstration area. A site-specific analysis would need to be made to determine an area that would be suitable for this purpose. However, a grazing techniques demonstration area could also be established in Management Prescription 2.1 areas.

The other Priority 3 Action is **Action 2.5.3**, **"Provide and distribute FS recommended grazing-system practices to other agencies and individuals as needed."** (U.S. Fish and Wildlife Service 2003b). There is nothing in the Revised Forest Plan that would prevent the Forest Service from providing such assistance if and when requested.

Other Recovery Actions which are not listed in Table 3 and therefore have no assigned priority, but for which MTNF can contribute are as follows:

Action 2.1, 2.1.1, and 2.1.2: **Identify and continue cleanup of refuse sites and abandoned homesteads.** (U.S. Fish and Wildlife Service 2003b). There are illegal trash dumps scattered across the Forest. The Forest Service has worked on cleaning these up and preventing further dumping for decades. Until each county has some sort of trash pick-up that is convenient and inexpensive for county residents, trash will continue to be dumped on National Forest lands. In addition, illegal methamphetamine labs are set up on and near National Forest lands, and the materials used in the manufacture of meth are dumped on public lands. The Revised Forest Plan requires that any "suspected uncontrolled or abandoned hazardous materials, sites, or contamination found on or near National Forest lands shall be reported promptly to the Forest Service Law Enforcement and Investigation personnel." (U.S. Forest Service 2005a).

Action 2.1.4 Improve human sewage treatment disposal facilities that have the potential to adversely affect water quality of Tumbling Creek. (U.S. Fish and Wildlife Service 2003b). There is one sewage lagoon located on National Forest lands that is under permit to the Mark Twain School as of 3/23/05. This lagoon was constructed in 1953 and reconstructed in 1975 and shows evidence of long-term leakage. The Forest Service is working with the school, U.S. Fish and Wildlife Service, and Missouri Department of Conservation to transfer ownership of the land to the school (Tracy Kremer, Mark Twain National Forest Special Uses, pers. comm. 3/24/05). This will allow them to apply for and receive grant money to construct a new, modern system that will not leak, and rehabilitate the old lagoon.

Action 2.5, 2.5.2 and 2.5.4 Implement applicable standards and guidelines on National Forest lands for timber harvest, range management, glade and savannah restoration, and prescribed fire within the recharge area and ensure that any special use permits authorized within the recharge area include provisions for protection of water quality. (U.S. Fish and Wildlife Service 2003b). Appendix D of this BA identifies standards and guidelines specific to each federal species and those which would minimize soil movement and sedimentation into waterways, and protect water quality and quantity. These standards and guidelines include requirements for avoiding certain activities in riparian areas or upland waterways, and for modifying or avoiding certain techniques when conducting timber harvest, prescribed burning, and other vegetation management activities. These standards and guidelines would be implemented in any alternative, except Alternative 5 which would continue with current standards and guidelines.

- **Effects of implementation of the proposed action**

Effects analysis will

A). identify actions which may affect Tumbling Creek cavesnail individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
    a) identifying how many individuals would be exposed
    b) which populations are represented by those individuals
    c) identifying specific stressors associated with exposure to the action
    d) identifying where and when exposure would occur
    e) identifying the duration and extent of exposure
C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of Tumbling Creek cavesnail individuals, groups, or habitat.
E) estimate the risk posed to Tumbling Creek cavesnail by the action.

There are no studies or published research on the effects of forest management practices on Tumbling Creek cavesnail, and very little known about the life history or habitat needs of the species (U.S. Fish and Wildlife Service 2003b).

Direct Effects

There would be no direct effects to Tumbling Creek cavesnail since there is no habitat or known populations located on MTNF lands.

Indirect Effects

All effects which may occur to Tumbling Creek cavesnail would be indirect changes to water quality or quantity as a result of management activities undertaken within the cave recharge area. While the factor or factors responsible for the precipitous decline of the cavesnail is unknown, it is highly likely that it is related to the water quality or quantity of the cave stream in which they live (U.S. Fish and Wildlife Service 2003b). Water quality/quantity in turn is related to the land uses on the surface of the cave recharge area.

There are only 40 individuals of this species known to exist, and they all occur within Tumbling Creek cave stream. Therefore, any effects to water quality or quantity could affect one or all of those individuals.

National Forest lands within the cave recharge area are all located over 2 miles from the cave, and most are over 3 miles from the cave. All National Forest lands are at the northern end of the recharge area (see Figure 6 on page 15 of the Recovery Plan).

Potential Negative Effects

There are several vegetation management activities which have the potential for soil movement off-site. These include timber harvest, road construction, reconstruction or maintenance, prescribed burning and fireline construction, and grazing practices. Under the preferred alternative, these activities would take place to "emulate historical vegetation patterns" and would be done primarily on glades, savannas and open woodlands in the Big Creek Basin Glades area, which is the area of National Forest

lands within the cave recharge area. (U.S. Forest Service 2005a). These activities may occur year-round, but are constrained to avoid periods or seasons when impacts to soil and water would be most likely (U.S. Forest Service 2005a, pages 2-28, 2-37). Revegetation of disturbed soils is required for most activities, and may be accomplished in several ways.

- ***Timber Harvest***

Timber harvest activities in a sale area normally occur over a period of several years, with some periods of inactivity. Harvest units are generally from 10 acres to several hundred acres in size (depending on the type of harvest). Within the Big Creek Basin Glades area, timber harvest could be expected for the purposes of reducing tree numbers on woodlands, removing cedar and some hardwoods from glades, and a limited amount of regeneration harvest. Soil movement would be most likely where canopy closure is reduced to less than 20%, or where skid trails and log landings are located. Standards and guidelines prohibit timber harvest within 100 feet of a sinkhole, cave entrance, or within wetland buffer zones, and require all ground-disturbing activities be designed and implemented to prevent or minimize soil dislocation, compaction, rapid runoff, disruption of water movement, or loss of water and soil quality. (U.S. Forest Service 2005a, page 2-28).

Standards and guidelines for skid trails prohibit the use of stream channels as skid trails, and prohibit skid trails within 100 feet of sinkholes, cave entrances or other karst features or within the buffer zones of wetland features (U.S. Forest Service 2005a, page 2-29). They also require erosion control measures to be implemented based on skid trail grade, and prohibit operation of skidders on slopes over 35%. Operations would also be suspended during wet periods when excessive rutting or soil displacement are anticipated (U.S. Forest Service 2005a, page 2-29). “Major increases in erosion from harvest areas themselves are unusual due to the ground roughness and the ability of downed vegetation to contain sediment-laden runoff.” (U.S. Forest Service 2005b, page 3-203). “All alternatives include implementation of standards and guidelines that would limit erosion and sedimentation from leaving a site…” (U.S. Forest Service 2005b, page 3-204).

- ***Prescribed burning***

Prescribed burning has normally occurred from January through April, although the revised Forest Plan calls for some prescribed burning of glades and savannas to occur from May through December. In the Big Creek Basin Glades area, past prescribed burns have ranged from several acres to about 6000 acres in size. A prescribed burn normally takes 1-3 days to complete, although preparing for the burn may take several days or weeks. Soil movement would be most likely where firelines are constructed using bulldozers and on steep slopes. The Revised Forest Plan includes guidelines for drainage features to be constructed on firelines to reduce sediment movement off-site (U.S. Forest Service 2005a, page 2-14). Within the Big Creek Basin Glades area, there are many roads and streams which could be used as firelines, reducing the need for constructed firelines. Standards and guidelines for prescribed burning, including construction of firelines are found on pages 2-13 through 2-18 of the Revised Forest Plan. “Closure and rehabilitation of any firelines would improve the hydrologic regime of the area, whether they are located in riparian area or not.” (U.S. Forest Service 2005b, page 3-206).

» ***Transportation System Management***

Road construction, reconstruction or maintenance may occur at any time of year, and can take place over the course of several days, weeks, or months depending on the length and amount of work to be done. Soil movement would be most likely where roads are in riparian areas, where roads cross streams, or are on steep slopes. Standards and guidelines provide direction for using minimum necessary construction, reconstruction and maintenance standards; scheduling work to take advantage of favorable ground conditions; using existing roads in preference to building new roads; designing roads to maintain natural hydrologic functioning of karst features; avoiding cave and karst features; keeping road grades normally at less than 10%; designing appropriate drainage features, and limiting stream crossings (U.S. Forest Service 2005a, pages 2-37 through 2-39). All these measures are intended to reduce, minimize, or prevent soil movement off-site.

In the case of impacts to the Tumbling Creek cave stream, soil could quickly enter the subsurface water system at discrete recharge sites (i.e. sinkholes or losing streams) if road drainage were allowed to enter those sites. The Revised Forest Plan has standards and guidelines which discourage road construction above known cave passages, within 100 feet of known cave entrances, sinkholes or other karst features, and losing streams (U.S. Forest Service 2005a, page 2-39 through 2-40). In addition, there are standards and guidelines for temporary roads to maintain natural hydrologic functioning of karst features, and discouraging road drainage into sinkholes or water features (U.S. Forest Service 2005a, page 2-40).

» ***Rangeland Management***

There are currently active grazing allotments within Tumbling Creek Cave recharge area. Within Management Prescription 1.1, which includes the Big Creek Basin Glades area in the cave recharge area, grazing is only permitted on existing improved pastures and all areas that contain glade or woodland natural communities will be closed to grazing when current permits expire (U.S. Forest Service 2005a, page 3-5).

The hydrologic regime of an area can be altered by grazing activities. Grazing can alter runoff and infiltration rates and patterns, these changes can affect the local groundwater system. The extent and duration of changes depends largely on the number of animals and season(s) of use. Standards and guidelines for rangeland management require that timing, duration and intensity of livestock use be controlled in order to achieve desired vegetation structure and species composition objectives (U.S. Forest Service 2005a, page 2-19). Grazing is not allowed within 100 feet of springs, wetlands, or sinkholes, and is allowed within the riparian management zone (RMZ) only under limited conditions.

The presence of grazing livestock can cause areas of soil compaction, especially on animal-created trails, which cover a small or large part of the total area used. These compacted areas decrease the historic infiltration rate of rainfall, and promote an increase in runoff (NRCS, 2003). The creation of cattle trails also focuses water runoff down artificial flow paths, thus not allowing for the larger scale water / surface contact during which additional infiltration could occur.

Heavy grazing or grazing in certain seasons can change vegetation composition of the grazed area, which can in turn affect water yield. Many noxious weeds that increase as a result of heavy or inappropriate grazing, as well as some non-native forage species,

require more water for survival than most glade species which have adapted to a drier climate. The uptake of water by these plants decreases the amount of water available for the groundwater system. It is difficult to describe the exact effects of different vegetation as many site specific factors influence water yields (soil types, percent of cover, type of cover, etc.). Different grasses and shrubs do affect infiltration and runoff rates (NRCS, 2003). Standards and guidelines for rangeland management require that timing, duration and intensity of livestock use be controlled in order to achieve desired vegetation structure and species composition objectives (U.S. Forest Service 2005a, page 2-19). In addition, for Management Prescription 1.1, timing, intensity and frequency of grazing must maintain or increase populations of rare or sensitive plants (U.S. Forest Service 2005a, page 3-5).

» ***Ava Glades Study***

From 1981 through 1987, a paired watershed study was conducted on the Ava glades in Ozark and Taney Counties, Missouri. This study looked at effects on soil, water and vegetation of red cedar cutting, prescribed burning, and limited grazing on glade ecosystems. The results showed that there appeared "to be no statistical evidence that either the harvesting or the burning produced any changes in total water or sediment yields from either watershed." (Settergren 1990). The study found that vegetation regrowth following prescribed burns was rapid and the increased growth of grasses and forbs lasted for about 4 years post-burn.

Although there was an increase in discharge of nitrogen, the actual magnitude was very low relative to probable atmospheric inputs, and there was no detrimental effect in runoff to receiving streams (Settergren 1990). Soil nitrogen did not change significantly, and both harvest and prescribed burning showed little influence on soil nutrients (Settergren 1990.) Other research in the eastern United States has also shown that the seemingly dramatic disturbances of harvesting and prescribed burning have little, if any, long-term hydrologic changes when done on forested watersheds (Settergren 1990).

The conclusions of this study are that 1) no adverse changes occurred to hydrology, water quality or soil productivity on glade sites from cedar harvest, prescribed burning, and grazing as practiced for the study; 2) that there are no major changes in nutrient pools, off-site changes are not discernable, and there is no net nutrient loss; and 3) there was no accelerated erosion or significantly elevated sediment yields to streamflow (Settergren 1990).

» ***Waste Disposal***

Illegal dumping of household and other waste products on National Forest lands is fairly common in rural counties which have no widespread waste disposal system. Waste is dumped on the side of roads, or in sinkholes. Dumping of household waste also occurs on private lands, with sinkholes or drainages being likely dump locations. Leakage from these dumps can enter the groundwater system, and is filtered very little before reaching subsurface waters (U.S. Forest Service 2005b). If waste products did enter the cave stream from illegal dumps on National Forest lands, effects on Tumbling Creek cavesnail are unknown, although there are documented cases of other aquatic cave species being harmed or killed from point source pollutants (Several sources cited in U.S. Fish and Wildlife Service 2003b).

While there are no standards and guidelines directing cleanup of these dumps, the Forest Service has traditionally identified them and worked to clean them up. Law

enforcement officers investigate and pursue legal action, when possible, against persons responsible for illegal dumping.

» ***Stressors and Responses***

While the nature and extent of impacts of sedimentation to Tumbling Creek cavesnail are unknown, hypotheses include reduction of habitat due to cementation of rocks/gravel to the stream bottom, possible impacts to food sources and reproductive behavior, possible increased susceptibility to bacteria, viruses, and disease, and potential increase in habitat suitability for competitors (U.S. Fish and Wildlife Service 2003b).

Standards and guidelines specific to timber harvest, transportation system management, prescribed burning, and rangeland management are found in Chapters 2 and 3 of the Revised Forest Plan. Implementation of standards and guidelines for these activities would remove or minimize the potential for soil to move off-site by limiting activities in sensitive areas and modifying actions to improve drainage and catch any soil moving off-site. Therefore, the potential for impacts to Tumbling Creek cavesnail from water quality degradation as a result of management activities on National Forest lands is so small as to be considered insignificant and discountable.

Potential Beneficial Effects

» ***Restoration of glade/woodland/savanna complex communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the glade/woodland communities that occur on National Forest lands within the cave recharge area. The major benefit of restoration of healthy natural communities would be less water runoff to surface streams and increased water filtering into the groundwater system as a result of increased herbaceous vegetation (Nelson 2005). This change in hydrologic functioning may help buffer the effects of periodic drought, which may be a contributing factor in the decline of the cavesnail (U.S. Fish and Wildlife Service 2003, page 23).

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including caves (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

» ***Rangeland Management***

Standard and guidelines for Management Prescription 1.1 require the closure of all current allotments which contain glade and woodland communities when the current permits expire. Until that time, timing, duration and intensity of grazing must be controlled to achieve desired vegetation structure and species composition objectives (U.S. Forest Service 2005a, page 3-5). Once livestock are removed from the glade and woodland communities, plant species diversity, distribution, and volume should increase. This increase in native plant material results in decreased water runoff and increased water holding capacity, so that hydrologic functioning can begin returning toward a more historic state. Over time the re-establishment of healthy glade and woodland natural communities can increase the water available to the groundwater systems of an area.

» ***Transportation System Management***

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39).

» ***Waste Disposal***

Where illegal dumps are found, cleaning them up and removing potential sources of waste material from entering the groundwater system would contribute toward maintaining water quality in Tumbling Creek.

» ***Stressors and Responses***

Because of the small number of individuals known to exist, it is not certain that beneficial effects to water quality or quantity would result in concomitant increases in the population of Tumbling Creek cavesnail. We do not know which of several suspected causes are responsible for the decline of the species, and so cannot know for certain what actions will or will not result in beneficial effects to individuals, their habitat, or the population as a whole. However, contributing to the natural hydrologic functioning of the cave recharge area is likely to beneficially affect other cave species, including the federally endangered gray bat which inhabits Tumbling Creek Cave.

No Effect

All activities which implement the Revised Forest Plan and which are outside the cave recharge area would have no effect on Tumbling Creek cavesnail.

Questionable or Unknown

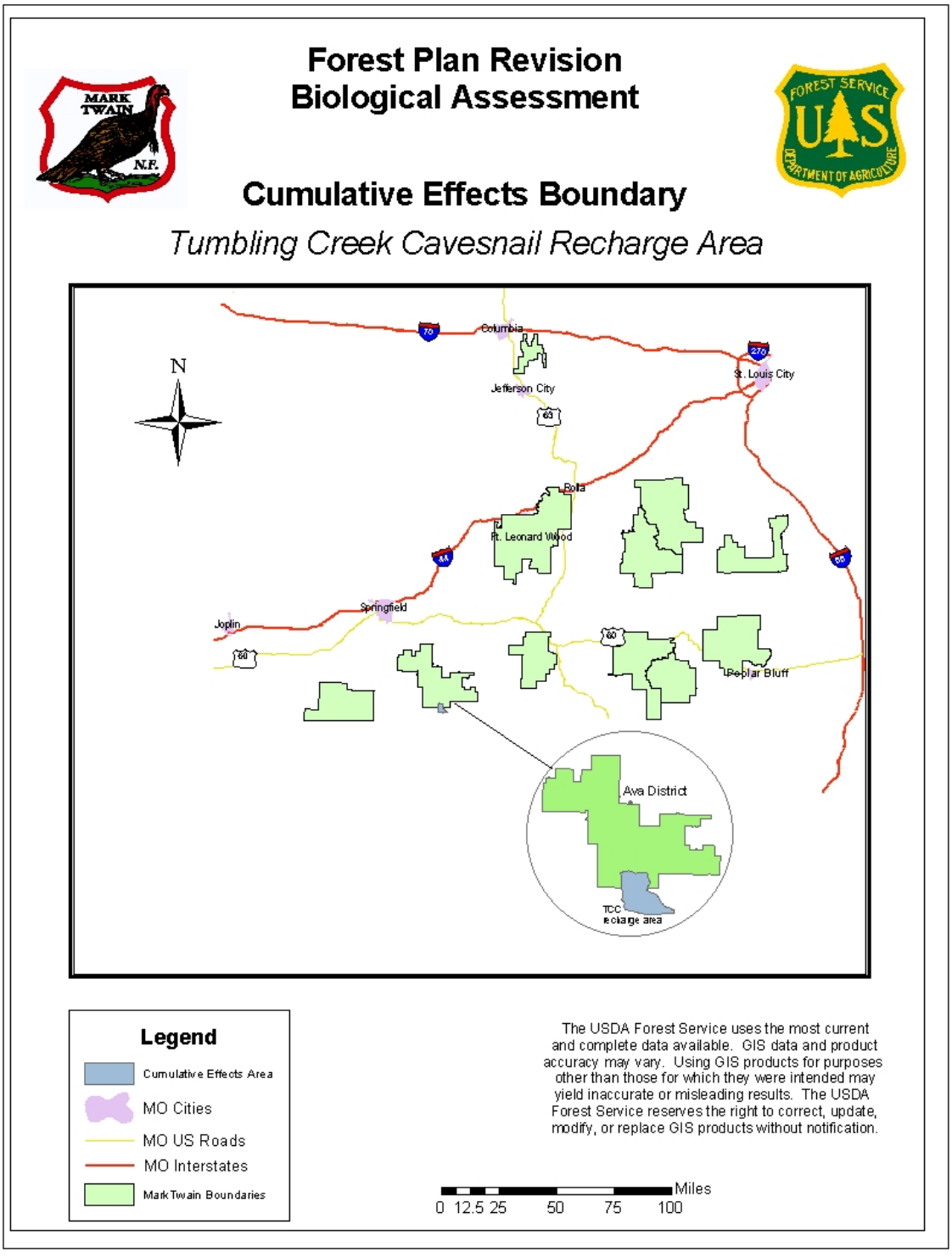
Feral hogs are becoming a nuisance on MTNF lands. Even small groups of hogs can adversely affect vegetation and soil in a wide area by rooting and wallowing. However it is not known if this activity would increase soil movement and sedimentation of Tumbling Creek, nor if hog waste would contribute to decreased water quality in the cave stream.

Cumulative Effects

Boundaries:

The spatial boundary for cumulative effects analysis for Tumbling Creek cavesnail is the recharge area for Tumbling Creek Cave. All effects to Tumbling Creek cavesnail are related to activities which occur in this area.

Figure TCC-2: Cumulative Effects Boundary for Tumbling Creek Cavesnail



The temporal boundary for cumulative effects analysis for Tumbling Creek cavesnail is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected because any potential effects of

sedimentation would be through the system by at least that time, and any potential beneficial impacts from improvement of the glade/savanna/woodland natural communities would have been realized by then.

Past and Present Actions

Past and present actions on National Forest lands in the recharge area are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. Pages 3-46 through 3-54 specifically describe conditions on glades as a result of past and present actions on National Forest lands.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, many open glades and woodlands were overgrazed by early settlers' livestock, then were invaded by woody species or non-native invasive species and fires suppressed (U.S. Forest Service 2005b, page 3-52). Some of these glades were later acquired by the Forest Service and some are still on other ownerships.

Reasonably Forseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;

- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are many owners within the Tumbling Creek Cave recharge area.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects. The Army Corps of Engineers controls the level of Bull Shoals Lake, which occasionally backs up into Tumbling Creek Cave (U.S. Fish and Wildlife Service 2003, page 22). The Army Corps of Engineers has proposed raising the conservation pool of the lake 5 feet, meaning that frequency and duration of water backing up into the cave may increase in the future (U.S. Fish and Wildlife Service 2003, page 22). Projects on federal highways and on ACOE lands are subject to Section 7 consultations and would therefore not be included in discussions of cumulative effects under ESA.

About 28% of the recharge area is in ownerships where land uses may still contribute to increased soil movement into the subsurface watershed. Most of the land recently purchased by the cave owner has been impacted by overgrazing, excessive land clearing, and a failed earthen dam, all potentially causing silt to enter the cave stream (Federal Register Vol. 67, No. 157, 8/14/02). Past trends on private properties within the Tumbling Creek Cave recharge area are some indication of reasonably foreseeable trends for the future.

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on Tumbling Creek cavesnails or their habitat include:

- Clearing of forest to expand pastures or to accommodate residential growth from the Branson area resulting in potential for increased silt movement into the cave stream.
- Fertilizer use, pesticide use or livestock feeding operations resulting in potential for waste runoff into subsurface waters
- Highway construction/relocation/improvement/maintenance potentially resulting in increased silt or waste products moving into the cave recharge waters ;
- Inadequate waste disposal, including dumping of household waste on private lands which may result in waste materials leaching into groundwater, leading to poor water quality or contamination
- Feral hog presence

These are the types of activities identified in the Tumbling Creek Cavesnail Recovery Plan as significant threats to the existence of the species (U.S. Fish and Wildlife Service 2003, pages 16-23).

Effects Analysis

Approximately 23% of Tumbling Creek Cave recharge area is in National Forest ownership. About 72% of the recharge area is in ownerships that could be expected to manage the land to benefit the species, including National Forest lands (Federal

Register Vol. 67, No. 157, 8/14/02). That leaves about 28% of the recharge area in ownerships where land uses may still contribute to increased soil movement into the subsurface watershed.

Counties within the Ava/Cassville/Willow Springs District of MTNF, including Taney County, experienced population growth of about 38% from the 1900 to 2000 census (U.S. Forest Service 2005b, page 3-277). These trends are likely to continue into the reasonably foreseeable future as the Branson and Table Rock/Bull Shoals Lakes area continues to attract tourists, retirees, and new residents. It is reasonably certain that some land development as a result of population growth will alter recharge area terrestrial habitat to some degree. To what degree these changes might affect Tumbling Creek cavesnail is unknown.

Highway projects planned in Taney County from 2004-2008 are concentrated in the western part of the state, far from Tumbling Creek Cave and would be unlikely to contribute to adverse impacts within the recharge area.
http://www.modot.state.mo.us/plansandprojects/documents/D8FinalMaps.pdf

Many of the rural counties in which MTNF lands are located do not have county-wide waste disposal systems. Residents must dispose of their own waste, and some dump it on their own property, or on public lands nearby. These dumps have potential to leach waste materials directly into the groundwater systems that feed Tumbling Creek Cave stream. Landfills and industrial/commercial waste sites may also leach waste materials into the groundwater system. While MTNF does not permit dumping on National Forest lands, and cleans up illegal dumps when and where possible, dumps within the recharge area of Tumbling Creek Cave do have potential to contaminate the cave stream. Whether or not there would be adverse impacts to Tumbling Creek cavesnail is uncertain, but the species' decline in numbers may be due to pollutants degrading water quality of the cave stream (U.S. Fish and Wildlife Service 2003, page 17).

Conclusions:

With 24% of the known recharge area for Tumbling Creek Cave, MTNF is a significant contributor to the survival of Tumbling Creek cavesnail. Under the Revised Forest Plan, the recharge area would be managed to maintain or restore glade and woodland natural communities that would contribute water of good quality to the subsurface waters feeding Tumbling Creek cave. There would be no conversion of forests, woodlands, or glades to other uses. There would be site-specific analysis of potential effects of proposed management activities within the recharge area prior to implementing any activity to insure proper timing, methods, and minimization of risk to Tumbling Creek cavesnail. The probability of forest management activities adversely affecting Tumbling Creek cavesnail is so low that it is considered insignificant and discountable. The effects of implementation of the Revised Forest Plan when added to other potential impacts within the recharge area would result in little or no cumulative adverse effects.

Beneficial effects from management on National Forest lands include an increase in both quantity and quality of terrestrial natural communities within the recharge area. This in turn, would be likely to increase the quality of water reaching the groundwater system, and may help moderate water fluctuations through better water holding capacity of the native vegetation of the restored natural communities. Whether this would translate into increased survival or reproduction for the species is unknown. With 24% of the known

recharge area, MTNF would be likely to have cumulative beneficial effects on the species through maintenance of suitable habitat.

» **Additional measures needed for species conservation and recovery**

There are no additional measures which could be taken by the Forest Service that would contribute significantly to species conservation or recovery.

» **Effects of additional measures**

Since there are no additional measures required, there would be no effects of additional measures.

» **Determination – May Affect, Not Likely to Adversely Affect**

Rationale: The primary need on MTNF lands within the Tumbling Creek Cave recharge area is to avoid soil movement off-site and into the subsurface watershed which feeds Tumbling Creek. Implementation of standards and guidelines in all alternatives would prevent or minimize soil movement as a result of management activities in the recharge area. Past experience, monitoring, and research have shown minimal effects on soil and water from forest management activities. Therefore, it is highly unlikely that activities on MTNF lands would contribute to sedimentation or adverse impacts to the water quality or quantity in Tumbling Creek. Removing grazing from the glade/woodland communities would have a long-term beneficial effect on the hydrologic functioning of National Forest lands within the cave recharge area. Any adverse impacts from MTNF lands would be so slight as to be insignificant and discountable.

Tumbling Creek cavesnail

Pink mucket pearlymussel (*Lampsilis orbiculata* (=. abrupta))

» Life History summary

While relatively little is known about the life history of the pink mucket pearly mussell, the biology of this species is presumed to be similar to other Unionid mussels. Adults are filter feeders, siphoning water to extract detritus, plankton, and other microorganisms. Adults spend their entire lives buried partially or completely in the substrate.

Males release sperm into the water in August and fertilization occurs in the gills of the female. Glochidia are released into the water the following June, when they must attach to the gills of a host fish. The fish hosts for pink mucket pearly mussel most likely include sauger (*Stizostedion canadense*), freshwater drum (*Aplodinotus grunniens*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*) and spotted bass (*Micropterus punctulatus*) bass species (U.S. Forest Service 1998, page 4 pink mucket; NatureServe 2005).

Pink mucket pearly mussels are found in medium to large rivers with a variety of substrates in moderate to fast-flowing waters. They are found in depths from 2.5 cm to 8.0 m (U.S. Fish and Wildlife Service 1985).

» Population status range-wide, in Missouri, and on MTNF

Rangewide

Historically, pink mucket pearly mussels are known from 25 river systems, almost exclusively in the Tennessee, Cumberland, and Ohio River drainages, with occasional records from the Mississippi River drainage (U.S. Fish and Wildlife Service 1985, page 2). While widespread in distribution, it was nowhere common and was apparently rare throughout its range (U.S. Fish and Wildlife Service 1985, page 7).

Currently, pink mucket pearly mussel is found in 16 different rivers with the greatest concentrations in the Tennessee, Cumberland, Osage, and Meramec Rivers.

This species is ranked G2 (Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors) and N2 (Imperiled in the nation because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation) (NatureServe 2005).

Missouri

Historical records of pink mucket pearly mussel are from 1919 on the Black River (questionable specimens); 1 relict from the Sac River in 1969; and 4 relict specimens from the St. Francis River in 1972 (U.S. Fish and Wildlife Service 1985, page 5).

Living pink mucket pearly mussels were found at 7 sites (16 individuals) on the Meramec River and at 1 site (1 individual) on the Big River during a 1997 survey (Roberts and Bruenderman 2000, page 39). All locations were in Jefferson or St. Louis Counties,

about 35 air miles from the nearest National Forest lands. Buchanan (1996) also found dead pink mucket pearly mussels on the Little Black River near the Arkansas/Missouri border, but surveys at that site in 1998 found no specimens (Missouri Natural Heritage Database 2005). Other rivers in Missouri with current records include the Sac, Osage, Black, and Gasconade Rivers.

Within the Black River, areas surveyed in 1969-1982 and resurveyed in 2003 showed a 17% decrease in the number of live individuals found (Hutson and Barnhart 2004).

Mark Twain NF
During 1981-1982 surveys, 9 living individuals were found at 7 sites in the Black River between Clearwater Dam and Poplar Bluff, Missouri (Buchanan1996). Five of these sites are within the proclamation boundary of MTNF, and one is located on National Forest lands (Missouri Natural Heritage Database 2005). At that site, one living individual and several dead specimens were observed.

In this same survey, one living individual was found on the lower Current River at river mile -4.8, which is in Arkansas.

» **Causes of past and/or current declines and Limiting factors**

The pink mucket pearly mussel was listed as Endangered throughout its range on June 14, 1976 (Federal Register Vol. 41, No. 115, 6/14/76). This species is also listed as Endangered in Missouri (Missouri Department of Conservation 2005, page 10).

There is no critical habitat designated for pink mucket pearly mussel.

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** The greatest single factor in the decline of pink mucket pearly mussel in the Tennessee Valley and other drainages is probably the impoundment of rivers and streams for flood control, navigation, hydro-power and recreation (U.S. Fish and Wildlife Service 1985, page 16). Since the early 1930's, 51 impoundments have been constructed in the Tennessee and Cumberland River systems (U.S. Fish and Wildlife Service 1985, page 16). Impoundments affect mussels by eliminating species not able to adapt to altered flows, temperature regimes and oxygen conditions. Impoundments alter habitat, food sources, fish host availability, water temperature and chemistry. They can interfere with movement of fish hosts and isolate mussel beds from each other, leading to decreased recruitment and a decrease in genetic diversity (U.S. Fish and Wildlife Service 1985, page 17).

Sedimentation is a natural process that can be greatly accelerated by land uses that expose soil (such as development for agriculture, industries, homes or businesses; channelization of streams; impoundment of streams; heavy recreational use; timber harvest in riparian zones). Increased sediment in a stream can smother mussels or interfere with their feeding or respiration, leading to decreased survival. Heavy siltation can also interfere with reproduction and survival of host fishes. In-stream work such as channelization, gravel mining, or dredging, can crush or remove mussels. These activities can also change the functioning of a stream and decrease the amount or suitability of mussel habitat.

Both point and non-point sources, including municipal, agricultural, and industrial waste discharges, can contribute toxic materials which can decrease or eliminate mussel populations through acute and chronic effects such as direct mortality, reduced reproductive success, or compromised health of mussels or host fish. The addition of nutrients through runoff into waters can decrease oxygen and cause changes in water chemistry that are harmful to mussel survival, as well as impacting host fish.

Listing Factor B. *Overutilization for commercial, recreational, scientific, or educational purposes.* While no mention of overcollecting was made in the Recovery Plan, indirect impacts from commercial collection of other mussels are possible. As mussel beds were overharvested, pink mucket shells may have been trampled or removed along with other species, and habitat may have been destroyed or damaged through disturbance of the stream bottom.

Listing Factor C. *Disease or predation.* These factors are not mentioned as possible causes of decline in the Recovery Plan.

Listing Factor D. *The inadequacy of existing regulatory mechanisms.* The Clean Water Act (CWA) has resulted in many improvements in water quality throughout the pink mucket pearly mussel range. However, water quality degradation is still a concern for sensitive aquatic species like mussels. Passage of CWA has led to regulatory and voluntary measures to protect and improve water quality. However, many activities which could affect water quality are not regulated, or are subject to limited regulatory authority.

While mussel species may be taken and used as bait throughout the year in Missouri, endangered species of mussels may not be taken or possessed (Missouri Department of Conservation 2005, page 73-74).

Listing Factor E. *Other natural or manmade factors affecting its continued existence*. Potential impacts from non-native zebra mussels and Asiatic clams are a concern for the future of all native freshwater mussels. The non-native zebra mussel (*Dreissena polymorpha*) was introduced into the United States in 1985 and has spread throughout the Mississippi River and many of its tributaries. Zebra mussels suffocate native mussels by attaching to their shells in large numbers. Zebra mussels spread as they are carried from infected waters on recreational and commercial vessels. Zebra mussels are found in the Mississippi and Missouri Rivers, and it is likely that they will continue to spread throughout Missouri's larger rivers.

The Asian clam (*Corbicula fluminea*) is a freshwater mussel that is now ubiquitous across the pink mucket pearly mussel's range. This mussel forms dense colonies that are believed to compete with native mussels for food, nutrients and space, as well as displacing juveniles. Asian clams are also subject to sudden die-offs which can result in oxygen depletion and high levels of ammonia in the water (U.S. Fish and Wildlife Service 2004, page 20).

The black carp (*Mylopharyngodon piceus*) is another new threat to freshwater mussels. This fish is native to eastern Asia and adults feed extensively on freshwater mollusks (U.S. Fish and Wildlife Service 2005, page 20). Black carp are currently proposed for use in fish ponds to control snail populations, but at least one individual has been found

in the wild (March 2003 in an oxbow of the Mississippi River near the mouth of the Ohio River) (U.S. Fish and Wildlife Service 2005, page 20). Farm fish ponds are often located in bottomlands subject to flooding. If these fish escape, they are likely to proliferate as grass carp have done (U.S. Fish and Wildlife Service 2005, page 20).

» Causes of past and/or current recovery

Although the range of this species has decreased, pink mucket pearly mussel appears to have adapted somewhat to living in impounded river systems and "conditions are apparently being met for the continued survival of this species" (U.S. Fish and Wildlife Service 1985, page 10).

» Occurrence on MTNF, existing and potential habitat

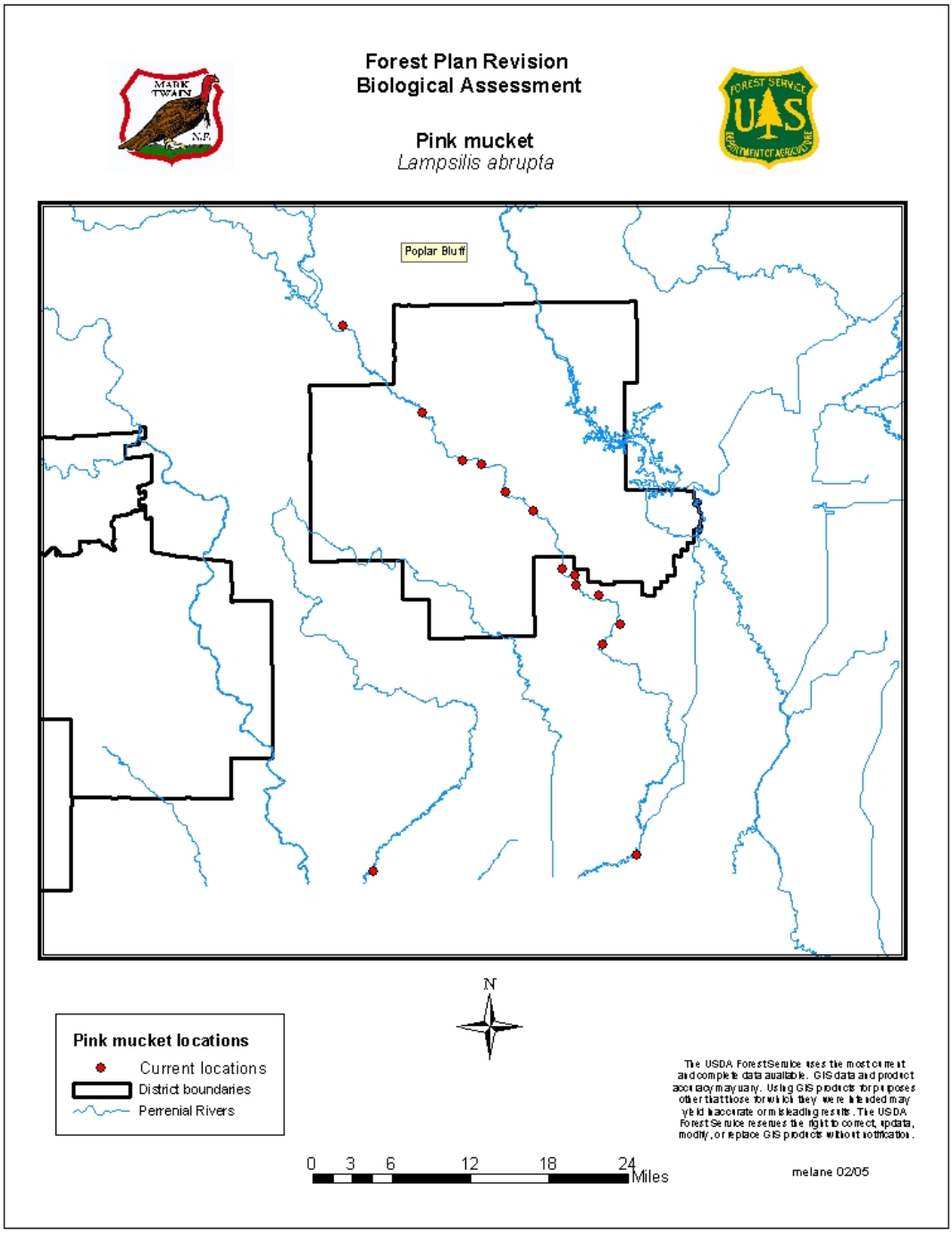
The only known location for pink mucket pearly mussel on MTNF is one site in the Black River on the Poplar Bluff District. At this site, one living individual and several dead specimens were found in 1981 and 1982. A survey in 2003 found no pink mucket pearly mussels in the Black River within the MTNF proclamation boundary.

There are four other previously known locations within the MTNF proclamation boundary on the Black River. There are also several known sites on the Black River downstream of the MTNF proclamation boundary. A 2003 survey found four live female pink mucket pearly mussels between river miles 10.5 and 48.5 (Hutson and Barnhart 2004, page 153). All of these sites are outside the MTNF proclamation boundary.

So it appears that currently, there are no locations of living pink mucket pearly mussel within the MTNF proclamation boundary.

Pink mucket pearly mussel shells
Photographer: Tennesee Division of Natural Heritage

Figure PM-1: Pink mucket pearly mussel locations in or near MTNF



» **Surveys for Pink mucket pearlymussel**

A survey of freshwater mussels was conducted in 2003 on the Sac, Pomme de Terre, St. Francis and Black River systems (Hutson and Barnhart 2004). Pink mucket pearly mussels were found only in the Sac and Black Rivers.

The Missouri Department of Conservation conducted surveys for Unionid mussels in the Upper Gasconade River Basin from 1998-1999. No pink mucket pearly mussels were found during this survey (Bruenderman et al. 2001).

A freshwater mussel survey of the Big Piney River, Roubidoux Creek and selected tributaries was conducted by Missouri Department of Conservation in 1993. No pink mucket pearly mussels were found in this survey (Sietman and Sternburg 1994).

A survey of 26 Missouri streams was conducted in 1981-1982 to locate freshwater mussels, particularly the endangered Curtis' pearly mussel. During this survey, pink mucket pearly mussel was found in the Black River, and Little Black River (Buchanan 1996).

- **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

There are no actions listed in the Recovery Plan that identify the Forest Service as the Responsible Agency.

However, the Forest Service will continue to cooperate with the Missouri Department of Conservation and U.S. Fish and Wildlife Service in surveying MTNF rivers and streams for the presence of endangered and threatened mussels (**Action 1. Conduct population and habitat surveys and Action1.1 Determine species' present distribution and status**). Chapter 4 of the Revised Forest Plan contains a monitoring item to determine the extent to which Forest management is contributing to the conservation of threatened and endangered species and moving toward their habitat conditions (U.S. Forest Service 2005, page 4-11). Standards and guidelines require pre-work assessments of suitable habitat and presence of threatened and endangered mussel species prior to any in-stream work (U.S. Forest Service 2005, page 2-7).

The Revised Forest Plan contains goals (U.S. Forest Service 2005, pages 1-2 through 1-3). that would address **Action 2. Preserve populations and present habitat of L. orbiculata.** These include:

- Protect the water quality and integrity of the watershed on Forest lands.
- Maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the riparian corridor.
- Maintain streams in normal function within natural ranges of flow, sediment movement, temperature, and other variables.
- Support recovery of Federal and State listed species.

There are also numerous standards and guidelines in the Revised Forest Plan that would contribute to the maintenance of quality habitat for pink mucket pearly mussel. These include standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs), for soil productivity and water management, (pages 2-2 through 2-5), streams and rivers (pages 2-9 through 2-10) and others throughout the plan that limit or modify activities to protect water quality and minimize soil movement.

» **Effects of implementation of the proposed action**

Effects analysis will

A). identify actions which may affect pink mucket pearly mussel individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
- a) identifying how many individuals would be exposed
- b) which populations are represented by those individuals
- c) identifying specific stressors associated with exposure to the action
- d) identifying where and when exposure would occur
- e) identifying the duration and extent of exposure

C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of pink mucket pearly mussel individuals, groups, or habitat.
E) estimate the risk posed to pink mucket pearly mussel by the action.

Direct Effects

Since there are no longer any extant populations known to occur in any waters of the MTNF, including the Black River, there would be no direct effects as a result of management activities implementing the Revised Forest Plan.

Indirect Effects

Because there are no known locations on National Forest lands or within the proclamation boundary, any effects on pink mucket pearly mussel would be indirect. The primary potential impacts would come from activities which result in soil movement off-site, increasing sediment in the waterways where pink mucket pearly mussels occur.

Potential Negative Effects

» ***Physical alteration of substrate***

Pink mucket pearly mussel habitat may be affected by soil movement into waters when in-stream activities disrupt the substrate and soil moves into the water and downstream. National Forest management activities which may be done within stream segments include such things as streambank improvement, aquatic habitat enhancement, recreation site development, road or bridge construction/maintenance, or fireline construction. Heavy equipment may be needed to complete these types of projects where some amount of in-stream work is necessary. The Revised Forest Plan limits in-stream use of heavy equipment to the minimal amount of time necessary for completing a project (U.S. Forest Service 2005, page 2-5). Pre-work surveys are required to assess the presence of suitable habitat and threatened or endangered mussel species (U.S. Forest Service 2005, page 2-7). If threatened or endangered mussels are found at a proposed project location, that project must be modified or relocated to avoid impacts to the mussels present at that site (U.S. Forest Service 2005, page 2-7). Mechanical fireline construction for prescribed burns is prohibited within the RMZ, and for wildfire

suppression except when necessary to protect life, property, or public and firefighter safety (U.S. Forest Service 2005, pages 2-15 and 2-17). If it is necessary to cross stream channels during wildfire suppression, it must be at right angles and the crossing must be stabilized and revegetated as soon as possible after the fire is controlled (U.S. Forest Service 2005, page 2-17).

Over the past 15 years, a few dozen projects involving in-stream work have been accomplished on the Forest. Most of these have been improvements to existing developed recreation sites, such as boat/canoe accesses; repair of road crossings; or bank stabilization projects. Construction and maintenance has occurred at the Hendrickson boat ramp on the Black River, which is approximately 13 miles upstream from the closest known pink mucket pearly mussel site.

Also, aquatic habitat enhancement projects or hydrologic control structures should be designed to mimic as much as possible the appearance and function of natural habitat features. Aquatic organism passage must also be maintained unless done in conjunction with prescribed fish-management objectives (U.S. Forest Service 2005, page 2-9). Because projects designed to improve habitat for one fish species might negatively affect habitat for other fish species, and because each mussel species has specific fish host species, the Revised Forest Plan requires that all fish management plans must be designed to minimize impacts on host species for threatened or endangered mussel species (U.S. Forest Service 2005, page 2-7). With this measure, it is highly unlikely that there would be impacts to fish hosts due to MTNF activities.

These measures help insure that the structure and function of the substrate and stream segment function in as natural a manner as possible in the long-term, and that additional sediment is not added to or moved through the aquatic system from MTNF activities. Surveying to determine the presence of suitable habitat and mussels themselves, and the requirement to relocate or modify projects where mussels are present would minimize the potential for in-stream work to negatively affect pink mucket pearly mussels. The potential for indirect effects to pink mucket pearly mussels located at least 6 miles downstream from the nearest National Forest land and over 10 miles to the nearest National Forest land adjacent to the Black River, from any activities is considered to be so remote that it is insignificant and discountable.

- ***Sand & gravel mining***

Mining for sand or gravel disturbs the substrate and may cause sediment to move through a stream. It may also physically remove mussels from the stream, crush them, or suffocate them by rearranging the substrate. Mining for sand or gravel could be a one-time event, or more likely, a long-term use of an area. With such low populations of this species, even a one-time event, if it occurred at an extant site, could be devastating to local populations and could negatively impact the long-term survival of an entire stream stretch.

The use of common variety minerals (sand and gravel) is limited to the needs of the Forest Service and other public agencies when the action benefits National Forest management (U.S. Forest Service 2005, page 2-34). In addition, removal of sand and gravel from stream channels or RMZs is prohibited unless needed to protect infrastructure or public health and safety (U.S. Forest Service 2005, page 2-34).

Since there are no extant pink mucket pearly mussel sites within the proclamation boundary of MTNF, there would be no impact to this species from any removal of gravel permitted on National Forest lands.

» ***Sedimentation***

Although sedimentation is a natural process, human activities such as intensive agriculture, timber harvesting in riparian zones, heavy recreational use, urbanization, channelization and impoundments can accelerate erosion and increase sediment loads in nearby waterways (U.S. Fish and Wildlife Service 2004, page 10). Sediment can reduce mussel feeding efficiency, resulting in decreased growth or survival; can physically smother mussels, and sediment particles can carry toxic materials (U.S. Fish and Wildlife Service 2004, page 10).

The activities which have potential for soil movement off-site include timber harvest, prescribed burning and fireline construction, road reconstruction and maintenance, mineral exploration and development activities under existing permits, and range management, including grazing. These activities, under the current Forest Plan, occur on approximately 43,000 acres annually (about 3% of the Forest) (U.S. Forest Service 1998, page 5). Under the preferred alternative (Alternative 3) of the Revised Forest Plan, there would be about 120,415 acres of these types of treatments annually (about 8% of the Forest) (U.S. Forest Service, 2005, page E-3).

Water yields on lands subject to timber harvest and some prescribed fires, can be significant on small scale watersheds, with possible channel degradation and soil movement. However, on a large scale, such as the Forest as a whole, these temporary, increased yields are a small fraction of overall water yield from MTNF lands, and are not measurably detectable on an annual basis (U.S. Forest Service 2005(a), page 3-195) (U.S. Forest Service 1998, Pink mucket pages 8-11).

Timber harvest is prohibited within RMZs unless needed to move toward desired condition, and mechanical construction of firelines for prescribed burning is also prohibited in the RMZ (U.S. Forest Service 2005, page 2-3). These measures would further decrease the potential for any soil movement to occur within the riparian corridor.

Road construction, reconstruction or maintenance may occur at any time of year, and can take place over the course of several days, weeks, or months depending on the length and amount of work to be done. Soil movement would be most likely where roads are in riparian areas, where roads cross streams, or are on steep slopes. Standards and guidelines provide direction for using minimum necessary construction, reconstruction and maintenance standards; scheduling work to take advantage of favorable ground conditions; using existing roads in preference to building new roads; locating roads outside the RMZ and WPZ; avoiding losing streams; keeping road grades normally at less than 10%; designing appropriate drainage features, and limiting stream crossings (U.S. Forest Service 2005a, pages 2-37 through 2-39). All these measures are intended to reduce, minimize, or prevent soil movement off-site.

Mineral exploration and development (drill sites, temporary roads, vent shafts) under the current Forest Plan occurs on a very small proportion of MTNF lands each year (on average, less than 10 acres/year), and although some of these are in the upper Black River watershed, all are well over 50 miles from the closest known pink mucket pearly mussel site on the lower river. The possibility that soil movement from these sites would

reach pink mucket pearly mussel sites is extremely remote. There are no significant changes in administration of mineral permits in the Revised Forest Plan, and no reason to think that the acreage affected by mineral activities would change significantly in the foreseeable future.

In Alternative 3 of the Revised Forest Plan there are approximately 1,050-1,780 acres of grazing allotments within riparian management zones (RMZs). Approximately 290 acres of allotments are within the Black River RMZ, and all are over 10 miles from the closest pink mucket pearly mussel site .

All areas within 100 feet of rivers or streams would be fenced to keep livestock away from waterways. However, the presence of livestock in floodplains makes it more likely that some soil loss would occur, particularly during flooding events, and that some enrichment of waters would take place as livestock waste enters the waterways (U.S. Forest Service 2005a, page 3-208 through 3-209). However, standards and guidelines require that grazing allotments within the RMZ must be foreclosed at the earliest opportunity; that timing, duration, and intensity of livestock grazing be controlled to achieve desired vegetation objectives; and that the functionality of the RMZ shall not be degraded by grazing (U.S. Forest Service 2005, page 2-19).

Therefore, although some soil loss is possible on individual allotments or individual units in an allotment, on the Forest as a whole the impact would not be enough to cause a short or long term increase in sediment or nutrient input to the Black River. If soil loss on a particular unit or allotment was documented, the timing, intensity, and/or duration of grazing would be adjusted to reduce, minimize or eliminate that potential in the future. With these measures in place, any sedimentation or water quality impacts resulting from livestock grazing would be so slight as to be considered insignificant and discountable.

The Missouri Department of Conservation collects various kinds of data on fish populations on major waterways. The Missouri Department of Conservation's 2005 Fishing Prospects report shows that game fish populations are "fair", "good", "great", and "excellent" in the rivers which run through MTNF lands that are listed in the report (Missouri Department of Conservation 2005). This is an indication that any sediment reaching the rivers from past MTNF management activities has not affected the availability of host fish. For the Black River, the report shows that spotted bass are common throughout the river. The Black River Watershed Assessment says "Angling opportunities for black bass and shadow bass are good throughout the basin" (Missouri Department of Conservation 2004).

- ***Nutrient enrichment***

Nutrient enrichment of waters can lead to decreased oxygen concentration, increased acidity, excessive growth of filamentous algae, and other changes in water chemistry that may affect the survival of mussels and their host fish (U.S. Fish and Wildlife Service 2004, page 9). Excess algae can alter substrate surfaces and disrupt food supplies for juveniles by altering algal communities (U.S. Fish and Wildlife Service 2004, page 9).

The primary source of nutrients from MTNF lands which may reach waterways within the Black River watershed are pastures with permitted grazing or hayfields that are regularly fertilized. There are approximately 290 acres of current allotments within the Black River RMZ. All are located over 10 miles from the nearest pink mucket pearly mussel site.

The Revised Forest Plan requires that livestock be fenced at least 100 feet away from streambanks (U.S. Forest Service 2005, page 2-3); no fertilization be done in the RMZ or WPZ (U.S. Forest Service 2005, pages 2-3 and 2-4); and avoids the placement of livestock distribution tools (water tanks, salt blocks) in WPZ (U.S. Forest Service 2005, page 2-4). In addition, grazing allotments that are within the RMZ, and under an active permit as of September 2005 must be foreclosed at the earliest opportunity (U.S. Forest Service 2005, page 2-19). The timing, duration, and intensity of livestock grazing are to be controlled to achieve desired objectives for structure and species composition (U.S. Forest Service 2005, page 2-19). These measures would reduce, but not eliminate, the potential for animal waste to run-off into area waters (U.S. Forest Service 2005(a), page 3-208 through 3-209). Flooding may transport animal waste into the adjacent stream.

Other minor sources of nutrients could include sanitation facilities and food plots which are regularly fertilized. The Revised Forest Plan requires that existing food plots within the RMZ/WPZ be closed and rehabilitated (U.S. Forest Service 2005, page 2-9) and that sanitation facilities not be constructed in the RMZ (U.S. Forest Service 2005, page 2-3). These measures would eliminate the potential for nutrient enrichment from these sources.

The potential for nutrient enrichment from National Forest activities to affect pink mucket pearly mussel is so remote as to be considered insignificant and discountable.

- ***Non-native invasive species***

Non-native zebra mussels, Asiatic clams and black carp have the potential to negatively impact individuals and populations of pink mucket pearly musselsl. The mussels attach to native mussels and interfere with their feeding and respiration, as well as outcompeting native mussels for food, nutrients and space. Black carp feed on freshwater mussels.

There is nothing included in the Revised Forest Plan that would change the potential for zebra mussels, Asiatic clams or black carp to colonize waters occupied by pink mucket pearly mussels. There are two monitoring items included in Chapter 4 that would track potential effects of non-native invasive species on mussels. These are, to what extent Forest management is contributing or responding to non-native invasive species and to what extent Forest management contributes to the conservation of endangered species and their habitats (U.S. Forest Service 2005, pages 4-10 and 4-11). In addition, should non-native species be discovered on MTNF lands or waters, a standard and guideline requires the Forest Service to prioritize treatments based on threats to resources, species status, size of infestation, potential for spread, effectiveness of control measures, and relationship to boundaries (U.S. Forest Service 2005, page 2-2). While implementation of the Forest Plan cannot change the mechanism of spread of zebra mussels, Asiatic clams or black carp, it does allow the Forest Service to monitor for problems and deal with them if they occur.

Since all known locations are outside the Forest proclamation boundary, there would be nothing the Forest Service could do directly to address non-native invasive species impacts to pink mucket pearly mussels.

- ***Pesticides***

The use of pesticides in the Riparian Management Zone and Watercourse Protection Zones is prohibited unless needed to move toward desired condition (U.S. Forest

Service 2005, page 2-3). The least impacting application method is to be used, and all equipment used in the application of pesticides must be washed and rinsed where runoff would not reach surface waters, wetlands or other special habitats (U.S. Forest Service 2005, page 2-18). Only pesticides labeled for use in or near aquatic systems may be used in RMZs and WPZs, and only hand or single plant application may be used, unless approved by the Forest Supervisor when other methods are shown to be environmentally sound and the most biologically effective method practicable (U.S. Forest Service 2005, page 2-19). With these measures, the potential for pesticide use on MTNF to cause any impact to individual mussels or the population is so remote as to be considered insignificant and discountable

Potential Beneficial Effects

The most widespread and lasting indirect impact on pink mucket pearly mussels would be the protection of water quality and the integrity of watersheds in which the mussel occurs.

» ***Prevent channelization***

Permanent stream channelization is prohibited by the Revised Forest Plan (U.S. Forest Service 2005, page 2-5).

» ***Prohibit impoundments***

New man-made impoundments, mine tailings ponds, and water diversions are prohibited within the RMZ and discouraged in the WPZ (U.S. Forest Service 2005, page 2-5). This means there could be no impoundment of the Black River or its permanent stream tributaries where they are on National Forest lands.

» ***Prevent commercial mussel harvest***

Permits for any kind of collection involving federally listed species from MTNF lands would only be given if the collector has a valid U.S. Fish and Wildlife Service collecting permit (U.S. Forest Service 2005, page 2-6). Regulation of commercial harvest is the responsibility of the state of Missouri which does not allow taking of endangered mussels (Missouri Department of Conservation 2005, page 73-74).

» ***Protect water quality and minimize sedimentation***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways, maintain or improve the vegetative communities within these zones, and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to water quality, modification of habitat, or resultant impacts on pink mucket pearly mussel mussel survival or reproductive success.

In addition to standards and guidelines which limit, modify, or direct management activities within the riparian corridors and upland waterways (see paragraph above), there are standards and guidelines designed to reduce, minimize or eliminate soil movement from Forest management activities on upland sites and in or near streams and rivers (U.S. Forest Service 2005, pages 2-5, 2-9 through 2-10, 2-14 through 2-17, 2-

18, 2-19 through 2-20, 2-28 through 2-30, 2-31 through 2-34, 2-37 through 2-2-40). Implementation of these measures would reduce the potential for soil to move off-site and reach a water source, and therefore reduce the potential for any adverse effects to occur to water quality.

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39). All these actions would minimize the amount of soil moving off-site and help protect area waterways from additional sedimentation.

» ***Restoration of natural communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the natural communities that occur on National Forest lands. The major benefit of restoration of healthy natural communities would be less water runoff to surface streams and increased water filtering into the groundwater system as a result of increased herbaceous vegetation (Nelson 2005). This change in hydrologic functioning may help buffer the effects of periodic drought on adjacent waterways, and maintain more stable water flow during dry summer months.

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including riparian corridors (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

No Effects

Activities which take place on MTNF outside of the watersheds of the Black River would have no effect on pink mucket pearly mussels. This would include activities on all Districts except the Poplar Bluff District.

Unknown or Questionable Effects

The Black and Current Rivers are premiere recreational opportunities and are visited by thousands of people each year. Fishing and canoeing are the major activities, but boats, kayaks, tubes, and personal watercraft also make use of some segments of rivers. In the low water of mid-late summer, canoes may scrape bottom over some of the gravel riffles. This dislodges some bottom material and may increase turbidity in a small area. Boat wakes can wash against dirt banks and dislodge soil into the water. If mussels are in that area, they may be temporarily impacted until the water clears. If mussels are present in the riffle area, some may be dislodged by canoe bottoms. Floaters generally spend some time swimming or playing in the water. This can also temporarily increase turbidity in the local area, and may also dislodge mussels as people walk through the

water. Some people may collect shells to take home as a souvenir. Because of the very low density of pink mucket pearly mussels compared to other mussels, it is unlikely that casual collectors would pick a pink mucket pearly mussel. Whether or not any of these activities would result in short or long-term impacts to any pink mucket pearly mussel mussels is uncertain.

The Revised Forest Plan makes no changes in recreation management from the current Forest Plan. Canoeing, floating, rafting, fishing and swimming in rivers are recreation uses that are expected to increase by less than 10% between 2000 and 2010 (U.S. Forest Service 2005(a), page 3-260).

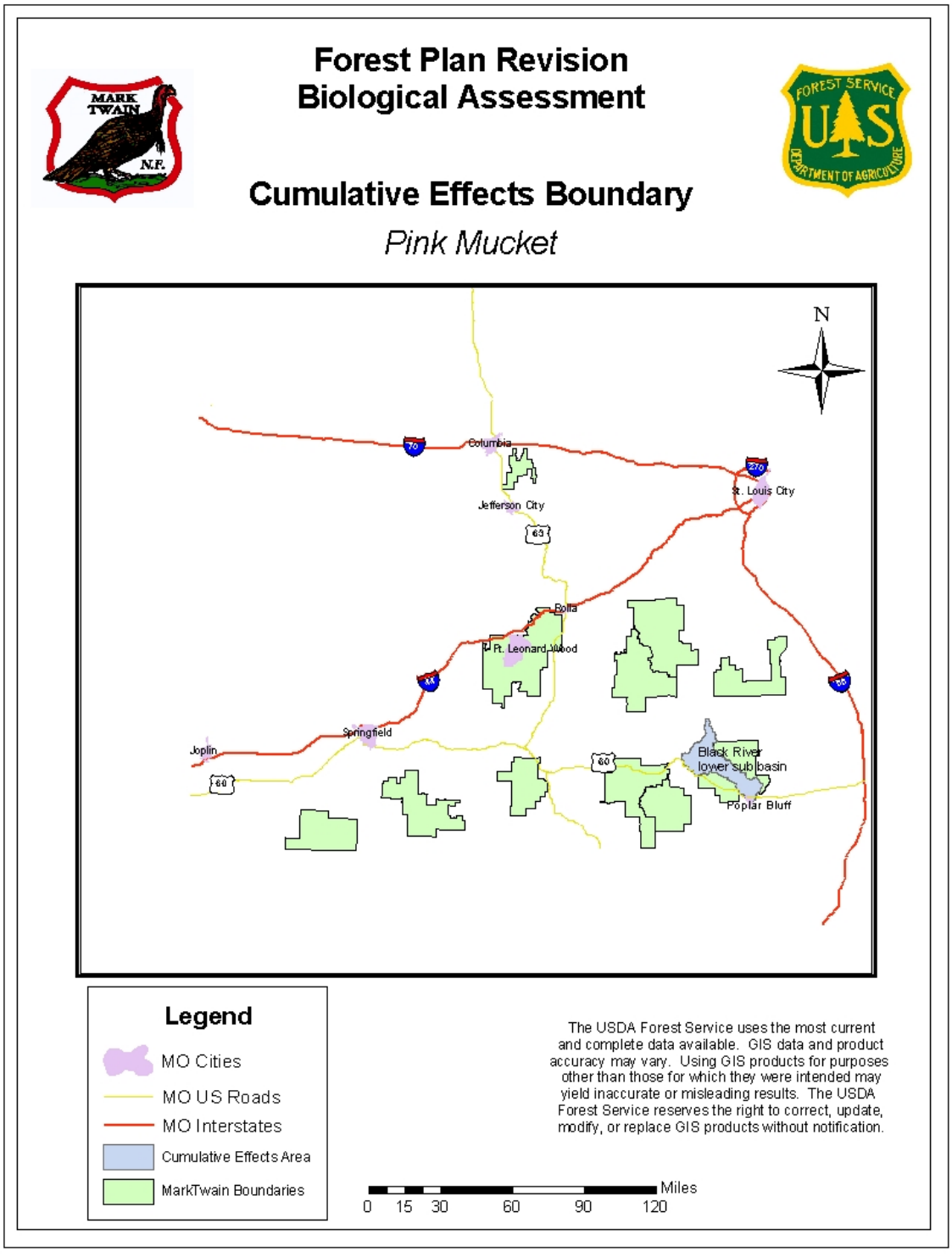
Cumulative Effects

Boundaries:

The spatial boundary for cumulative effects for pink mucket pearly mussel mussel is the 11-digit watershed of the lower Black River. This is the only river in which pink mucket pearly mussel occurs and that has MTNF lands within the watershed within which National Forest activities may result in potential effects. All potential effects to pink mucket pearly mussel mussel as a result of National Forest activities would occur in that area.

Black River
MDC photo

Figure PM-2: Cumulative Effects Boundary for Pink Mucket Pearly Mussel



The Sac and Osage Rivers are not included in the cumulative effects boundary because there is no National Forest land in either of those watersheds.

The Meramec River watershed is not included in the cumulative effects boundary because all of the extant sites for pink mucket pearly mussel are well over 20 miles

downstream of MTNF proclamation boundary. The Gasconade River watershed is not included in the cumulative effects boundary because all but one of the extant sites is well over 20 miles downstream of the MTNF proclamation boundary. The one site that is about 18 air miles downstream of the proclamation boundary had only 1 subfossil shell found in 1994. All of the land between the proclamation boundary and the site is in private ownership. The Current River is not included in the cumulative effects boundary because the closest known pink mucket site is in Arkansas, over 15 miles downstream from the National Forest boundary. Activities on MTNF in these watersheds would have no impact on sites this far away because of the low rate of soil loss from forested soils, the low sediment yield to streams in the Ozarks, and the length that soil would have to travel to reach these pink mucket sites.

The temporal boundary for cumulative effects analysis for pink mucket pearly mussel mussel is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected because any potential effects of sedimentation would be through the system by at least that time, and any potential beneficial impacts from improvement of terrestrial natural communities and their hydrology would have been realized by then.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. Specifically for pink mucket pearly mussel, much of the riparian corridor along the Black River was converted from bottomland forest to pasture, sediment was added to the stream, and flooding and water flow regimes were changed. Management of National Forest lands in the Black River over the past several decades have resulted in stabilization of bank segments and re-growth of forest cover in some riparian areas. Today, the streams in the Ozark portion of the lower sub basin of the Black River generally exhibit good water quality, riparian corridors are mostly forested and streambank erosion is not a major problem (Missouri Department of Conservation 2004).

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. During the 1880's through early 1900's, the rivers In short, much of the riparian corridor was cut, farmed, converted to pasture and overgrazed. (U.S. Forest Service 2005b, page 3-46). Some of these riparian areas were later acquired by the Forest Service but most are still in other ownerships.

Today, there is generally good water quality and good aquatic diversity throughout the Ozark portion of both sub basins of the Black River (Missouri Department of Conservation 2004). The lower sub basin is about 55% forested and 45% row crop or pasture (primarily SE of Poplar Bluff in the bootheel). The Ozark portion of the sub basin is primarily forested, while the lowland portion (SE) is almost entirely in row crops. The majority of channelization and floodplain alterations occur south of Poplar Bluff where the primary land use is agriculture (Missouri Department of Conservation 2004).

Mussel species diversity in the Black River is very high and is apparently higher than most other rivers of similar size in Missouri (Hutson and Barnhart 2004, page 148).

Reasonably Foreseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the proclamation boundary of MTNF. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can reasonably be predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section 7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the Black River watershed, and determining reasonably foreseeable activities on those ownerships is nearly impossible. However, past trends on private properties are some indication of reasonably foreseeable trends for the future. Population in the Poplar Bluff unit grew about 7% from 1990 to 2000 (U.S. Forest Service 2005(a), page 3-278).

Water quality and the availability of stable substrates are of primary importance to the continued existence of pink mucket pearly mussel mussels in Missouri and rangewide. Water quality is generally good in the Black River lower sub basin (Missouri Department of Conservation 2004).

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on water quality, pink mucket pearly mussel mussels or their habitat include:

- Impoundments
- Siltation
- Pollution

These are the types of activities identified in the Pink mucket pearly mussel Mussel Recovery Plan as threats to freshwater mussels (U.S. Fish and Wildlife Service 1985). In addition, habitat alteration through bank, channel, and substrate instability may have impacts on mussels in the Black River. Some private landowners may take steps to stabilize streambanks or otherwise improve water quality in streams adjacent to their property. Water quality is the common factor in all these activities, and will be the primary focus of the cumulative effects analysis.

Effects Analysis

All of the four sites with living pink mucket pearly mussels in 2003 are located downstream of the MTNF proclamation boundary. Three of the four are within 5 miles of the boundary and the fourth is almost 20 miles from the boundary. Although about 28% of the watershed of the lower sub basin of the Black River is comprised of MTNF lands, there is very little of the riparian corridor in National Forest lands. MTNF has only 10%

ownership of streambanks in the lower sub basin of the Black River, (8.5 miles out of a total of 80.5 miles).

Three of the four extant sites for pink mucket pearly mussel in the lower Black River (found during 2003 survey) are in a section of the river that has large and diverse mussel beds with very stable and diverse substrate and some of the best mussel habitat in the basin (Hutson and Barnhart 2004, page 153). The fourth site had only sand, silt, and clay substrate and was in a swamp-like section of the river. The one female pink mucket pearly mussel was found with several other mussel species (Hutson and Barnhart 2004, page 153).

» ***Impoundments***

Two reservoirs have been constructed in the upper sub basin of the Black River. The largest of these is Clearwater Lake (1650 acres) in Wayne and Reynolds Counties (Missouri Department of Conservation 2004). Construction on this reservoir was completed in 1951. It is operated by the Corps of Engineers for flood control, with recreation and conservation of fish and wildlife as other purposed (Missouri Department of Conservation 2004). This impoundment affects the lower sub basin since "Flow in the lower Black River is primarily regulated by water released through Clearwater Lake" (Missouri Department of Conservation 2004). Maximum river stage in the authorized regulating plan is 11.5 feet from December 1 through March 31, and a maximum stage of 10.5 feet from April 1 through November 30 (Missouri Department of Conservation 2004).

Because there would be no impoundments within the RMZ on National Forest lands, there would be no cumulative impact from impoundments.

» ***Siltation and Pollution***

One of the four extant sites for pink mucket pearly mussel is located in downtown Poplar Bluff (population 18,000) and is vulnerable to damage by bridge construction/repair and/or flow modifications (Hutson and Barnhart 2004, page 153). Discussions have taken place with the construction company to discuss possible modifications that would minimize impacts to the mussel beds (Hutson and Barnhart 2004, page 153).

Within the Black River watershed lower sub basin, stream habitat conditions are rated "good" for 62-92% of riparian corridors (excluding the Lowland ditches, where only 4% were rated "good"). Riparian corridors averaged 60-75 feet of forested cover (Missouri Department of Conservation 2004). Streambank erosion is not a major problem in the lower sub basin, and where erosion is occuring, it is associated with deforested riparian corridors (Missouri Department of Conservation 2004).

Black River watershed sheet and gully erosion rates have decreased significantly over the past 15 years and are not considered a serious problem (Missouri Department of Conservation 2004). For the two rivers for which data was given, sediment yield to streams (soil actually reaching the water) was 0.6-0.8 tons/acre/year, which MDC regards as "typically low in the Ozark region" (Missouri Department of Conservation 2001).

Natural rates of soil loss from forested lands are about 0.05 to 0.1 tons/acre/year. Monitoring of timber sales on MTNF showed soil loss from 0 tons/acre/year to 0.8 tons/acre/year with an average of about 0.2 tons/acre/year (U.S. Forest Service 1998).

In comparison, sheet erosion (0.5 to 1.5 tons/acre/year) and gully erosion (0 to 0.16 ton/acre/year) in the Black River basin are not considered a serious problem (MDNR 1995 as cited in Missouri Department of Conservation 2004). The estimated amount of commercial timber harvest under the Revised Forest Plan would be about 225,025 acres per year (U.S. Forest Service 2005, page E-3). Limiting or modifying soil-disturbing activities in RMZs and WPZs in particular would reduce the amount of soil loss from National Forest lands and the amount of sediment reaching waterways. The implementation of standards and guidelines to minimize soil movement and protect water quality in all forest management activities across the Forest would reduce the potential for any negative impacts to water quality or pink mucket pearly mussel mussels from these activities.

Although there have been a variety of attempts to stabilize streambanks (many unsuccessful), MDC has not installed any bank improvement projects on private lands within the lower or upper Black River sub basins (Missouri Department of Conservation 2004). It is likely that MDC, MDNR, and NRCS will continue to work with some private landowners to address problems of soil erosion, bank stabilization and proper disposal of waste from their properties.

However, it is also likely that some landowners will continue poor grazing, gravel mining, and other land use practices within the Black River watershed that will contribute to non-point source pollution in both the short and long-term.

Standards and guidelines in the Revised Forest Plan would help insure that streambanks, substrates, and channels are within their natural range of variability and are functioning in a way that provides for the needs of all aquatic and terrestrial flora and fauna that depend upon them. Specifically in-stream equipment use would be minimized, hydrologic or habitat improvement structures would be designed to be natural appearing and functioning, aquatic organism passage would not be blocked or prevented, canopy closures would be maintained on all permanent streams less than 25 feet wide, and in-stream work would be minimized during spawning periods (U.S. Forest Service 2005, pages 2-5, 2-9 and 2-10). Therefore, there would be no added impact from instable banks, substrates or channels caused by National Forest management activities.

Since the removal of sand or gravel from stream channels or the RMZ is prohibited in most cases, (U.S. Forest Service 2005, page 2-34), there would be almost no potential for impact from this activity on National Forest lands. If gravel or sand removal was proposed, the site-specific impacts of that proposal would be evaluated in terms of potential effects on federally listed species, including the pink mucket pearly mussel mussel. This analysis would include Section 7 consultation with the U.S. Fish and Wildlife Service. Known pink mucket pearly mussel mussel sites would be avoided. While gravel mining does occur on private ownerships in the Gasconade River watershed, there would be few, if any, added impacts since this activity is very unlikely to occur on National Forest lands.

There have been no major channelization of streams in the north and west part of the lower sub basin (the part in which the majority of MTNF lands are located), although small channelization projects and poor gravel removal practices are widespread and relatively common (Missouri Department of Conservation 2004). Effects of these types of projects may be significant, but are localized and very difficult to quantify (Missouri

Department of Conservation 2004). There would be no channelization of streams on National forest lands in the Black River lower sub basin and therefore no cumulative effects.

Permitted livestock on MTNF allotments do not have access to the river and therefore, there would be no cumulative impact from MTNF rangeland management.

There are 16 public and 29 private wastewater treatment plants in the Black River basin (Missouri Department of Conservation 2004). MTNF does not dispose of municipal or industrial waste. Since there is no direct or indirect effect from activities on MTNF, there would be no cumulative effects from this activity.

» ***Other Effects***

On MTNF, there would be no conversion of riparian areas or bottomland forest to other land uses, no stream channelization or impoundment, and therefore, no habitat loss or additive impacts. Major rivers are managed to protect the unique qualities of those rivers with limited vegetation management allowed. Water quality would be protected through application of soil and water standards and guidelines. The restoration of terrestrial natural communities throughout the Forest would increase the quality of water reaching the groundwater system, and may help moderate water fluctuations through better water holding capacity of the native vegetation of the restored natural communities. Whether or not this would result in increased survival or reproductive success of pink mucket pearly mussel mussels is unknown.

Conclusions:

MTNF lands comprise about 28% of the lower sub basin of the Black River watershed. About 72% of the watershed is in other ownerships. Only 10% of lands adjacent to the river are in National Forest ownership. MTNF would not contribute at all to impoundment, channel alteration or activities that might destabilize substrate, channel, or banks.

With soil loss from MTNF averaging about 0.2 ton/acre/year, sediment yield to rivers in the Ozark region less than 1 ton/acre/year, and the rates of sheet and gully erosion not considered a problem in the lower Black River watershed, activities on MTNF would not contribute significantly to potential impacts on pink mucket pearly mussel caused by excessive sedimentation.

Hutson and Barnhart (2004), who surveyed the Black River in 2003, state that pink mucket pearly mussel “was one of the rarest mussels encountered during this survey. Due to its extreme scarcity, this species may be in danger of becoming extirpated from the Black River in the near future.” Due to the distance of any MTNF lands from the known pink mucket sites and the extremely low likelihood that sediment from MTNF activities would reach the Black River at any point, the potential for implementation of the Revised Forest Plan to contribute to the possible extirpation of this species is remote.

Since MTNF would continue to provide suitable habitat and protect water quality within the range of pink mucket pearly mussel mussels, the effects of implementing Alternative 3 of the Revised Forest Plan, added to effects occurring from activities on other ownerships would be primarily beneficial. The possibility of potential negative effects to individual pink mucket pearly mussel mussels occurring from activities implementing the

Forest Plan are so remote as to be considered insignificant and discountable and would not individually or cumulatively result in decreased potential for recovery of pink mucket pearly mussel mussels.

» **Additional measures needed for species conservation and recovery**

There are no other measures needed that would significantly contribute to conservation or recovery of this species.

» **Effects of additional measures**

Since there are no additional measure identified, there would be no impacts.

» **Determination - May Affect, Not Likely to Adversely Affect**

Rationale: The Revised Forest Plan contains measures to protect soil and water quality, to minimize soil movement caused by management activities, to maintain streambank and channel stability, and to restore and maintain natural communities, such as bottomland hardwood forest along riparian corridors. There are also measures that limit or modify the type and amount of activities that can occur within riparian corridors, in order to protect the integrity and healthy functioning of the watershed. Surveys prior to in-stream work would minimize the potential for direct impacts to mussels. The potential for sedimentation from National Forest activities in an amount that could negatively impact pink mucket pearly mussels is so remote as to be considered insignificant and discountable.

Scaleshell mussel (*Leptodea leptodon*)

» Life History summary

While relatively little is known about the life history of the scaleshell, the biology of this species is presumed to be similar to other Unionid mussels. Adults are filter feeders, siphoning water to extract detritus, plankton, and other microorganisms (Federal Register Vol. 66, No. 195, 10/9/01). Adults spend their entire lives buried partially or completely in the substrate. Scaleshells have been found on the surface of the substrate and buried up to a depth of 5 inches (U.S. Fish and Wildlife Service 2004, page 4). Juvenile mussels are believed to use cilia lining their feet to carry food particles into the mouth (U.S. Fish and Wildlife Service 2004, page 4).

Reproduction occurs when males release sperm into the water column and females draw the water into their mantle. Fertilized eggs develop into glochidia, which when mature are expelled into the water where they attach to the gills or fins of an appropriate fish host. It appears that the scaleshell uses freshwater drum (*Aplodinotus grunniens*) as its fish host (Federal Register Vol. 66, No. 195, 10/9/01).

Based on observations from Missouri, spawning and brooding begin in early August and glochidia are released the following June (U.S. Fish and Wildlife Service 2004, page 5). Scaleshell glochidia are among the smallest of the Unionid mussels, but females produce a large number of larvae (U.S. Fish and Wildlife Service 2004, page 6).

It appears from recent observations that scaleshell mussels are relatively short-lived for Unionid mussels. Life expectancy appears to be less than 10 years, while many other Unionid mussels live longer than 10 years; some considerably longer (U.S. Fish and Wildlife Service 2004, page 7). Sex ratio also appears to be somewhat skewed toward males (U.S. Fish and Wildlife Service 2004, page 7).

Habitat for scaleshell mussels is medium to large rivers with low to moderate gradients with a variety of substrate types. It is primarily found in stable riffles with slow to moderate current and clear, unpolluted waters. Stable stream bed and good water quality appear to be common factors in all scaleshell occurrences (Federal Register Vol. 66, No. 195, 10/9/01). Scaleshell mussels are often found in mussel beds in association with a high diversity of other mussel species (Federal Register Vol. 66, No. 195, 10/9/01).

» Population status range-wide, in Missouri, and on MTNF

Rangewide:
The scaleshell mussel was historically known to occur in 55 rivers in 13 eastern states. Currently, this species is known to occur in only 14 rivers within the Mississippi River basin in Missouri, Arkansas and Oklahoma. The scaleshell mussel has always been rare locally, even though it was broadly distributed (Federal Register Vol. 66, No. 195, 10/9/01).

Because of the low densities of currently known populations, determining status and trends are difficult. Factors in considering "health" of populations are outlined in the Federal Register. Only 1 of the known populations are thought to be stable (Federal Register Vo. 66, No. 195, 10/9/01). With the exception of the Gasconade, Meramec, and Bourbeuse Rivers in Missouri, all rivers listed as containing scaleshell are based on the collection of one or a few individuals (Federal Register Vol. 66, No. 195, 10/9/01).

Missouri
Scaleshell mussels are known to occur in the Gasconade, Meramec, Big, Osage, and Bourbeuse Rivers in Missouri. All of these are considered declining populations (Federal Register Vol. 66, NO. 195, 10/9/01). The Missouri Natural Heritage Database has 41 documented sites for scaleshell mussel.

Mark Twain National Forest
The Big, Osage, and Bourbeuse Rivers have no MTNF lands within their watersheds. MTNF lands do occur within the watersheds of the Gasconade and Meramec Rivers.

Three sites within MTNF had a single weathered dead shell collected in 1999 on the Gasconade River (Missouri Natural Heritage database). Six other sites on the Gasconade River within the proclamation boundary of MTNF had one or two live individuals or dead shells during the 1999 survey. There were 5 other sites found on the Gasconade River in the 1999 survey that are within 10 miles downstream of the MTNF proclamation boundary. None of these sites had more than 2 live individuals collected in 1999, and most were only single dead shells (Missouri Natural Heritage database).

All known sites on the Meramec River are over 50 miles downstream of the MTNF proclamation boundary.

- **Causes of past and/or current declines and Limiting factors**

The scaleshell mussel was listed as Endangered on November 8, 2001. No critical habitat has been designated (Federal Register Vol. 66, No. 195, 10/9/01).

The species is also currently listed as Endangered in Missouri (Missouri Department of Conservation 2005, page 10).

Although much of the decline may have occurred prior to 1950 (NatureServe 2005), populations continue to decline. The current range is much reduced from historic extent and only about 24% of historic streams still have existing populations. Thirteen of the fourteen known streams with scaleshell are believed to have declining populations (U.S. Fish and Wildlife Service 2004, page iii).

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** The primary causes of decline have been habitat loss and adverse effects associated with water quality degradation, sedimentation, channelization, sand and gravel mining, dredging, and reservoir construction (Federal Register Vol. 66, No. 195, 10/9/01). Both point and non-point sources can contribute toxic materials which can decrease or eliminate mussel populations through acute and chronic effects such as direct mortality, reduced reproductive success, or compromised health of mussels or host fish (Federal Register Vol. 66, No. 195, 10/9/01). The addition

of nutrients through runoff into waters can cause increased eutrophication, decrease oxygen and cause changes in water chemistry that are harmful to mussel survival, as well as impacting host fish (Federal Register Vol. 66, No. 195, 10/9/01).

Sedimentation is a natural process that can be greatly accelerated by land uses that expose soil (such as development for agriculture, industries, homes or businesses; channelization of streams; impoundment of streams; heavy recreational use; timber harvest in riparian zones). Increased sediment in a stream can smother mussels or interfere with their feeding or respiration, leading to decreased survival. In-stream work such as channelization, gravel mining, or dredging, can crush or remove mussels. These activities can also change the functioning of a stream and decrease the amount or suitability of mussel habitat (Federal Register Vol. 66, No. 195, 10/9/01).

Impoundments alter habitat, food sources, fish host availability, water temperature and chemistry. They can interfere with movement of fish hosts and isolate mussel beds from each other, leading to decreased recruitment and a decrease in genetic diversity (Federal Register Vol. 66, No. 195, 10/9/01).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** Because scaleshell mussels are small with thin shells, commercial collection has not likely been a direct impact. However, indirect impacts from commercial collection of other mussels are probable (Federal Register Vol. 66, No. 195, 10/9/01). As mussel beds were overharvested, scaleshells may have been trampled or removed along with other species, and habitat may have been destroyed or damaged through disturbance of the stream bottom (Federal Register Vol. 66, No. 195, 10/9/01). Scientific and recreational interest in collecting scaleshells may increase as they become rarer.

Listing Factor C. ***Disease or predation.*** While natural predation and disease are not considered as primary factors in the decline of scaleshell mussels, the impact of predation on small populations may reduce the population's ability to recolonize or rebound from the loss of even a few individuals (Federal Register Vol. 66, No. 195, 10/9/01). Mussel glochidia and ova are susceptible to infections when bacteria and protozoa are present in high concentrations due to unnaturally high concentrations of sediment load or point-source pollution (Federal Register Vol. 66, No. 195, 10/9/01). In addition, disease and parasites may have been responsible for large die-offs of mussels in the Meramec and Bourbeuse Rivers in Missouri in 1977 and 1978, since no environmental impact could be found (Federal Register Vol. 66, No. 195, 10/9/01).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms.***
The Clean Water Act (CWA) has resulted in many improvements in water quality throughout the scaleshell range. However, water quality degradation is still a concern for sensitive aquatic species like the scaleshell. Passage of CWA has led to regulatory and voluntary measures to protect and improve water quality. However, many activities which could affect water quality are not regulated, or are subject to limited regulatory authority (Federal Register Vol. 66, No. 195, 10/9/01).

While mussel species may be taken and used as bait throughout the year in Missouri, endangered species of mussels may not be taken or possessed (Missouri Department of Conservation 2005, page 73-74).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. The reproductive cycle of mussels and the scaleshell's dependence on one fish species as its host increase the susceptibility to extinction, particularly with small populations (Federal Register Vol. 66, No., 195, 10/9/01). Any decreases in the drum population would decrease the available hosts, resulting in decreased survival of glochidia and lower population numbers.

Potential impacts from non-native zebra mussels and Asiatic clams are a concern for the future (U.S. Fish and Wildlife Service 2004, page iii). The non-native zebra mussel (*Dreissena polymorpha*) was introduced into the United States in 1985 and has spread throughout the Mississippi River and many of its tributaries. Zebra mussels suffocate native mussels by attaching to their shells in large numbers (Federal Register Vol. 66, No. 195, 10/9/01). Zebra mussels spread as they are carried from infected waters on recreational and commercial vessels. In 1999, a live zebra mussel was discovered in the Lower Meramec River, and another was discovered in the Missouri River near Iowa. It is likely that zebra mussels will continue to spread in the Meramec River and eventually may reach the Gasconade River (a tributary of the Missouri River) (Federal Register Vol. 66, No., 195, 10/9/01). The Meramec and Gasconade Rivers hold the largest two populations of scaleshell mussel still known to occur (Federal Register Vol. 66, No., 195, 10/9/01).

The Asian clam (*Corbicula fluminea*) is a freshwater mussel that is now ubiquitous across the scaleshell's range. This mussel forms dense colonies that are believed to compete with native mussels for food, nutrients and space, as well as displacing juveniles. Asian clams are also subject to sudden die-offs which can result in oxygen depletion and high levels of ammonia in the water (U.S. Fish and Wildlife Service 2004, page 20).

The black carp (*Mylopharyngodon piceus*) is another new threat to scaleshell mussels. This fish is native to eastern Asia and adults feed extensively on freshwater mollusks (U.S. Fish and Wildlife Service 2005, page 20). Black carp are currently proposed for use in fish ponds to control snail populations, but at least one individual has been found in the wild (March 2003 in an oxbow of the Mississippi River near the mouth of the Ohio River) (U.S. Fish and Wildlife Service 2005, page 20). Farm fish ponds are often located in bottomlands subject to flooding. If these fish escape, they are likely to proliferate as grass carp have done (U.S. Fish and Wildlife Service 2005, page 20).

The small populations of scaleshell, and the scattered nature of the remaining populations render the species more vulnerable to all the previous factors. Shorter life spans may make it less possible for scaleshell populations to persist through periods of poor recruitment or higher mortality (Federal Register Vol. 66, No., 195, 10/9/01).

» **Causes of past and/or current recovery**

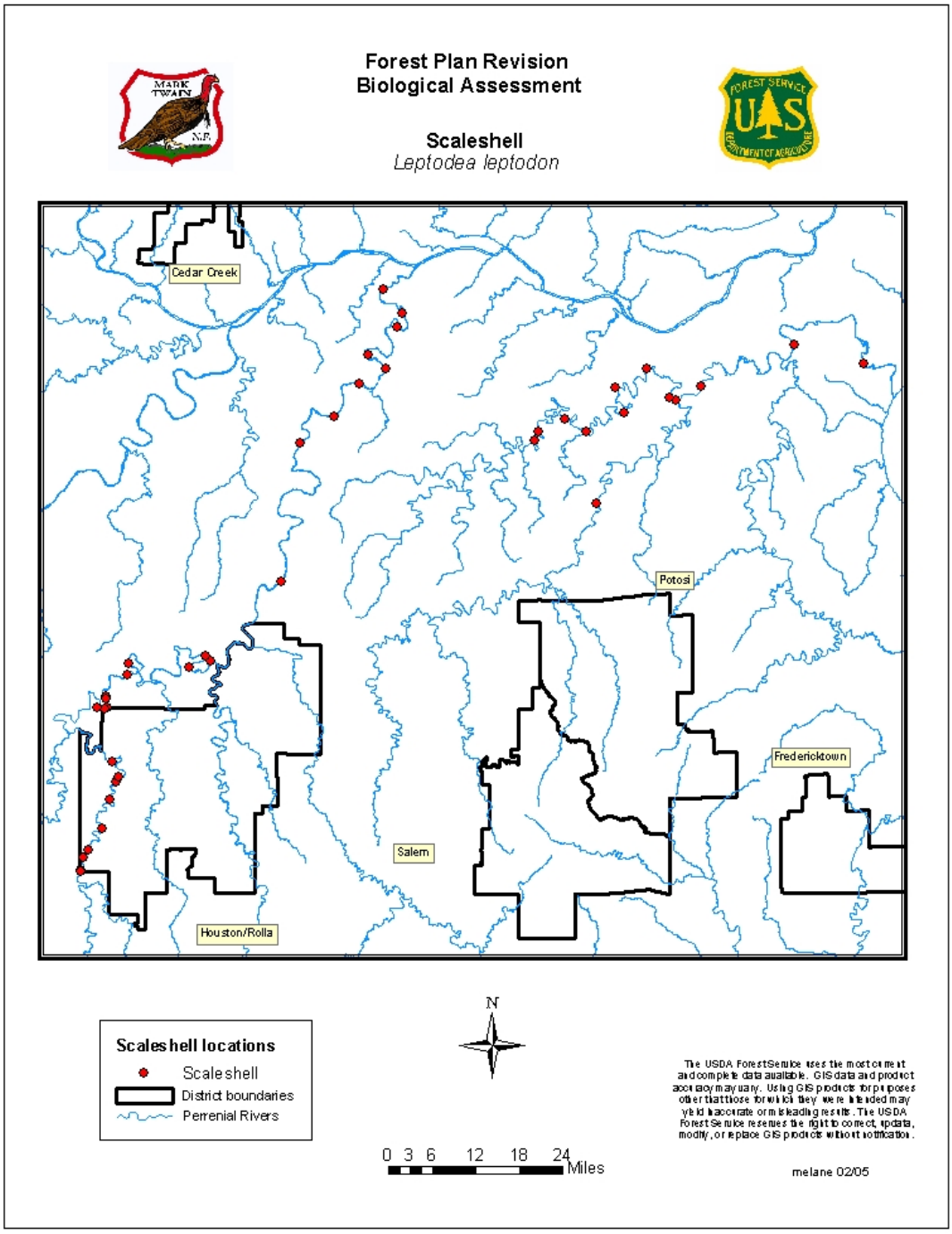
From all indications, the scaleshell mussel is still in decline and no recovery is occurring.

» **Occurrence on MTNF, existing and potential habitat**

The Gasconade and Meramec Rivers are the only rivers with known scaleshell sites which contain any MTNF lands within their watershed. All other rivers known to contain

scaleshells have no MTNF lands in their watersheds. All known scaleshell sites on the Meramec River are over 50 miles downstream of the MTNF proclamation boundary.

Figure SSM-1: Scaleshell mussel locations in and near MTNF



» **Surveys for scaleshell mussel**

Surveys in Missouri have covered all of the rivers in which scaleshell are known to occur, and a live scaleshell was discovered in 2001 in the Osage River where no previous occurrences of the species were known. Mussel surveys have also been conducted on rivers in other states with historic and extant occurrences (Federal Register Vol. 66, No. 195, 10/9/01).

A survey of the Big Piney River in 1981 found one fresh, dead shell. Surveys of the Big Piney between 1994 and 1996 found no evidence of scaleshell mussels, and no living or dead scaleshells were found in a 1998 survey (Federal Register Vol. 66, No. 195, 10/9/01).

Surveys of other rivers and streams on MTNF for various mussel species have found no additional sites for scaleshell mussel other than those listed here.

» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

In the August 2004 Draft Scaleshell Recovery Plan, there are 6 recovery actions where federal agencies are identified as Potential Partners. Three of these are Priority 1 Actions, or those which must be taken to prevent extinction or prevent the irreversible decline of the species in the foreseeable future. Three of the actions are Priority 3 Actions, or those which are necessary to meet recovery objectives.

Action 1.1 Assemble a scaleshell recovery implementation team (Priority 1). MTNF has only 7% of the known sites in Missouri, and only weathered dead shells were found at those sites. MTNF lands comprise only 18% of the Gasconade watershed and 11% of the Meramec watershed. The Revised Forest Plan calls for the Forest Service to carry out Forest Service responsibilities for conservation of endangered and threatened species and habitat through interagency cooperation with the U.S. Fish and Wildlife Service, and to manage federally listed species in accordance with approved recovery plans (U.S. Forest Service 2005, page 2-5). If asked, the Forest Service would consider appointing a person to serve on the recovery implementation team for scaleshell mussel.

Action 2.4 Carry out cooperative projects using existing programs to protect the species and habitat, restore degraded habitat, and improve surface lands in occupied watersheds (Priority 1). The protection of aquatic species and habitat is addressed in the Revised Forest Plan through application of standards and guidelines for soil and water and for aquatic habitat (U.S. Forest Service 2005, pages 2-2 through 2-5 and pages 2-9 through 2-10). These include modifications and limitations on management actions carried out in riparian management zones (RMZs) and in upland waterways or watercourse protection zones (WPZs). Central goals of the Revised Forest Plan are to maintain, enhance, or restore site-appropriate native natural communities (U.S. Forest Service 2005, page 1-1) and to protect the water quality and integrity of the watershed on Forest lands U.S. Forest Service 2005, page 1-2). Standards and guidelines require pre-work assessments of suitable habitat and presence of threatened and endangered mussel species prior to any in-stream work (U.S. Forest Service 2005, page 2-7).

Action 2.8.2 Identify and investigate methods to prevent the spread of zebra mussels and black carp (Priority 1). The Revised Forest Plan includes a goal to prevent new invasions and control or reduce existing occurrences of non-native invasive species (U.S. Forest Service 2005, page 1-2). Investigating methods to prevent the spread of these species would be compatible with that goal.

Action 4.1 Identify suitable sites for future reintroductions within the historical range (Priority 3). The Revised Forest Plan includes a goal to support recovery of federal species and to manage federal species in accordance with approved recovery plans. The Forest Service would work cooperatively with the U.S. Fish and Wildlife Service and Missouri Department of Conservation to identify suitable sites on MTNF lands for reintroduction of species proposed by either/both agencies.

Action 4.3. Develop and implement a habitat protection and restoration strategy for each target historical watershed (Priority 3) and **Action 4.4 Perform cooperative projects to protect, improve, or restore unoccupied scaleshell habitat in target historical watersheds (Priority 3).** The Revised Forest Plan contains a number of standards and guidelines designed to maintain and improve watershed conditions across the Forest (U.S. Forest Service 2005, pages 2-2 through 2-5) and to improve in-stream habitat for aquatic organisms (U.S. Forest Service 2005, pages 2-9 through 2-10). If MTNF lands were included in target watersheds, the Forest Service would work cooperatively with U.S. Fish and Wildlife Service and Missouri Department of Conservation to insure habitat protection and restoration on National Forest lands within the target watershed(s).

- **Effects of implementation of the proposed action**

Effects analysis will

A). identify actions which may affect scaleshell individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
    a) identifying how many individuals would be exposed
    b) which populations are represented by those individuals
    c) identifying specific stressors associated with exposure to the action
    d) identifying where and when exposure would occur
    e) identifying the duration and extent of exposure
C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of scaleshell individuals, groups, or habitat.
E) estimate the risk posed to scaleshell by the action.

In the upper Gasconade River (which includes much private land as well as some National Forest land), live or dead shells of scaleshell mussel were found at 19 sites. Of these, 12 living scaleshell mussels were found at 9 sites. Scaleshell relative abundance was 0.2% of all mussels found (Bruenderman et al. 2001).

5 sites within the MTNF proclamation boundary contained living individuals. 4 sites within the MTNF proclamation boundary contained only dead shells (Missouri Natural Heritage Database 2005).

Direct Effects

Direct effects to scaleshell would occur if individuals were crushed or buried by in-stream work or vehicles passing over them at low-water crossings. Direct mortality may also occur if sediment slugs suffocated individuals or if toxic materials were to reach occupied waters. Mortality or reduced fitness or reproductive success may also occur if zebra mussels colonize waters occupied by scaleshell.

Potential Negative Effects

- ***Physical alteration of substrate***

Scaleshell mussels may be displaced, crushed, buried or removed from the stream when activities disrupt the substrate in which they occur. National Forest management activities which may be done within stream segments include such things as streambank improvement, recreation site development, road or bridge construction/maintenance, or fireline construction. Heavy equipment may be needed to complete these types of projects where some amount of in-stream work is necessary. Pre-work surveys are required to assess the presence of suitable habitat and threatened or endangered mussel species (U.S. Forest Service 2005, page 2-7). If threatened or endangered mussels are found at a proposed project location, that project must be modified or relocated to avoid impacts to the mussels present at that site (U.S. Forest Service 2005, page 2-7). The Revised Forest Plan limits in-stream use of heavy equipment to the minimal amount of time necessary for completing a project (U.S. Forest Service 2005, page 2-5). Mechanical fireline construction for prescribed burns is prohibited within the RMZ, and for wildfire suppression except when necessary to protect life, property, or public and firefighter safety (U.S. Forest Service 2005, pages 2-15 and 2-17). If it is necessary to cross stream channels during wildfire suppression, it must be at right angles and the crossing must be stabilized and revegetated as soon as possible after the fire is controlled (U.S. Forest Service 2005, page 2-17).

Over the past 15 years, a few dozen projects involving in-stream work have been accomplished on the Forest. Most of these have been improvements to existing developed recreation sites, such as boat/canoe accesses; repair of road crossings; or bank stabilization projects. None of these projects has been within the Gasconade River watershed, although a few projects have been proposed in on-going analysis (April 2005).

Also, aquatic habitat enhancement projects or hydrologic control structures should be designed to mimic as much as possible the appearance and function of natural habitat features. Aquatic organism passage must also be maintained unless done in conjunction with prescribed fish-management objectives (U.S. Forest Service 2005, page 2-9). Because projects designed to improve habitat for one fish species might negatively affect habitat for other fish species, and because each mussel species has specific fish host species, the Revised Forest Plan requires that all fish management plans must be designed to minimize impacts on host species for threatened or

endangered mussel species (U.S. Forest Service 2005, page 2-7). With this measure, it is highly unlikely that there would be impacts to fish hosts due to MTNF activities.

These measures help minimize the short-term impacts of in-stream work, and help insure that the structure and function of the substrate and stream segment function in as natural a manner as possible in the long-term. Surveying to determine the presence of suitable habitat and mussels themselves, and the requirement to relocate or modify projects where mussels are present would minimize the potential for in-stream work to negatively affect pink mucket pearly mussels.

- ***Sand & gravel mining***

Mining for sand or gravel disturbs the substrate and may cause sediment to move through a stream. It may also physically remove mussels from the stream, crush them, or suffocate them by rearranging the substrate. Mining for sand or gravel could be a one-time event, or more likely, a long-term use of an area. With such low populations of this species, even a one-time event, if it occurred at an extant site, could be devastating to local populations and could negatively impact the long-term survival of an entire stream stretch.

The use of common variety minerals (sand and gravel) is limited to the needs of the Forest Service and other public agencies when the action benefits National Forest management (U.S. Forest Service 2005, page 2-34). In addition, removal of sand and gravel from stream channels or RMZs is prohibited unless needed to protect infrastructure or public health and safety (U.S. Forest Service 2005, page 2-34).

- ***Sedimentation***

Although sedimentation is a natural process, human activities such as intensive agriculture, timber harvesting in riparian zones, heavy recreational use, urbanization, channelization and impoundments can accelerate erosion and increase sediment loads in nearby waterways (U.S. Fish and Wildlife Service 2004, page 10). Sediment can reduce mussel feeding efficiency, resulting in decreased growth or survival; can physically smother mussels, and sediment particles can carry toxic materials (U.S. Fish and Wildlife Service 2004, page 10).

The activities which have potential for soil movement off-site include timber harvest, prescribed burning and fireline construction, road reconstruction and maintenance, mineral exploration and development activities under existing permits, and range management, including grazing. These activities, under the current Forest Plan, occur on approximately 43,000 acres annually (about 3% of the Forest) (U.S. Forest Service 1998, page 5). Under the preferred alternative (Alternative 3) of the Revised Forest Plan, there would be about 120,415 acres of these types of treatments annually (about 8% of the Forest) (U.S. Forest Service, 2005, page E-3).

Water yields on lands subject to timber harvest and some prescribed fires, can be significant on small scale watersheds, with possible channel degradation and soil movement. However, on a large scale, such as the Forest as a whole, these temporary, increased yields are a small fraction of overall water yield from MTNF lands, and are not measurably detectable on an annual basis (U.S. Forest Service 2005(a), page 3-195) (U.S. Forest Service 1998, Pink mucket pages 8-11).

Timber harvest is prohibited within RMZs unless needed to move toward desired condition, and mechanical construction of firelines for prescribed burning is also prohibited in the RMZ (U.S. Forest Service 2005, page 2-3). These measures would further decrease the potential for any soil movement to occur within the riparian corridor.

Road construction, reconstruction or maintenance may occur at any time of year, and can take place over the course of several days, weeks, or months depending on the length and amount of work to be done. Soil movement would be most likely where roads are in riparian areas, where roads cross streams, or are on steep slopes. Standards and guidelines provide direction for using minimum necessary construction, reconstruction and maintenance standards; scheduling work to take advantage of favorable ground conditions; using existing roads in preference to building new roads; locating roads outside the RMZ and WPZ; avoiding losing streams; keeping road grades normally at less than 10%; designing appropriate drainage features, and limiting stream crossings (U.S. Forest Service 2005a, pages 2-37 through 2-39). All these measures are intended to reduce, minimize, or prevent soil movement off-site.

Mineral exploration and development (drill sites, temporary roads, vent shafts) under the current Forest Plan occurs on a very small proportion of MTNF lands each year (on average, less than 10 acres/year), and none of these are in the Gasconade River watershed. Some are in the Meramec River watershed, but are well over 50 miles from the closest known scaleshell site on that river. The possibility that soil movement from these sites would reach scaleshell mussel sites is extremely remote. There are no significant changes in administration of mineral permits in the Revised Forest Plan, and no reason to think that the acreage affected by mineral activities would change significantly in the foreseeable future.

In Alternative 3 of the Revised Forest Plan there are approximately 1,050-1,780 acres of grazing allotments within riparian management zones (RMZs). Approximately 350 acres of allotments are within the Gasconade River RMZ.

All areas within 100 feet of rivers or streams would be fenced to keep livestock away from waterways. However, the presence of livestock in floodplains makes it more likely that some soil loss would occur, particularly during flooding events, and that some enrichment of waters would take place as livestock waste enters the waterways (U.S. Forest Service 2005a, page 3-208 through 3-209). However, standards and guidelines require that grazing allotments within the RMZ must be foreclosed at the earliest opportunity; that timing, duration, and intensity of livestock grazing be controlled to achieve desired vegetation objectives; and that the functionality of the RMZ shall not be degraded by grazing (U.S. Forest Service 2005, page 2-19).

Therefore, although some soil loss is possible on individual allotments or individual units in an allotment, on the Forest as a whole the impact would not be enough to cause a short or long term increase in sediment or nutrient input to the Gasconade or Meramec Rivers. If soil loss on a particular unit or allotment was documented, the timing, intensity, and/or duration of grazing would be adjusted to reduce, minimize or eliminate that potential in the future. With these measures in place, any sedimentation or water quality impacts resulting from livestock grazing would be so slight as to be considered insignificant and discountable.

The Missouri Department of Conservation collects various kinds of data on fish populations on major waterways. The Missouri Department of Conservation's 2005 Fishing Prospects report shows that game fish populations are "fair", "good", "great", and "excellent" in the rivers which run through MTNF lands that are listed in the report (Missouri Department of Conservation 2005). This is an indication that any sediment reaching the rivers from past MTNF management activities has not affected the availability of host fish.

» ***Nutrient enrichment***

Nutrient enrichment of waters can lead to decreased oxygen concentration, increased acidity, excessive growth of filamentous algae, and other changes in water chemistry that may affect the survival of mussels and their host fish (U.S. Fish and Wildlife Service 2004, page 9). Excess algae can alter substrate surfaces and disrupt food supplies for juveniles by altering algal communities (U.S. Fish and Wildlife Service 2004, page 9).

The primary source of nutrients from MTNF lands which may reach waterways within the Gasconade River watershed are pastures with permitted grazing or hayfields that are regularly fertilized. There are approximately 350 acres of current allotments within the Gasconade River RMZ. Two of these areas are adjacent to documented scaleshell mussel sites.

The Revised Forest Plan requires that livestock be fenced at least 100 feet away from streambanks (U.S. Forest Service 2005, page 2-3); no fertilization be done in the RMZ or WPZ (U.S. Forest Service 2005, pages 2-3 and 2-4); and avoids the placement of livestock distribution tools (water tanks, salt blocks) in WPZ (U.S. Forest Service 2005, page 2-4). In addition, grazing allotments that are within the RMZ, and under an active permit as of September 2005 must be foreclosed at the earliest opportunity (U.S. Forest Service 2005, page 2-19). The timing, duration, and intensity of livestock grazing are to be controlled to achieve desired objectives for structure and species composition (U.S. Forest Service 2005, page 2-19). These measures would reduce, but not eliminate, the potential for animal waste to run-off into area waters (U.S. Forest Service 2005(a), page 3-208 through 3-209). Flooding may transport animal waste into the adjacent stream.

Other minor sources of nutrients could include sanitation facilities and food plots which are regularly fertilized. The Revised Forest Plan requires that existing food plots within the RMZ/WPZ be closed and rehabilitated (U.S. Forest Service 2005, page 2-9) and that sanitation facilities not be constructed in the RMZ (U.S. Forest Service 2005, page 2-3). These measures would eliminate the potential for nutrient enrichment from these sources.

» ***Non-native invasive species***

Non-native zebra mussels, Asiatic clams and black carp have the potential to negatively impact individuals and populations of scaleshell. The mussels attach to native mussels and interfere with their feeding and respiration, as well as outcompeting native mussels for food, nutrients and space. Black carp feed on freshwater mussels.

There is nothing included in the Revised Forest Plan that would change the potential for zebra mussels, Asiatic clams or black carp to colonize waters occupied by scaleshell mussels. There are two monitoring items included in Chapter 4 that would track potential effects of non-native invasive species on scaleshell mussels. These are, to

what extent Forest management is contributing or responding to non-native invasive species and to what extent Forest management contributes to the conservation of endangered species and their habitats (U.S. Forest Service 2005, pages 4-10 and 4-11). In addition, should non-native species be discovered on MTNF lands or waters, a standard and guideline requires the Forest Service to prioritize treatments based on threats to resources, species status, size of infestation, potential for spread, effectiveness of control measures, and relationship to boundaries (U.S. Forest Service 2005, page 2-2). While implementation of the Forest Plan cannot change the mechanism of spread of zebra mussels, Asiatic clams or black carp, it does allow the Forest Service to monitor for problems and deal with them if they occur.

Potential Beneficial Effects

- ***Prevent channelization***

Permanent stream channelization is prohibited by the Revised Forest Plan (U.S. Forest Service 2005, page 2-5).

- ***Prohibit impoundments***

New man-made impoundments, mine tailings ponds, and water diversions are prohibited within the RMZ and discouraged in the WPZ (U.S. Forest Service 2005, page 2-5). This means there could be no impoundment of the Gasconade River or its permanent stream tributaries where they are on National Forest lands.

- ***Prevent commercial mussel harvest***

Permits for any kind of collection involving federally listed species from MTNF lands would only be given if the collector has a valid U.S. Fish and Wildlife Service collecting permit (U.S. Forest Service 2005, page 2-6). Regulation of commercial harvest is the responsibility of the state of Missouri which does not allow taking of endangered mussels (Missouri Department of Conservation 2005, page 73-74).

Indirect Effects

Potential Negative Effects

- ***Substrate Disruption***

When activities disrupt the substrate in which mussels occur, turbidity may temporarily increase and disrupt mussel feeding or respiration. National Forest management activities which may be done within stream segments include such things as streambank improvement, aquatic habitat enhancement, recreation site development, road or bridge construction/maintenance, or fireline construction. Heavy equipment may be needed to complete these types of projects where some amount of in-stream work is necessary. The Revised Forest Plan limits in-stream use of heavy equipment to the minimal amount of time necessary for completing a project (U.S. Forest Service 2005, page 2-5). Pre-work surveys are required to assess the presence of suitable habitat and threatened or endangered mussel species (U.S. Forest Service 2005, page 2-7). If threatened or endangered mussels are found at a proposed project location, that project must be modified or relocated to avoid impacts to the mussels present at that site (U.S. Forest Service 2005, page 2-7). Mechanical fireline construction for prescribed burns is prohibited within the RMZ, and for wildfire suppression except when necessary to protect life, property, or public and firefighter safety (U.S. Forest Service 2005, pages 2-15 and 2-17). If it is necessary to cross stream channels during wildfire suppression, it must be

at right angles and the crossing must be stabilized and revegetated as soon as possible after the fire is controlled (U.S. Forest Service 2005, page 2-17).

Also, aquatic habitat enhancement projects or hydrologic control structures should be designed to mimic as much as possible the appearance and function of natural habitat features. Aquatic organism passage must also be maintained unless done in conjunction with prescribed fish-management objectives (U.S. Forest Service 2005, page 2-9). Because projects designed to improve habitat for one fish species might negatively affect habitat for other fish species, and because each mussel species has specific fish host species, the Revised Forest Plan requires that all fish management plans must be designed to minimize impacts on host species for threatened or endangered mussel species (U.S. Forest Service 2005, page 2-7). With this measure, it is highly unlikely that there would be impacts to fish hosts due to MTNF activities.

These measures help insure that the structure of the substrate is disturbed as little as possible and minimize the potential for mussels to be adversely impacted by these activities. These measures also help insure that the aquatic and terrestrial parts of the riparian ecosystem function in as natural a manner as possible in the long-term. Surveying to determine the presence of suitable habitat and mussels themselves, and the requirement to relocate or modify projects where mussels are present would minimize the potential for in-stream work to negatively affect scaleshell mussels.

- ***Removal of riparian forest cover:***

If existing forest/woodland natural communities along streams and rivers were removed, the potential for sediment to enter the water is greater since the soil holding vegetation is gone. Water temperature may also be changed as shade is removed and the sun hits the water for a longer time each day. The Revised Forest Plan contains standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) that prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). In particular, most timber management is prohibited, as is construction or maintenance constructed wildlife openings and food plots. These measures would insure that existing forest/woodland cover along streams and rivers is maintained or improved and would eliminate the potential for increased sedimentation along riverbanks.

- ***Water quality changes***

Mussels are sensitive to water quality degradation as a result of sedimentation or pollution. Decreases in water quality of streams and rivers could decrease the fitness, reproductive success or survival of both individual scaleshells and local populations. Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways and help maintain good water quality in the adjacent waterways. This in turn would insure that quality habitat is available to scaleshell mussels.

- ***Illegal ATV use - along or in rivers/streams/lakesides***

The popularity of riding all-terrain vehicles has grown dramatically in the last 20 years. While ATV use is permitted on Forest System roads under state law, illegal ATV use has also increased across the Forest over the past decade. ATV's traveling through streams and rivers and along riparian corridors may be sources of sedimentation that could affect

habitat suitability and availability in those sections of stream. ATV's could also crush individual or groups of mussels and disrupt mussel beds.

Forest Service law enforcement officers investigate and warn/ticket individuals engaging in illegal ATV use. There is nothing in the Revised Forest Plan that would be likely to change the patterns of illegal ATV use.

» ***Pesticides***

The use of pesticides in the Riparian Management Zone and Watercourse Protection Zones is prohibited unless needed to move toward desired condition (U.S. Forest Service 2005, page 2-3). The least impacting application method is to be used, and all equipment used in the application of pesticides must be washed and rinsed where runoff would not reach surface waters, wetlands or other special habitats (U.S. Forest Service 2005, page 2-18). Only pesticides labeled for use in or near aquatic systems may be used in RMZs and WPZs, and only hand or single plant application may be used, unless approved by the Forest Supervisor when other methods are shown to be environmentally sound and the most biologically effective method practicable (U.S. Forest Service 2005, page 2-19). With these measures, the potential for pesticide use on MTNF to cause any impact to individual mussels or the population is so remote as to be considered insignificant and discountable

Potential Beneficial Effects

The most widespread and lasting indirect impact on scaleshell mussels would be the protection of water quality and the integrity of watersheds in which the mussel occurs.

» ***Protect water quality and minimize sedimentation***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways, maintain or improve the vegetative communities within these zones, and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to water quality, modification of habitat, or resultant impacts on scaleshell mussel survival or reproductive success.

In addition to standards and guidelines which limit, modify, or direct management activities within the riparian corridors and upland waterways (see paragraph above), there are standards and guidelines designed to reduce, minimize or eliminate soil movement from Forest management activities on upland sites and in or near streams and rivers (U.S. Forest Service 2005, pages 2-5, 2-9 through 2-10, 2-14 through 2-17, 2-18, 2-19 through 2-20, 2-28 through 2-30, 2-31 through 2-34, 2-37 through 2-2-40). Implementation of these measures would reduce the potential for soil to move off-site and reach a water source, and therefore reduce the potential for any adverse effects to occur to water quality.

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance

provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39). All these actions would minimize the amount of soil moving off-site and help protect area waterways from additional sedimentation.

- ***Restoration of natural communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the natural communities that occur on National Forest lands. The major benefit of restoration of healthy natural communities would be less water runoff to surface streams and increased water filtering into the groundwater system as a result of increased herbaceous vegetation (Nelson 2005). This change in hydrologic functioning may help buffer the effects of periodic drought on adjacent waterways, and maintain more stable water flow during dry summer months.

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including riparian corridors (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

No Effects

Activities which take place on MTNF outside of the watersheds of the Gasconade or Meramec Rivers would have no effect on scaleshell mussels.

While National Forest lands comprise approximately 11% of the Meramec River watershed, the closest living scaleshell mussel site in the Meramec River is over 25 air miles from any National Forest lands, and about 27 river miles from the nearest National Forest lands. There is essentially no chance that any soil displaced during Forest management activity would move 25 miles overland from National Forest lands to the Meramec River. The chances of soil moving off National Forest lands without being filtered out, reaching an area waterway, and moving about 27 miles downstream without being deposited are almost equally as unlikely. In any case, the amount of sediment contributed by National Forest management would be so small as to be unmeasurable and would not impact any of the mussel sites on the Meramec River.

Unknown or Questionable Effects

Many MTNF rivers and streams, including the Gasconade River, are premiere recreational opportunities and are visited by thousands of people each year. Canoeing and fishing are the major activities, but boats, kayaks, tubes, and personal watercraft also make use of some segments of rivers. In the low water of mid-late summer, canoes may scrape bottom over some of the gravel riffles. This dislodges some bottom material and may increase turbidity in a small area. Boat wakes can wash against dirt banks and

dislodge soil into the water. If mussels are in that area, they may be temporarily impacted until the water clears. If mussels are present in the riffle area, some may be dislodged by canoe bottoms. Floaters generally spend some time swimming or playing in the water. This can also temporarily increase turbidity in the local area, and may also dislodge mussels as people walk through the water. Some people may collect shells to take home as a souvenir. Because of the low density of scaleshells compared to other mussels, it is unlikely that casual collectors would pick a scaleshell. Whether or not any of these activities would result in short or long-term impacts to any scaleshell mussels is uncertain.

The Revised Forest Plan makes no changes in recreation management from the current Forest Plan. Canoeing, floating, rafting, fishing and swimming in rivers are recreation uses that are expected to increase by less than 10% between 2000 and 2010 (U.S. Forest Service 2005(a), page 3-260).

Cumulative Effects

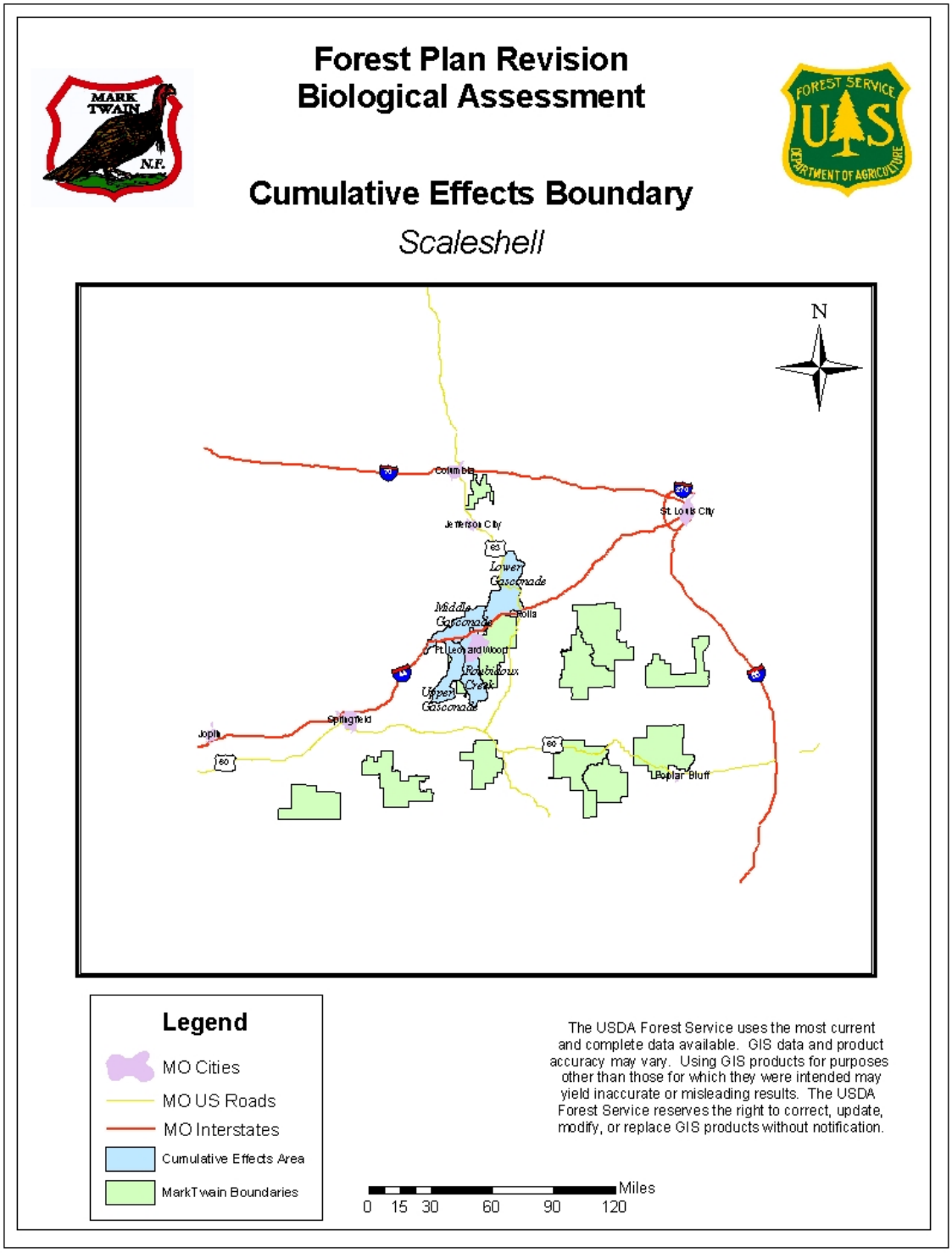
Boundaries:

The spatial boundary for cumulative effects for scaleshell mussel is composed of the Upper, Middle, and Lower 11-digit Gasconade River basins, along with the 11 digit Roubidoux Creek basin. This is the only river in which scaleshell occurs and that has MTNF lands within its watershed within which National Forest activities may result in potential effects. All potential effects to scaleshell mussel as a result of National Forest activities would occur in that area.

The Meramec River watershed is not included in the cumulative effects boundary because all of the extant sites for scaleshell mussel are over 50 miles downstream of MTNF proclamation boundary. Activities on MTNF in these watersheds would have no impact on sites this far away because of the low rate of soil loss from forested soils, the low sediment yield to streams in the Ozarks, and the length that soil would have to travel to reach these scaleshell sites.

Gasconade River
MDC Photo

Figure SSM-2: Cumulative Effects Boundary for Scaleshell Mussel



The temporal boundary for cumulative effects analysis for scaleshell mussel is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be

effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected because any potential effects of sedimentation would be through the system by at least that time, and any potential beneficial impacts from improvement of terrestrial natural communities and their hydrology would have been realized by then.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. Specifically for scaleshell, much of the riparian corridor along the Gasconade River was converted from bottomland forest to pasture, sediment was added to the stream, and flooding and water flow regimes were changed. Management of National Forest lands in the Gasconade River over the past several decades have resulted in stabilization of bank segments and re-growth of forest cover in some riparian areas. Today, the upper tributaries of the Gasconade, which contain a large percentage of National Forest lands, is rated as “a relatively pristine environment” and ranks as least impacted of all the Gasconade watershed, due to the presence of Mark Twain National Forest (Missouri Department of Conservation 2001).

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, much of the riparian corridor was cut, farmed, converted to pasture and overgrazed. (U.S. Forest Service 2005b, page 3-46). Some of these riparian areas were later acquired by the Forest Service but most are still in other ownerships.

Reasonably Foreseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches

- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the proclamation boundary of MTNF. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can reasonably be predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section 7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the proclamation boundary of MTNF. However, past trends on private properties within the Gasconade River watershed are some indication of reasonably foreseeable trends for the future. For nine counties included in the Gasconade River watershed, population growth was moderate between 1990-1997 with increases in population of rural areas greater than increases in population of towns and cities (Missouri Department of Conservation 2001).

Farm trends show an increase in cattle on farms, with a subsequent conversion of land area to pastures and hay production, and decreasing amounts of cropland (Missouri Department of Conservation 2001). The number of cattle per pastured acre is about 0.6 -0.8 in most counties within the watershed. Cattle are frequently watered in streams.

Sand and gravel mining permits are at relatively low densities in the Upper Gasconade watershed. The Missouri DNR regulates these permits and includes a requirement for operators to minimize impacts on stream environments (Missouri Department of Conservation 2001).

Water quality and the availability of stable substrates are of primary importance to the continued existence of scaleshell mussels in Missouri and rangewide. Water quality is generally good in the Gasconade River watershed, but with some problems due to non-point erosion and sedimentation and organic wastes from livestock (Missouri Department of Conservation 2001).

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on water quality, scaleshell mussels or their habitat include:

- Habitat alteration through bank, channel, and substrate instability;
- Continued grazing and access of livestock to the Gasconade River;
- Gravel dredging;
- Municipal and industrial wastes disposal;

These are the types of activities identified in the Draft Scaleshell Mussel Recovery Plan as threats to freshwater mussels in the Gasconade River (U.S. Fish and Wildlife Service 2004, page 12). In addition, some private landowners may take steps to stabilize streambanks or otherwise improve water quality in streams adjacent to their property. Water quality is the common factor in all these activities, and will be the primary focus of the cumulative effects analysis.

Effects Analysis

» *Habitat alteration and water quality*

Within the Gasconade River watershed, stream habitat conditions are variable. Approximately 19% of the stream corridors in the Upper Gasconade hydrologic unit are in poor condition (Missouri Department of Conservation 2001). Most of these are due to lack of adequate riparian corridors, excess nutrients, streambank erosion, instream gravel mining, and grazing practices.

However, 81% of stream corridors in the Upper Gasconade hydrologic unit were rated as good or acceptable.

Gasconade River watershed sheet and rill erosion rates did not exceed allowable limits of 2.5-5 tons/acre/year on pasture, but reached 18-24 tons/acre/year on tilled land. Forest soils losses were only 0.25-0.5 tons/acre/year (Missouri Department of Conservation 2001). Actual sediment reaching streams is low (0.8 tons/acre/year) compared to other watersheds in the state (Missouri Department of Conservation 2001).

Natural rates of soil loss from forested lands are about 0.05 to 0.1 tons/acre/year. Monitoring of timber sales on MTNF showed soil loss from 0 tons/acre/year to 0.8 tons/acre/year with an average of about 0.2 tons/acre/year (U.S. Forest Service 1998). In comparison, sheet erosion of 0.5 to 1.5 tons/acre/year and gully erosion of 0 to 0.16 ton/acre/year in the Black River basin are not considered a serious problem (MDNR 1995 as cited in Missouri Department of Conservation 2004). The estimated amount of commercial timber harvest under the Revised Forest Plan would be about 225,025 acres per year (U.S. Forest Service 2005, page E-3). Limiting or modifying soil-disturbing activities in RMZs and WPZs in particular would reduce the amount of soil loss from National Forest lands and the amount of sediment reaching waterways. The implementation of standards and guidelines to minimize soil movement and protect water quality in all forest management activities across the Forest would reduce the potential for any negative impacts to water quality or pink mucket pearly mussel mussels from these activities.

Since 1991, 7 bank stabilization projects have been completed on private lands, 3 on MDC lands, and 4 on National Forest lands within primarily Phelps County (Missouri Department of Conservation 2001). Only one of those on private land is listed as failed. It is likely that MDC, MDNR, and NRCS will continue to work with some private landowners to address problems of soil erosion, bank stabilization and proper disposal of waste from their properties.

However, it is also likely that some landowners will continue poor grazing, gravel mining, and other land use practices within the Gasconade River watershed that will contribute to non-point source pollution in both the short and long-term.

Standards and guidelines in the Revised Forest Plan would help insure that streambanks, substrates, and channels are within their natural range of variability and are functioning in a way that provides for the needs of all aquatic and terrestrial flora and fauna that depend upon them. Specifically there would be no stream channelization, no impoundments within the RMZ, in-stream equipment use would be minimized, hydrologic or habitat improvement structures would be designed to be natural appearing and functioning, aquatic organism passage would not be blocked or prevented, canopy closures would be maintained on all permanent streams less than 25 feet wide, and in-stream work would be minimized during spawning periods (U.S. Forest Service 2005, pages 2-5, 2-9 and 2-10). Therefore, there would be no added impact from instable banks, substrates or channels caused by National Forest management activities.

- ***Livestock access to river***

Permitted livestock on MTNF allotments do not have access to the river and therefore, there would be no cumulative impact from MTNF rangeland management.

- ***Gravel dredging;***

Since the removal of sand or gravel from stream channels or the RMZ is prohibited in most cases, (U.S. Forest Service 2005, page 2-34), there would be almost no potential for impact from this activity on National Forest lands. If gravel or sand removal was proposed, the site-specific impacts of that proposal would be evaluated in terms of potential effects on federally listed species, including the scaleshell mussel. This analysis would include Section 7 consultation with the U.S. Fish and Wildlife Service. Known scaleshell mussel sites would be avoided. While gravel mining does occur on

private ownerships in the Gasconade River watershed, there would be few, if any, added impacts since this activity is very unlikely to occur on National Forest lands.

» ***Municipal and industrial wastes disposal;***

Wastewater treatment facilities of the Cities of Mountain Grove, Waynesville, Newburg, Niangua, and Rolla-Vichy Road Waste Water Treatment Plant and Rolla SW Waste Treatment (see Point Source Pollution subsection) have the potential to threaten aquatic life and fishing designation with municipal treated sewage for several miles downstream of the respective receiving stream (MDNR 1984, 1997 as cited in Missouri Department of Conservation 2001). Missouri Department of Natural Resources determined that the FLW area had several poorly constructed sewage treatment facilities that could impair water quality in Roubidoux Creek (MDNR 1994b as cited in Missouri Department of Conservation 2001). Sampling of springs by the USGS in 1995 showed probable effects from septic contamination, as well as higher than background concentrations of NA, CL, NO2 and NO3, NH3, and SO4 (Imes et al. 1996 as cited in Missouri Department of Conservation 2001).

MTNF does not dispose of municipal or industrial waste. Since there is no effect from activities on MTNF, there would be no cumulative effects from this activity.

» ***Other Effects***

On MTNF, there would be no conversion of riparian areas or bottomland forest to other land uses, no stream channelization or impoundment, and therefore, no habitat loss or additive impacts. Major rivers are managed to protect the unique qualities of those rivers with limited vegetation management allowed. Water quality would be protected through application of soil and water standards and guidelines. The restoration of terrestrial natural communities throughout the Forest would increase the quality of water reaching the groundwater system, and may help moderate water fluctuations through better water holding capacity of the native vegetation of the restored natural communities. Whether or not this would result in increased survival or reproductive success of scaleshell mussels is unknown.

Conclusions:

MTNF lands only comprise about 18% of the Gasconade River watershed. About 82% of the watershed is in other ownerships. The added impacts of what happens on less than ¼ of the watershed that is National Forest land are insignificant compared to the effects of activities on over ¾ of the watershed lands.

Since MTNF would continue to provide suitable habitat and protect water quality within the range of scaleshell mussels, the effects of implementing Alternative 3 of the Revised Forest Plan, added to effects occurring from activities on other ownerships would be primarily beneficial. The possibility of potential negative effects to individual scaleshell mussels occurring from activities implementing the Forest Plan are so remote as to be considered insignificant and discountable and would not individually or cumulatively result in decreased potential for recovery of scaleshell mussels.

» **Additional measures needed for species conservation and recovery**

There are no other measures needed that would significantly contribute to conservation or recovery of this species.

» **Effects of additional measures**

Since there are no additional measure identified, there would be no impacts.

» **Determination - May Affect, Not Likely to Adversely Affect**

Rationale: The Revised Forest Plan contains measures to protect soil and water quality, to minimize soil movement caused by management activities, to maintain streambank and channel stability, and to restore and maintain natural communities, such as bottomland hardwood forest along riparian corridors. There are also measures that limit or modify the type and amount of activities that can occur within riparian corridors, in order to protect the integrity and healthy functioning of the watershed. Surveys prior to in-stream work would minimize the potential for direct impacts to mussels. The potential for sedimentation from National Forest activities in an amount that could negatively impact scaleshell mussels is so remote as to be considered insignificant and discountable.

Scaleshell mussel
Photo by St. Louis Post-Dispatch
October 5, 2003

Freshwater Drum – host for scaleshell mussel
MDC Photo

Topeka shiner (*Notropis topeka*)

» Life History summary

The Topeka shiner is a small minnow which swims midwater or near the surface in schools (http://mdc.mo.gov/nathis/endangered/endanger/topekas/). Maximum life span is 3 years, and reproduction occurs in silt-free gravel from late May to mid-July. Males defend small territories around the edges of sunfish nests where spawning occurred.

Habitat is small, quiet pools in clear upland prairie creeks with sand, gravel or rubble substrates. Some Topeka shiner streams are permanent, but many dry up in summer, with small pools maintained by groundwater seepage. The species does not occur in streams that have been channelized or impounded or that drain cultivated fields (The Nature Conservancy, no date).

Little is known about food habits of Topeka shiner, but it is thought to be a daytime feeder of aquatic insects (Federal Register Vol. 63, No. 240, 12/15/98).

» Population status range-wide, in Missouri, and on MTNF

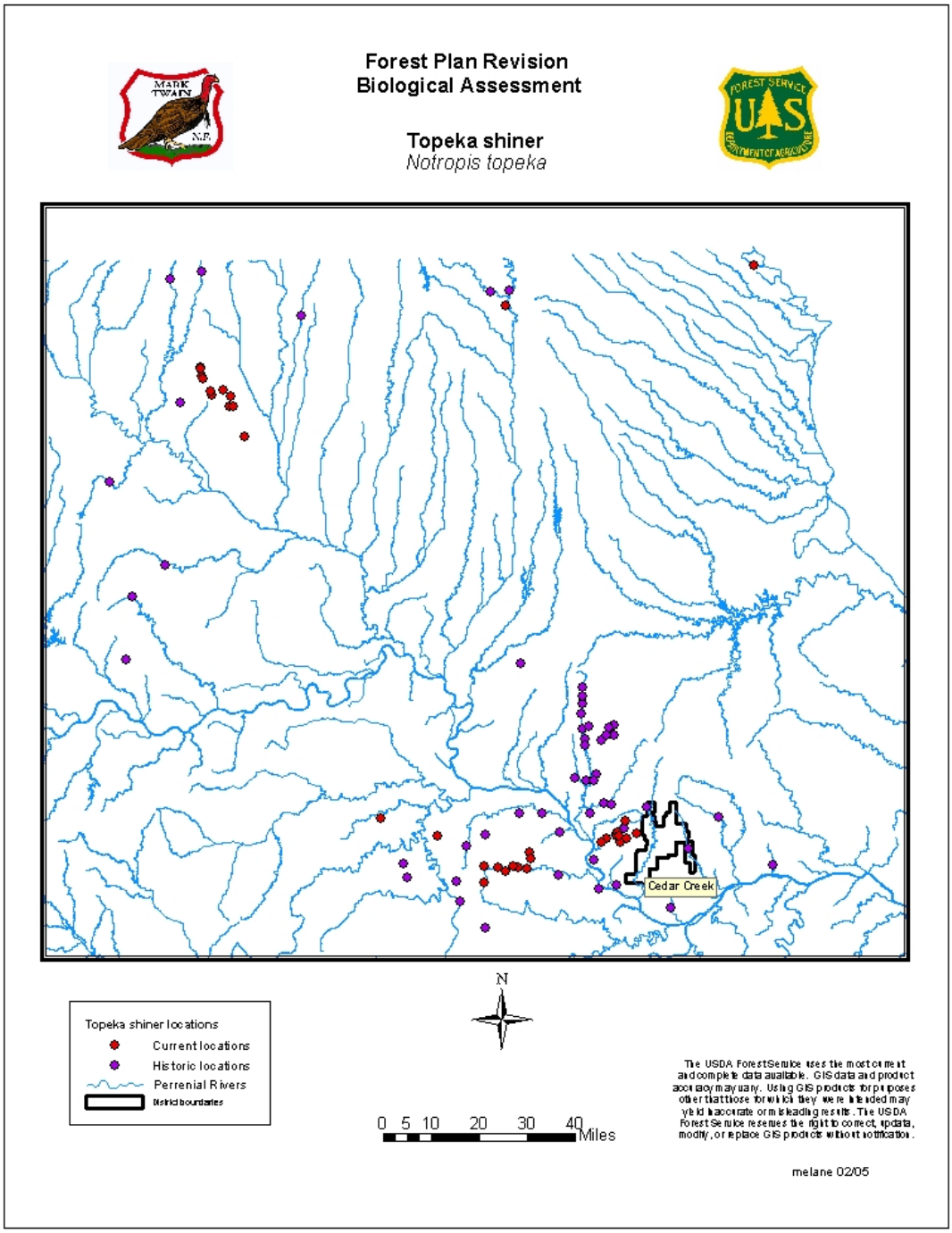
Topeka shiner inhabits small headwater prairie streams in parts of Kansas, Missouri, Iowa, South Dakota, and Minnesota. Historically abundant and widespread in its range, numbers of Topeka shiner have declined by about 80%, with approximately 50% of this decline occurring in the last 25 years (Federal Register Vol. 63, No. 240, 12/15/98). Populations of Topeka shiner are now primarily isolated and fragmented, and inhabit less than 10% of the original range (Federal Register Vol. 63, No. 240, 12/15/98).

There are 34 existing sites for Topeka shiner documented in Missouri. Almost all of the known sites in Missouri are on private land, with a few on lands managed by Missouri Department of Conservation and Missouri Department of Natural Resources (Missouri Heritage Database 2004).

There are no known populations or individuals of this species on MTNF or within the proclamation boundary of MTNF as of March 2005.

Topeka shiner
MDC Photo

Figure TS-1: Topeka Shiner locations in Missouri



» **Causes of past and/or current declines and Limiting factors**

Topeka shiner was federally listed as Endangered on December 15, 1998. Critical habitat for Topeka shiner has been designated as 836 miles of streams in Iowa,

Minnesota, and Nebraska, but none was designated in Missouri because the State of Missouri has developed an action plan that identifies conservation measures necessary to achieve recovery of the Topeka shiner in the state (U.S. Fish and Wildlife Service, no date. Topeka shiner is also designated as Endangered in Missouri (Missouri Department of Conservation 2005).

Primary causes of decline are habitat destruction, degradation, modification and fragmentation resulting from siltation, reduced water quality, stream impoundment or channelization and dewatering (Federal Register Vol. 63, No. 240, 12/15/98). The species is also threatened by the introduction of predaceous fish throughout its range (Federal Register Vol. 63, No. 240, 12/15/98).

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.*** This is the most likely cause of the majority of decline for this species (Federal Register Vol. 63, No. 240, 12/15/98). Threats include water quality degradation due to excessive runoff of animal wastes, fertilizer, pesticides, and other wastes from agricultural and urban development near streams. Removal of streamside vegetation, livestock direct access to streams, stream channelization & impoundment, poorly designed gravel removal are also factors in water quality degradation.

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes*** is not thought to be contributing to the decline of Topeka shiner (Federal Register Vol. 63, No. 240, 12/15/98).

Listing Factor C. ***Disease or predation***. No studies have been conducted on impacts of disease or predation on Topeka shiner, but observations suggest that declines in specific situations may be related to the presence of newly-introduced piscivorous fish (Federal Register Vol. 63, No. 240, 12/15/98). In Missouri, one population of Topeka shiner was found to be affected by scoliosis, a deformity of the spine which can be caused by environmental contaminants or genetic isolation (Federal Register Vol. 63, No. 240, 12/15/98).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms****.* Topeka shiner is listed as a “species in need of conservation” in Kansas, which prohibits direct taking but does not protect habitat. This species is listed as Endangered in Missouri which prohibits direct taking and provides limited review process for actions potentially impacting habitat (Federal Register Vol. 63, No. 240, 12/15/98).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Competition with other small, insectivorous fish has been suggested as a cause of decline in some situations (Federal Register Vol. 63, No. 240, 12/15/98). However, the extent and impact of possible competition is undocumented.

- **Causes of past and/or current recovery**

Currently, it appears that the species is still in decline.

» Occurrence on MTNF, existing and potential habitat

There are no existing sites for Topeka shiner on MTNF or within any of the watersheds which include MTNF lands (Missouri Heritage Database 2004). There is one known historic location for Topeka shiner within the proclamation boundary of MTNF, and one known location within a watershed which includes MTNF lands. The location within the proclamation boundary was on private lands at mile 20 of Middle River in Callaway County with a 1941 record of 9 individuals. Surveys of this site in 1995 failed to capture any individuals. The location within an MTNF watershed was at mile 1 of Little Cedar Creek in Boone County with a 1962 record of 1 individual. Surveys of this site in 1995 also failed to capture any individuals.

The closest extant sites for Topeka shiner to National Forest lands are in Bonne Femme Creek, Turkey Creek, and Little Turkey Creek, all within 5 miles of the Forest boundary, but outside any watersheds which contain National Forest lands. Topeka shiner is not currently known to occur in any watershed with National Forest lands, and the chance of the species recolonizing historical locations on MTNF is remote.

» Surveys for Topeka shiner

The Topeka shiner was first described in 1884 from Kansas. In Missouri, the earliest survey record is from 1940, with additional survey records each decade since then up until 2003 (Missouri Heritage Database). Recent surveys have been conducted throughout the range at previously documented sites and in other suitable habitat (Federal Register Vol. 63, No. 240, 12/15/98). These surveys in Missouri identified Topeka shiners at 14 of 72 (19%) of historic locations, and at 20 of 136 (15%) of all sites sampled (Federal Register Vol. 63, No. 240, 12/15/98).

The historic site on National Forest lands was last surveyed in 1995 as part of a state-wide reassessment of Pflieger's earlier fish survey work. There were no individuals found at that site, and no further surveys planned at the present time. The Missouri Department of Conservation monitors the extant sites in the state (Missouri Department of Conservation 1999).

Reintroduction of Topeka shiner into appropriate habitat within the range is identified as a possible goal in the Missouri State Action Plan (page 5). However, no streams were specifically identified as potential reintroduction sites. In 1997 Dr. Paul McKenzie, U.S. Fish and Wildlife Service identified Cedar Creek as a potential reintroduction site. As of March 28, 2005, Dr. McKenzie stated that Cedar Creek could still be considered as a potential reintroduction site, but the final selection would be made by Missouri Department of Conservation (Paul McKenzie, U.S. Fish and Wildlife Service, pers. comm. 3/28/05). The Forest Service would cooperate with U.S. Fish and Wildlife Service and MDC in identification of appropriate reintroduction sites and possible reintroductions on National Forest lands.

» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

There is no approved Recovery Plan for Topeka shiner as of March 2005. However, the Revised Forest Plan has numerous standards and guidelines dealing with the protection of soil and water quality and quantity, as well as specific standards and guidelines limiting or modifying actions which can be taken in streams, riparian corridors and upland waterways (U.S. Forest Service 2005).

» **Effects of implementation of the proposed action**

Direct Effects - Because there are no known populations of Topeka shiner on MTNF, there would be no direct effects. If populations of Topeka shiner are discovered in the future on MTNF, the Forest Service would reinitiate consultation with USFWS on this species.

Indirect Effects – While some historic habitat exists on MTNF, there are only two historic records which comprise a total of 10 individuals. These records are from 1941 and 1962 respectively (64 years and 43 years ago). Surveys of both sites in 1995 failed to capture any individuals. Until such time as there is evidence Topeka shiner may actually occur on MTNF, there would be no indirect effects on potential habitat.

Cumulative Effects - Since there are no direct or indirect effects, there are no cumulative effects.

» **Additional measures needed for species conservation and recovery**

There are no additional measures which could be taken by the Forest Service to contribute to the recovery of this species.

» **Effects of additional measures**

Since there are no additional measures needed for species recovery, there would be no effects.

» **Determination – No Effect**

Rationale: There are no known locations of Topeka shiner in MTNF watersheds.

Bald eagle (*Haliaeetus leucocephalus*)

» Life History summary

Breeding habitat for bald eagles is associated with aquatic habitats with forested shorelines. They select large, super-canopy trees that are open and accessible as nest sites. Bald eagles are monogamous and are thought to mate for life, unless one of the pair dies. They build large nests of sticks lined with soft materials. The same nest may be used for years by the same pair. Nests may be up to 6 feet across and weigh hundreds of pounds. Average clutch size is 2 eggs, and young eagles fledge in about 12 weeks, although parents continue to feed them for up to 6 weeks while they learn to hunt. (U.S. Fish and Wildlife Service 2005). Bald eagles may live up to 50 years in captivity, although life expectancy in the wild is about 30 years. Mortality rates for bald eagles are estimated at about 50% in the first year, about 10% the second year, and about 5% per year thereafter (Missouri Department of Conservation, no date).

Wintering habitat is along rivers and coastal estuaries in the lower 48 states and Alaska. (U.S. Fish and Wildlife Service 2005). Bald eagles may roost communally in winter.

Bald eagles forage opportunistically, taking fish, ducks, other birds, and a variety of mammals, amphibians, crustaceans and carrion.

» Population status range-wide, in Missouri, and on MTNF

The North American population in the early 1990's was estimated at about 70,000 (NatureServe 2005) and in 1997 at about 98,648 individuals (U.S. Fish and Wildlife Service 2005). The number of nesting territories in the lower 48 states was estimated at about 3,014, with 1,165 of those in the northern states (including Missouri) (NatureServe 2005). Wintering populations in the lower 48 states were estimated to be about 11,250 bald eagles in 1980 (NatureServe 2005).

In the lower 48 states, Missouri is the leading state in numbers of wintering bald eagles, with about 2000 – 3000 individuals per year. Wintering eagles are concentrated where open water is available throughout the winter, including major impoundments like Truman Lake, Lake of the Ozarks, and Table Rock Lake; the Missouri and Mississippi Rivers, and other large rivers such as the Eleven Point, Current, and North Fork in southern Missouri.

Today, Missouri has over 90 breeding pairs of eagles, with 5-10 new nests being reported each year (Missouri Department of Conservation 2003).

MTNF routinely counts about 30-70 wintering eagles on National Forest lands along major rivers and impoundments. Most are individuals or small groups, and no communal night roosts have been found on MTNF. To date, only one nest has been located on National Forest land, and that nest has not had any activity since 2004 when it was discovered.

» **Causes of past and/or current declines and Limiting factors**

Bald eagles in Missouri were already essentially extirpated from the state by the mid 1900's. Market hunting in the 1800's and general persecution, combined with habitat loss as the bootheel swamps and big river floodplains were cut and drained, are the primary causes of the historic decline of Missouri's eagles. By 1890, eagles were virtually eliminated as nesters in Missouri (Missouri Department of Conservation, no date).

The bald eagle was listed as Threatened in the conterminous U.S. on March 11, 1967. On February 14, 1978 the bald eagle was listed as Endangered throughout the conterminous U.S, except in Washington, Oregon, Minnesota and Michigan where it was listed as Threatened (Federal Register Vol. 43, No. 31, 2/14/78). On July 12, 1995, the bald eagle was reclassified as Threatened in the lower 48 states (Federal Register Vol. 60, No. 133, 7/12/95). On July 6, 1999, the U.S. Fish and Wildlife Service proposed to remove the bald eagle from the list of endangered and threatened species (Federal Register Vol. 64, No. 128, 7/6/99).

Critical habitat was not designated in the 1978 listing (Federal Register Vol. 43, No. 31, 2/14/78).

The following factors were considered when reclassifying bald eagle from endangered to threatened:

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range:*** Habitat degradation or destruction is one of the two major threats to bald eagles at present (the other being environmental contaminants) (Federal Register Vol. 60, No. 133, 7/12/95). Because the bald eagle is associated with aquatic habitats throughout its range, and seldom nests further than 2 miles from water, water-associated development is a major concern. Direct cutting of trees for shoreline development, human disturbance from recreational uses of waters, and contamination of water are all causes of habitat destruction or degradation (Federal Register Vol. 60, No. 133, 7/12/95). Current threats to habitat in the northern recovery region include development, particularly near urban areas. However, nesting activity in the northern recovery region has more than doubled in the past 10 years and there is abundant habitat still available throughout the region (Federal Register Vol. 60, No. 133, 7/12/95). The construction of reservoirs has adversely affected riparian corridors, but has also created additional foraging areas for eagles (Federal Register Vol. 60, No. 133, 7/12/95).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** There is no legal commercial or recreational use of bald eagles. The U.S. Fish and Wildlife Service, under strict controls, issues permits for scientific, educational, and Native American religious activities which involve bald eagles or their parts. (Federal Register Vol. 60, No. 133, 7/12/95). The impact of these permits is not thought to be a concern to recovery of bald eagles.

Listing Factor C. ***Disease or predation:*** Neither predation nor disease are thought to be significant problems for bald eagle populations (Federal Register Vol. 60, No. 133, 7/12/95). In the mid 1990's bald eagles in Arkansas were found dead of an unknown

cause. Several other eagle populations in southern states were also affected in the late 1990's. Subsequent investigations have led to the hypothesis that a previously unknown form of pond scum carries a toxin that may cause avian vacuolar myelinopathy, a brain-eating disease. AVM is considered the most significant unknown cause of eagle deaths in United States history, according to the National Wildlife Health Center Web site, which describes it as a mysterious disease whose cause has eluded scientists (Peterson 2005). The algae grows on an invasive aquatic plant and is eaten by ducks and coots. Eagles apparently contract the disease from eating coots. Because the disease is emerging, nobody knows about its long-term effects (Peterson 2005).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms.*** There are at least four federal laws which afford uncommonly comprehensive protection to bald eagles (Federal Register Vol. 60, No. 133, 7/12/95).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Environmental contaminants are one of the two major threats to eagles, and continue to be a major problem in some areas (Federal Register Vol. 60, No. 133, 7/12/95). In the northern states recovery region, only the Great Lakes area is mentioned as having continued problems with long-term exposure to environmental contaminants, particularly along the shorelines of Lakes Michigan and Huron (Federal Register Vol. 60, No. 133, 7/12/95). Lead poisoning and mercury are also continued sources of concern. High levels of mercury can cause a variety of neurological problems which result in altered motor skills and reduced hatching of eggs (Federal Register Vol. 60, No. 133, 7/12/95). Illegal shooting, electrocution in powerlines, and human disturbance remain threats to eagles. Human disturbance can, and has, been reduced or eliminated by modifying land management practices and providing buffers for protection of eagle nests and wintering eagles (Federal Register Vol. 60, No. 133, 7/12/95).

In spite of continued threats, bald eagles were not considered to be at risk of extinction in 1995.

- **Causes of past and/or current recovery**

Missouri is included in the Northern States Recovery Region. Within this region, delisting goals were met in 1991 for occupied breeding territories and productivity (Federal Register, Vol. 64, No. 128, 7/6/99). The Northern States Bald Eagle Recovery Team is currently reviewing and updating the Recovery Plan and reviewing the delisting goals for this region (Federal Register Vol. 60, No. 133, 7/12/95). Many states within the northern recovery region have the majority of lands in private (not public) ownerships, and "habitat on private property has proven to be very important for the continued expansion of the bald eagle population in this region." (Federal Register, Vol. 64, No. 128, 7/6/99).

In Missouri, bald eagle recovery began in 1981 when the Missouri Department of Conservation, in cooperation with the U.S. Fish and Wildlife Service and Dickerson Park Zoo, released 74 young bald eagles (Missouri Department of Conservation, no date). By 2003, over 90 pairs of eagle had established nests in Missouri, with 5-10 new nests being reported each year. Breeding eagles are doing so well that the Missouri Department of Conservation does not conduct annual nest counts, but records them as

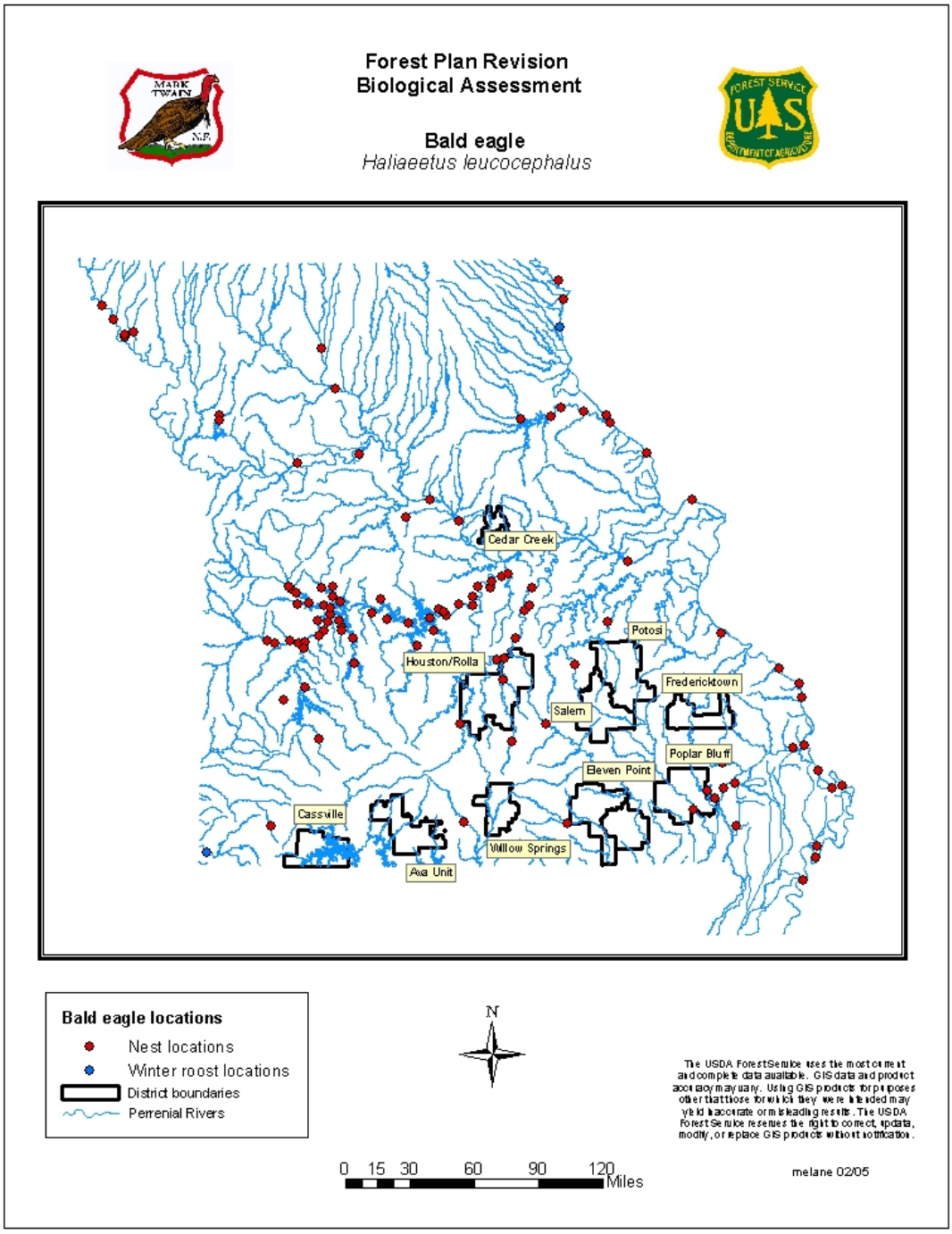
reports are received from field staff or the public (Missouri Department of Conservation 2003).

Range-wide, reproductive success has increase dramatically since DDT and other pesticides were banned in the United States (NatureServe 2005). In addition, active management and protection have helped eagles recover, particularly in the lower 48 states.

The U.S. Fish and Wildlife Service has proposed to remove the bald eagle from the List of Endangered and Threatened Wildlife in the lower 48 States of the United States, because available data indicate the species has recovered (Federal Register, Vol. 64, No. 128, 7/6/99). The reduction in organochlorine pesticide levels in the environment, as well as habitat management and protection are the primary factors responsible for recovery. Throughout the lower 48 states, bald eagles have doubled their population every 7-8 years for the past 30 years, with close to 6,000 occupied breeding areas in 1998 (Federal Register, Vol. 64, No. 128, 7/6/99). Reproductive rate has also met or exceed Recovery Plan objectives, with a national average of more than 1 fledgling per occupied breeding area since 1990 (Federal Register, Vol. 64, No. 128, 7/6/99).

Mature bald eagle feeding on fish in the Lower Current River
Photo by Ben Wyatt

Figure BE-1: Bald eagle locations in Missouri



The following factors have been considered in the proposal to remove the species from the list of endangered and threatened wildlife:

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range:*** Neither nesting nor wintering habitat appears to be

limiting based on the increasing population trends and expansion of the species' back into parts of its historical range (Federal Register, Vol. 64, No. 128, 7/6/99). With the knowledge of habitat management gained over the past decades, actions on federal land that result in loss of habitat are expected to be at an acceptable level that would not affect the population's stability (Federal Register, Vol. 64, No. 128, 7/6/99).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** There is no legal commercial or recreational use of bald eagles. The U.S. Fish and Wildlife Service, under strict controls, issues permits for scientific, educational, and Native American religious activities which involve bald eagles or their parts. (Federal Register Vol. 60, No. 133, 7/12/95). Permits would not be issued if the status of the bald eagle would be affected (Federal Register, Vol. 64, No. 128, 7/6/99).

Listing Factor C. ***Disease or predation:*** Neither predation nor disease are thought to be significant problems for bald eagle populations***.*** Although AVM causes mortality on a localized basis, there is no current evidence that overall recovery is affected (Federal Register, Vol. 64, No. 128, 7/6/99).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms.*** There are several federal laws and international agreements which would continue to fully protect bald eagles if they were taken off the list of endangered and threatened species (Federal Register Vol. 60, No. 133, 7/12/95).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. The reduction of levels of organochlorine pesticides has paralleled the increase in bald eagle populations in the lower 48 states (Federal Register, Vol. 64, No. 128, 7/6/99). Intentional shooting of bald eagles has been greatly reduced from the market hunting days of the 1800's and early 1900's. However, some illegal shooting is anticipated to continue, although it is not considered a significant threat to survival of the species (Federal Register, Vol. 64, No. 128, 7/6/99). Electrical powerlines and highways can be sources of eagle mortality, but efforts are being undertaken locally to reduce this threat. Human disturbance can be reduced or minimized through the modification of land management practices. While human disturbances will continue after removal from the list of endangered and threatened wildlife, many conflicts can be avoided or minimized through applying knowledge gained in the recovery process (Federal Register, Vol. 64, No. 128, 7/6/99).

» **Occurrence on MTNF, existing and potential habitat**

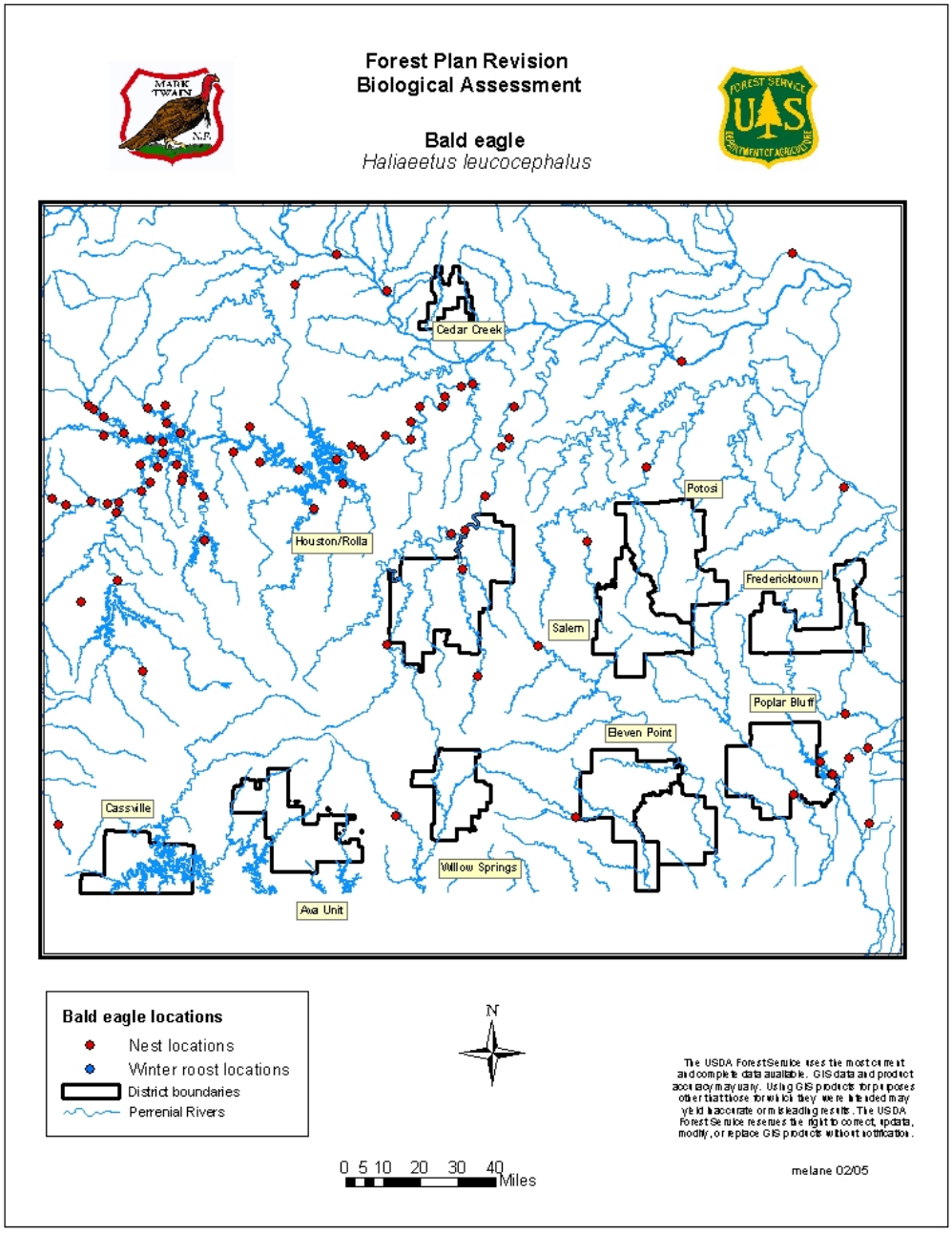
Winter

Winter habitat on MTNF consists of major rivers and impoundments where water is unfrozen all winter. The highest number of eagles have traditionally been counted on the Eleven Point River, Current River and Table Rock Lake. Other areas where smaller numbers of eagles have been noted include Lake Wapappello, Council Bluff Lake, Noblett Lake, McCormack Lake, North Fork River, Big Piney River, Gasconade River, St. Francois River, Huzzah and Courtois Creeks, Sunnen Lake, Spring Creek, Indian Creek, Mayfield Spring and others.

Summer

There is only one documented, but inactive, nest on National Forest lands, but there are a few documented nests on other ownerships within the proclamation boundary of MTNF. All are located along major rivers or their tributaries, and are constructed in large trees in the floodplain or on slopes above the river. One nest on Fort Leonard Wood along the Big Piney River fledged 2 chicks in 2004, and the parents were active around the nest in March 2005. An active nest on private lands within the Poplar Bluff District has apparently fledged several chicks over the past decade.

Figure BE-2: Bald eagle locations in and near MTNF



» **Surveys for bald eagle**

Since listing in 1978, bald eagle nesting and productivity have been monitored throughout the lower 48 states (Federal Register Vol. 64, No. 128, 7/6/99). Midwinter eagle surveys have also been conducted nation-wide.

The Mark Twain National Forest has conducted winter surveys for bald eagles since at least 1980. These surveys have generally concentrated on National Forest lands along major rivers and impoundments. The latest surveys were completed in February 2005.

If the bald eagle is delisted, monitoring must continue for 5 years following delisting. The U.S. Fish and Wildlife Service proposes continued monitoring of occupied breeding areas, number of young produced, and contaminant analysis (Federal Register Vol. 64, No. 128, 7/6/99).

» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

The Northern States Bald Eagle Recovery Plan was signed on July 29, 1983. In the intervening 22 years, the northern recovery region has exceeded delisting objectives for occupied breeding territories and productivity. Therefore, the recovery actions listed on pages 37-60 may no longer be applicable. Many of the original actions were never applicable to the Forest Service. However, the following actions may still be applicable and until a new Recovery Plan is in place or the eagle is taken off the Endangered and Threatened species list, we will continue to work with U.S. Fish and Wildlife Service and Missouri Department of Conservation to provide quality habitat and protection for known eagle sites on MTNF.

Action 1.12112 "Analyze National Wildlife Federation Midwinter Bald Eagle Survey data on a nation-wide basis" and Action 1.1212 "Conduct surveys". MTNF participated in this survey for over 20 years, until the Missouri Department of Conservation discontinued the surveys due to the abundance of bald eagles in the state. MTNF still conducts several winter bald eagle surveys along major rivers and impoundments. The Revised Forest Plan includes monitoring of population status of TES and the success of the plan in contributing to conservation of TES and moving toward objectives for their habitat conditions (U.S. Forest Service 2005, page 4-11).

Action 1.2 "Identify essential bald eagle habitat"; Action 1.21 "For the breeding season" and Action 1.2111 "Assess the attributes, including prey resources, of each area that contains a nest in usable condition". Until 2004, there were no known nests on MTNF lands, and therefore no chance to assess attributes of occupied habitat. The one nest on National Forest lands has not been active, and so there is still no opportunity to contribute to this action item. The Revised Forest Plan requires that suitable habitat be maintained for nesting, roosting, and foraging eagles (U.S. Forest Service 2005, page 2-6).

Action 1.2 "Identify essential bald eagle habitat"; Action 1.22 "For the wintering period" and Action 1.221 "Assess the attributes of occupied wintering areas". MTNF conducted numerous winter surveys over the past 20 years looking for communal night roosts or congregations of wintering bald eagles. None were ever found on National Forest lands, although there are some within the MTNF proclamation boundary

on private lands. Major eagle wintering areas on MTNF are identified as the major rivers and impoundments. The Revised Forest Plan requires that suitable habitat be maintained for nesting, roosting, and foraging eagles (U.S. Forest Service 2005, page 2-6).

Action 3.2 "Protect and manage habitats". The 1986 Forest Plan included standards and guidelines for protection of riparian forests, water quality, and specific standards and guidelines for protecting eagle nests. Amendment 25, dated 3/2000 included an additional standard and guideline to protect communal night roosts or concentrations of eagles on National Forest lands. The Revised Forest Plan requires that suitable habitat be maintained for nesting, roosting, and foraging eagles and requires that any management activities near known nesting sites protect and maintain suitable habitat (U.S. Forest Service 2005, page 2-6).

Action 4.112 "Establish coordination in each state or federal agency to coordinate all eagle work for that state or agency". The Forest Wildlife Biologist is responsible for coordination of all eagle information for MTNF in Missouri. The Forest Service cooperates and coordinates activities with Missouri Department of Conservation and U.S. Fish and Wildlife Service. The Revised Forest Plan requires that conservation of federally listed species be coordinated with U.S. Fish and Wildlife Service (U.S. Forest Service 2005, page 2-5).

Action 4.2.11 "Inform and educate the general public". MTNF biologists regularly present programs to schools, civic groups and other organizations. There is nothing in the Revised Forest Plan that would prevent us from continuing to give educational programs on eagles or other wildlife.

- **Effects of implementation of the proposed action**

Effects analysis will

A). identify actions which may affect bald eagle individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
    a) identifying how many individuals would be exposed
    b) which populations are represented by those individuals
    c) identifying specific stressors associated with exposure to the action
    d) identifying where and when exposure would occur
    e) identifying the duration and extent of exposure
C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of bald eagle individuals, groups, or habitat.
E) estimate the risk posed to bald eagle by the action.

Direct Effects

Potential Negative Effects

Because suitable habitat for nesting, roosting, and foraging eagles would be maintained, and management activities near known nesting sites would be conducted in a manner that protects existing nest sites, maintains suitable alternate nesting habitat, and occurs outside of the breeding, incubation, and brood rearing period, (U.S. Forest Service 2005, page 2-6), the primary avenue of direct negative effects to bald eagles would be human disturbance of a magnitude that would disrupt breeding, nesting, roosting, or brood rearing.

There are no known communal night roosts on MTNF lands, and therefore no potential negative effects from implementation of the Revised Forest Plan.

Many studies have documented that eagles will flush off the nest when disturbed by human presence (Federal Register Vol. 64, No. 128, 7/6/99). Although many sources cite the sensitivity of eagles to human disturbance, the evidence in Missouri shows increases in eagle populations and reproductive success, during the same time when human population has also been increasing. Eagles in Missouri are found both in winter and nesting in some of the most populated and fastest growing areas of the state (St. Louis along the Mississippi and Missouri Rivers, Truman Lake, Lake of the Ozarks, Table Rock Lake). Beebe 1974 as cited in NatureServe 2005 states that eagles "show a high degree of adaptability and tolerance if the human activity is not directed toward them." Martell 1992 states "Eagles may also adapt to some types and levels of human activity. Reports of farmers and fishermen going about their daily activities close to perching or foraging eagles indicate a degree of tolerance on the part of some birds. Managers should consider these variations in eagle and human behavior when setting buffer zones."

From 1986 to 1996, there was an estimated increase in visitor use days associated with canoeing on National Forest lands in the Ozark-Ouachita Highlands (including MTNF) of 38% (U.S. Department of Agriculture, Forest Service 1999 (a) page 161). In this same time period, both wintering populations and nesting territories for eagles in Missouri were increasing.

There is only one known nest location on MTNF lands, but several on private lands within the MTNF proclamation boundary. With a continued increase in nest locations each year in Missouri, it would not be surprising to find additional nest locations on MTNF lands in the foreseeable future. These would most likely be along the major rivers or lakes, as the majority of current nests are.

Nest locations would have a pair of adults and possibly one or two young. Wintering eagles tend to be solitary or in small groups, except at communal night roosts, none of which are known to occur on MTNF lands. The number of individuals that would be exposed to human disturbance could vary from one to several at a time. Unless floaters stopped at the eagle nest location to picnic, fish or swim, canoers would normally pass by a nest location within a few minutes and may not even notice the nest. This type of disturbance would be infrequent, low intensity, and of short duration, and would be unlikely to result in a permanent change in eagle behavior or use of an area.

The primary forms of disturbance would be recreationists canoeing or boating on the major rivers and lakes on which eagles tend to occur. Canoeing is a popular spring-summer activity on most of the large and small rivers of the Ozarks, including the North Fork, Current, Eleven Point, Gasconade, Big Piney, St. Francis, and others where bald eagles have known wintering and nesting locations. The heaviest canoeing activity is concentrated on the weekends, but some activity occurs throughout the warm months. In addition to canoes, motorized john boats, and some motorized personal watercraft are used on the rivers. Gigging season in the fall brings out many boaters who are active throughout the night time hours.

There are two known nest locations along the Eleven Point National Scenic River – one on private lands that was active and successful in fledging two chicks in 2002, and at least one chick in 2001; and another on MTNF lands that is apparently inactive. The active nest on private land is on the upper river where motorized boats are rare, and canoeists are few in mid to late summer because of low water conditions. The nest is about 25 feet from the river's edge and can be seen from the river during leaf-off, but is difficult to see once the leaves have emerged. MTNF personnel saw 2 adult eagles in the general vicinity of this nest during an aerial survey in February 2005, although there were no eggs in the nest at that time. The private landowners are protective of the tree and nest area. It is unlikely that there is much human disturbance near this site from at least late June through September. The fact that the eagles have successfully fledged young for at least two years is indicative that human activity has not resulted in negative impacts to this location.

The inactive nest along the Eleven Point River is on the lower river where canoe and boat traffic is fairly regular throughout the spring and summer, with heaviest activity on weekends. This nest can be seen from the river during leaf-off; however, there is no trail to the tree, as there are to other heavily visited locations along the river banks (i.e. caves, springs). This indicates that people are not getting out of their canoes to walk up to the tree. Whether or not canoe and boat traffic has caused this nest to be abandoned is unknown. There are many reasons for eagles not finishing a nest or abandoning a nest site, and some breeding territories include one or more alternate nests (Federal Register Vol. 64, No. 128, 7/6/99).

Boating on Lake Wapapello and Table Rock Lake is a very popular activity, and is likely to increase in the foreseeable future. MTNF has very little land on the shoreline of either of these lakes. Standards and guidelines require a ¼ mile wide old growth corridor be designated on MTNF lands along the waters' edge of Table Rock Lake and Lake Wapapello, which are traditional eagle wintering areas (U.S. Forest Service 2005, page 2-6). This would prevent any vegetative management from occurring in that strip, and could moderate the distance of eagle roosts or potential nest sites from human activity on the lakes themselves.

Standards and guidelines also direct that educational signs be developed in cooperation with U.S. Fish and Wildlife Service and Missouri Department of Conservation and placed at river and lake access points to inform people of appropriate behavior near bald eagle nests or perches (U.S. Forest Service 2005, page 2-6). Missouri's experience with the popularity of "Eagle Days" shows that most people want to protect our national symbol and do not want to do anything that would disturb the birds. If people know the appropriate behavior, most will comply.

However, there are normally a few instances of illegal shooting of bald eagles in Missouri each year. The public can anonymously report illegal eagle killings on Missouri Department of Conservation's Operation Game Thief phone number (Missouri Department of Conservation, no date). When requested, Forest Service law enforcement officers cooperate with other state and federal law enforcement personnel to investigate cases of eagle killings. There is nothing in the Revised Forest Plan that would prevent continued cooperation in these cases.

Recreational canoeing and boating activities have been taking place on MTNF waters for decades. The increase in bald eagle numbers over the past 20 years, along the same waters that support canoeing and boating, indicate that if negative effects are occurring as a result of human disturbance, they are temporary and isolated enough to be considered insignificant and discountable.

Potential Beneficial Effects

Standards and guidelines of the Revised Forest Plan require protection of occupied nest sites, and maintenance of suitable foraging, nesting, and roosting habitat for bald eagles, as well as conducting management activities to protect existing sites, maintain alternate nesting habitat, outside the active use seasons (U.S. Forest Service 2005, page 2-6).

In addition, Management Prescription 6.3 is assigned to segments of several rivers – Gasconade, Big Piney, Black, North Fork, St. Francis Rivers and Huzzah Creek. This prescription requires that the ¼ mile corridor along each bank be managed to maintain or enhance the free-flowing character and outstandingly remarkable values which make them eligible for classification as National Rivers (U.S. Forest Service 2005, page 3-32). Management activities are limited and confined to the period of October 1 though March 31. This would limit any disturbance to nesting eagles. Activities could occur during the time wintering eagles are present, but any impact would be temporary and limited in duration and scope.

The Eleven Point and Lower Current Rivers are included in Management Prescription 8.1 which includes a variety of specially designated areas. The purpose of this prescription is to protect and appropriately manage the special qualities of these areas (U.S. Forest Service 2005, page 3-39). Generally the only vegetation management permitted is for public safety, to perpetuate unique ecosystems, and to address habitat needs for threatened and endangered species (U.S. Forest Service 2005, pages 3-43 through 3-46 and 3-50 through 3-51).

These actions, along with designating a ¼ mile old growth area adjacent to Table Rock Lake and Lake Wapapello where there are National Forest lands, would provide areas of suitable habitat along lakes and rivers for both wintering and breeding eagles in both the short and long-term.

Indirect Effects

Potential Negative Effects

- ***Harvest of Large Trees***

Because bald eagles use very large trees to build their nests which are usually found within 2 miles of water (Gerrard and Bortolotti 1988 as cited in Federal Register Vol. 60,

No. 133, 7/12/95), harvest of large trees within 2 miles of a major river or lake could remove potential roost or nest trees.

Harvest within ¼ mile on each side of many of the major rivers is limited by the 6.3 and 8.1 Management Prescriptions, and is unlikely to occur. If harvest did occur, it is limited to very specific purposes, including the protection of the unique qualities of the river corridors or enhancement of natural riparian and bottomland forest communities, and the large diameter trees are the very trees most likely to be designated to remain. Removal of large diameter trees would be very unlikely in these river corridors, making any potential indirect negative effects so unlikely as to be considered insignificant and discountable.

Cutting dead trees which are public hazards in recreation areas may remove large diameter trees, but these would be marginally suitable nest trees because of their limited usefulness (i.e. dead trees would eventually be unable to support a large nest structure). However, they could be used as perch trees until such time as they fell down. The Revised Forest Plan contains a standard and guideline requiring hazard trees be identified and removed between November 1 and April 1 whenever possible to minimize risk to roosting Indiana bats (U.S. Forest Service 2005, page 2-6). This however, conflicts with the time that bald eagles would be most likely to be using large, dead trees. Since bald eagles have been proposed for removal from the list of threatened and endangered species, and Indiana bats are in a continued decline in Missouri and rangewide, the need is more urgent to protect the bats from potential direct impacts. Even if some large, dead hazard trees were removed from recreation areas, there are many other large trees that would be available as roost trees along the river corridors and lakeshores on National Forest lands. The chances that the absence of these trees would have any impact on the behavior or survival of individual eagles or the population as a whole is so remote as to be considered insignificant and discountable.

Some timber harvest could occur outside the 6.3 and 8.1 prescriptions within 2 miles of a major river or lakeshore. Within Management Prescriptions 1.1 and 1.2, harvest would be done only to improve, maintain, or enhance the natural communities, and large diameter trees would very likely not be cut.

In all Management Prescriptions, in all intermediate harvests, a standard and guideline emphasizes retaining the oldest and/or largest trees to meet the basal area objectives (U.S. Forest Service 2005, page 2-26). In all even-aged regeneration harvest at least 7-10% of the harvest unit would be left as reserve trees or groups, including the largest, long-lived species occurring on the site (U.S. Forest Service 2005, page 2-26). Significant stands or groups of trees greater than 175 years old are to be designated as old growth and not harvested (U.S. Forest Service 2005, page 2-26).

With these measures in place, it is unlikely that trees with large enough diameters to be suitable bald eagle roost trees would be harvested at such a scale to cause a reduction in available eagle nesting habitat either for individuals or for the population as a whole. The U.S. Fish and Wildlife Service has stated, “neither nesting nor wintering habitats appear to be limiting, and there are no indications that availability of these habitats will limit the bald eagle population in the near future.” (Federal Register Vol. 64, No. 128, 7/6/99).

» ***Sedimentation of waterways***

Since eagle's major prey is fish, the quality of water is important to maintaining an adequate food supply for both wintering and breeding eagles. Some Forest management activities have potential to contribute to sedimentation of waterways from soil movement off-site. The activities which have potential for soil movement off-site include timber harvest, prescribed burning and fireline construction, road reconstruction and maintenance, mineral exploration and development activities under existing permits, and range management, including grazing. These activities, under the current Forest Plan, occur on approximately 43,000 acres annually (about 3% of the Forest) (U.S. Forest Service 1998, page 5). Under the preferred alternative (Alternative 3) of the Revised Forest Plan, there would be about 120,415 acres of these types of treatments annually (about 8% of the Forest) (U.S. Forest Service, 2005, page E-3).

Water yields on lands subject to timber harvest and some prescribed fires, can be significant on small scale watersheds, with possible channel degradation and soil movement. However, on a large scale, such as the Forest as a whole, these temporary, increased yields are a small fraction of overall water yield from MTNF lands, and are not measurably detectable on an annual basis (U.S. Forest Service 2005(a), page 3-195) (U.S. Forest Service 1998, Bald eagle pages 8-11).

Road construction, reconstruction or maintenance may occur at any time of year, and can take place over the course of several days, weeks, or months depending on the length and amount of work to be done. Soil movement would be most likely where roads are in riparian areas, where roads cross streams, or are on steep slopes. Standards and guidelines provide direction for using minimum necessary construction, reconstruction and maintenance standards; scheduling work to take advantage of favorable ground conditions; using existing roads in preference to building new roads; locating roads outside the RMZ and WPZ; avoiding losing streams; keeping road grades normally at less than 10%; designing appropriate drainage features, and limiting stream crossings (U.S. Forest Service 2005a, pages 2-37 through 2-39). All these measures are intended to reduce, minimize, or prevent soil movement off-site.

Mineral exploration and development (drill sites, temporary roads, vent shafts) under the current Forest Plan occurs on a very small proportion of MTNF lands each year (on average, less than 10 acres/year). The possibility that soil movement from these sites would reach a major waterway which eagles use is extremely remote. There are no significant changes in administration of mineral permits in the Revised Forest Plan, and no reason to think that the acreage affected by mineral activities would change significantly in the foreseeable future.

In Alternative 3 of the Revised Forest Plan there are approximately 1,050-1,780 acres of grazing allotments within riparian management zones (RMZs). All areas within 100 feet of rivers or streams would be fenced to keep livestock away from waterways. However, the presence of livestock in floodplains makes it more likely that some soil loss would occur, particularly during flooding events, and that some enrichment of waters would take place as livestock waste enters the waterways (U.S. Forest Service 2005a, page 3-208 through 3-209). However, standards and guidelines require that grazing allotments within the RMZ must be foreclosed at the earliest opportunity; that timing, duration, and intensity of livestock grazing be controlled to achieve desired vegetation objectives; and that the functionality of the RMZ shall not be degraded by grazing (U.S. Forest Service 2005, page 2-19).

Therefore, although some soil loss is possible on individual allotments or individual units in an allotment, on the Forest as a whole the impact would not be enough to cause a short or long term reduction in fish prey or any subsequent reduction in survival of bald eagles using those waterways. If soil loss on a particular unit or allotment was documented, the timing, intensity, and/or duration of grazing would be adjusted to reduce, minimize or eliminate that potential in the future. With these measures in place, any sedimentation or water quality impacts resulting from livestock grazing would be so slight as to be considered insignificant and discountable.

The Missouri Department of Conservation collects various kinds of data on fish populations on major waterways. The Missouri Department of Conservation's 2005 Fishing Prospects report shows that game fish populations are "fair", "good", "great", and "excellent" in the rivers which run through MTNF lands that are listed in the report (Missouri Department of Conservation 2005). This is an indication that any sediment reaching the rivers from past MTNF management activities has not decreased the available fish prey for eagles.

- ***Smoke from prescribed burning***

The 1999 programmatic Biological Opinion indicated that smoke could be a potential impact to bald eagles (U.S. Fish and Wildlife Service 1999, page 33-35). However, in the past 5 years since the opinion was issued, MTNF has prescribed burned over 50,000 acres and has not documented any adverse impacts to bald eagles (U.S. Forest Service 1999(b), 2000, 2001, 2002, 2003, 2004).

Documentation of the effects of smoke on eagles is scarce, but bald eagles have been known to continue nesting during wildfire and return to the nest the following year (Snyder 1993). On February 27, 2004 MTNF personnel conducted a prescribed burn less than ½ mile from a known nest site. Smoke from the prescribed burn was monitored and did not drift near the nest location during or after the burn. That nest produced two young later in the year.

In the Revised Forest Plan, approximately 60,000 – 80,000 acres would be prescribed burned annually. This is about 4-5% of MTNF lands. Standards and guidelines require that prescribed burn plans be written to minimize adverse impacts of smoke (U.S. Forest Service 2005, page 2-18). Experience with prescribed fires on MTNF shows that most smoke dissipates within 24 hours. Under the Revised Forest Plan, prescribed burn areas are likely to be larger than the current average, and therefore, smoke may take longer to dissipate, but would be expected to take no longer than 24-72 hours to be completely gone. In that time period, there may be some smoke that settles in valleys and river corridors where eagles may occur. However, the amount of smoke present and the time period of exposure would make it unlikely that individual eagles' behavior, fitness, or reproductive success would be negatively impacted.

While smoke from prescribed fires may be present for short time periods in areas where bald eagles are nesting, foraging, or roosting, the potential for smoke to cause any change in individual eagles' behavior, fitness, or reproductive success; their prey; or the bald eagle population on MTNF is so remote as to be considered insignificant and discountable.

» ***Pesticide use***

Pesticides would only be used where their use is clearly demonstrated to be the most effective means to meet management objectives, and would comply with the product label (U.S. Forest Service 2005, page 2-18). The least impacting application method is to be used, and all equipment used in the application of pesticides must be washed and rinsed where runoff would not reach surface waters, wetlands or other special habitats (U.S. Forest Service 2005, page 2-18). There are also restrictions on the type and application of pesticides within riparian management zones, watercourse protection zones, and buffer zones of wetlands (U.S. Forest Service 2005, page 2-19). With these measures, the potential for pesticide use on MTNF to cause any impact to individual eagles, their prey, or the population is so remote as to be considered insignificant and discountable.

» ***Illegal ATV use - along rivers/streams/lakesides***

The popularity of riding all-terrain vehicles has grown dramatically in the last 20 years. While ATV use is permitted on Forest System roads under state law, illegal ATV use has also increased across the Forest over the past decade. ATV's traveling through streams and rivers and along riparian corridors may be sources of disturbance to nesting or roosting eagles. Whether or not there are permanent changes in eagle behavior or use of an area due to illegal ATV use probably depends on the amount, duration, and intensity of illegal ATV use in an area occupied by eagles. Forest Service law enforcement officers investigate and warn/ticket individuals engaging in illegal ATV use. There is nothing in the Revised Forest Plan that would be likely to change the patterns of illegal ATV use.

Potential Beneficial Effects

» ***Protection of RMZs & WPZs***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways, maintain or improve the vegetative communities within these zones, and maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to fish that eagles use as prey.

» ***Soil and water protection***

In addition to standards and guidelines which limit, modify, or direct management activities within the riparian corridors and upland waterways (see paragraph above), there are standards and guidelines designed to reduce, minimize or eliminate soil movement from Forest management activities on upland sites and in or near streams and rivers (U.S. Forest Service 2005, pages 2-5, 2-9 through 2-10, 2-14 through 2-17, 2-18, 2-19 through 2-20, 2-28 through 2-30, 2-31 through 2-34, 2-37 through 2-2-40). Implementation of these measures would reduce the potential for soil to move off-site and reach a water source, and therefore reduce the potential for any adverse effects to occur to the fish which bald eagles prey on.

» ***Public education***

Standards and guidelines direct the development and placement of educational signs at river/lake access points where the public may encounter bald eagles (U.S. Forest

Service 2005, page 2-6). These signs are intended to encourage people to stay away from occupied bald eagle sites to reduce or eliminate disturbance to nesting or roosting eagles. We expect that the majority of people would comply with the requested behavior and not approach eagles they may encounter while floating/boating on the waterways. There are always those who ignore any type of direction, so this measure would not totally eliminate the potential for human disturbance, but would reduce it somewhat.

- ***Designation of old growth***

Designation of old growth in the ¼ mile corridors adjacent to Table Rock Lake and Lake Wapapello would result in the development of large, old trees that may become suitable roost trees. Since these trees are located near water, as most documented nests are, they have better potential to be occupied in the future.

- ***Restoration of natural communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the natural communities that occur on National Forest lands. The major benefit of restoration of healthy natural communities would be less water runoff to surface streams and increased water filtering into the groundwater system as a result of increased herbaceous vegetation (Nelson 2005). This change in hydrologic functioning may help buffer the effects of periodic drought on adjacent waterways, and maintain more suitable fish habitat during dry summer months.

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including riparian corridors (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

- ***Transportation System Management***

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39).

No Effect

There is an active nest location on Fort Leonard Wood along the Big Piney River This nest successfully fledged two young in 2004. As of late March 2005, the adult pair was using the same nest. The nest tree is about 10-20 yards from the river bank, but is difficult to see, even if you know where it is. This stretch of river has less canoe use than other stretches of the Big Piney River due to poor access. Obviously, the amount of canoe traffic is not preventing the birds from successfully utilizing the nest. There is nothing in the Revised Forest Plan that would affect the future of this nest.

Boating on Table Rock Lake and Lake Wapapello, as well as other major lakes in the state, is extremely popular. Demand for this type of recreation, as well as most other

categories of recreation, is expected to increase in the next decade (U.S. Department of Agriculture, Forest Service 1999, page 13). Boating is regulated by state law, and MTNF has no jurisdiction other than on MTNF lands. Therefore, the implementation of the Revised Forest Plan would not have any direct effects as a result of boating disturbance and any potential negative effects from boating on these lakes would be covered under cumulative effects rather than direct effects.

Questionable or Unknown Effects

The Missouri Department of Natural Resources listed three MTNF waters as impaired waters in 2003 for atmospheric deposition of mercury; the Gasconade River, the Eleven Point River, and Noblett Lake on the Willow Springs Unit (U.S. Forest Service 2005, page 3-189). These same areas were also listed in 2004 (L. Wilson, hydrologist, Mark Twain National Forest, pers. comm. 4/4/05). All three of these areas are known eagle wintering areas, and nesting activity is known from the Eleven Point River. High levels of mercury (obtained from eating tainted fish) may cause a variety of neurological problems affecting flight and other motor skills, as well as reduce the hatching rate of eggs (Federal Register Vol. 60, No. 133, 7/12/95). Mercury impacts to bald eagles are currently being studied by the Southeaster Region of the U.S. Fish and Wildlife Service (Federal Register Vol. 60, No. 133, 7/12/95).

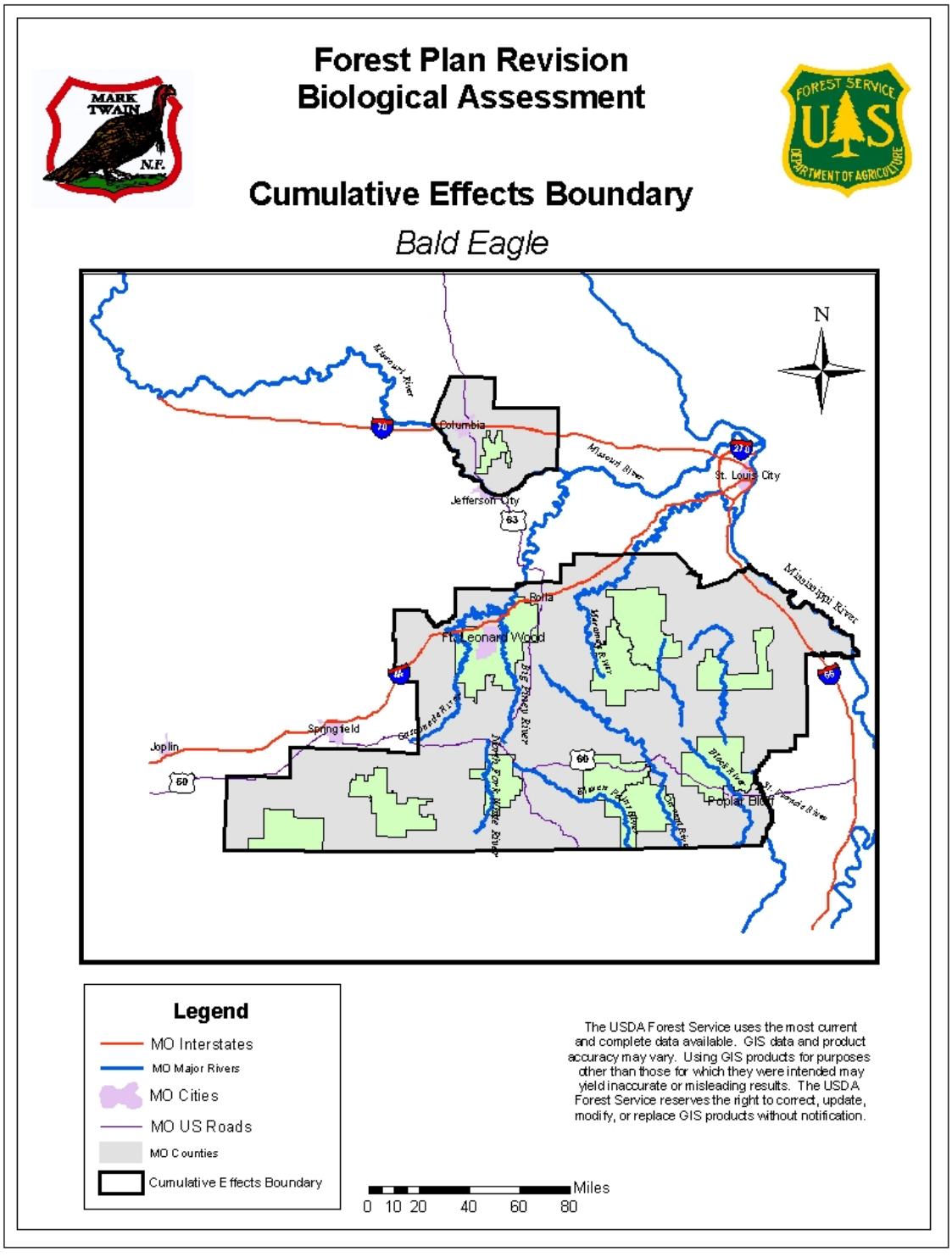
While potential mercury effects on eagles are not completely understood, the human-caused sources of atmospheric mercury include industrial processes such as electroplating, coal combustion, and paper manufacture (Missouri Department of Natural Resources 2005). These sources do not occur on MTNF lands. Since the atmospheric deposition is naturally occurring, or is exacerbated by activities occurring in other parts of the country or world, there is no management activity that could be taken by MTNF to reduce this occurrence or minimize its possible impact on bald eagles. The implementation of the Revised Forest Plan would not add to nor reduce the amount or area of deposition occurring.

Cumulative Effects

Boundaries:

The spatial boundary for cumulative effects analysis for bald eagle is the 29 county area in which all National Forest lands are located. The majority of both wintering and nesting bald eagles occur in Missouri outside the proclamation boundary of the Forest, and most are also outside the 29 counties in which National Forest lands are found. These birds would not be affected by activities on National Forest lands Potential effects from activities on National Forest lands would be human disturbance which would only affect eagles in the specific vicinity of the disturbance; cutting of large trees that could be potential roost trees, which would only affect individual eagles coming to that certain location; and increased habitat availability through protection of riparian corridors and occupied sites which may attract eagles from outside the proclamation boundary to reside on MTNF.

Figure BE-3: Cumulative Effects Boundary for Bald Eagle



Smoke from prescribed fires may travel outside the proclamation boundary but is unlikely to travel further than the 29 county area. In the rare instances where that may occur, the density, height, and area of smoke would be so dispersed as to be practically unmeasurable. Potential sediment added to waterways from activities on MTNF may

also travel outside the proclamation boundary of the Forest, but is unlikely to travel beyond the 29 county area due to the amount and duration of National Forest management activities which may create soil movement, and the distance soil would have to travel to go beyond the 29 county area.

The temporal boundary for cumulative effects analysis for bald eagle is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected since that is the amount of time the US Fish and Wildlife Service must monitor a species' population after being removed from the list of Endangered and Threatened wildlife, and is also the amount of time that effects from human disturbance could reasonably be expected to be evident.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, past and present actions on MTNF and other ownerships have resulted in Missouri harboring the largest wintering population of eagles in the lower 48 states, and having increased the number of nesting eagles so dramatically in the past 20 years that the state no longer conducts surveys specifically to identify new nests (Missouri Department of Conservation, no date).

Reasonably Forseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches

- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the proclamation boundary of MTNF. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can reasonably be predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section 7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Several highway projects are proposed within the 29 county area for the foreseeable future. Missouri Department of Transportation website shows projects planned over the next decade (http://www.modot.state.mo.us/plansandprojects/construction_program/stip5year.htm). Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

Boating is regulated by state laws. There are no state boating laws limiting the distance of boaters from eagle nests or roosting locations, but because bald eagles are listed by the state as Endangered, they are protected from “taking”, and the ACOE posts areas closed for protection of occupied nests. Human curiosity is such that most people want to get as close as possible to interesting sights like that of a bald eagle perched or

nesting. It is possible that individual eagles or pairs of eagles and their young may be disturbed by boaters attempting to get close to them, or simply by boaters who are uninterested by operating in the vicinity of a nest or roost location. No management activity on MTNF could reduce or contribute to this kind of activity or disturbance.

There are literally thousands of private landowners who own property within the 29 counties that contain National Forest lands. However, past trends on private properties within these counties are some indication of reasonably foreseeable trends for the future.

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on bald eagles or their habitat include:

- The construction and maintenance of powerlines which may result in electrocution in power lines not designed to reduce that threat to raptors;
- Construction and maintenance of roadways on which road-killed animals near the highway may result in car collisions with eagles feeding on carrion;
- Human disturbance of nests, possibly resulting in nest failure or abandonment;
- Human disturbance of wintering eagles.

These are the types of activities identified in the Federal Register as concerns to individuals, although none, either individually or collectively, are of sufficient magnitude to place the species at risk of extinction (Federal Register Vo. 64, No. 128, 7/6/99).

In addition, continued development for residential, commercial and industrial purposes near the large lakes and Missouri/Mississippi Rivers may affect the quantity and quality of habitat in those areas. Private landowners also conduct burns on their land and wildfires occur on both National Forest and private ownerships within the proclamation boundary.

Effects Analysis:

» ***Habitat Loss or Human Disturbance through Population Growth***

Of the 29 counties which have some land within MTNF proclamation boundary, all have experienced population growth ranging from 7% to 38% from the 1990 to 2000 census, with the exception of two counties that lost less than 1% of their population growth over that 10 year period (U.S. Forest Service 2005b, page 3-277). The fastest growing counties are near Branson (Table Rock Lake area) and Columbia, Missouri (Lake of the Ozarks/Truman Lake area). Average population growth for the 29 counties over the 10 year period was about 19%. These trends are likely to continue into the reasonably foreseeable future.

It is reasonably certain that some land development as a result of population growth will destroy, damage, or alter riparian corridors to some degree, possibly affecting individual eagles. It is also reasonably certain that boaters and canoers will continue to use the major rivers and lakes that eagles also use, with some potential for human disturbance of individual eagles. Whether or not these activities would result in decreased nesting success or productivity of individual eagle or specific populations of eagles is unknown.

In any case, neither nesting nor wintering habitat appears to be limiting the growth of bald eagle populations (Federal Register Vol. 64, No. 128, 7/6/99).

» ***Electrocution in Powerlines***

There are approximately 4300 acres (0.3% MTNF) of powerlines on National Forest lands under special use permit. These range from 40 Hz to 345 Hz and are in corridors ranging from 20 feet to 100 feet wide. The Forest Service has no information on whether or not these lines were constructed to be raptor friendly. The Forest Service has no documentation of any eagles killed by contact with powerlines on National Forest lands in the past 20 years. There is nothing in the Revised Forest Plan that requires powerlines be designed to be raptor friendly.

There are also hundreds of miles of powerlines of all sizes on private lands within the 29 county area. If these lines were constructed using federal monies, US Fish and Wildlife Service would have recommended raptor-friendly designs be used. However, there is no requirement that this occur, and it is unknown how many powerlines within the 29 county area have been constructed with a raptor-friendly design. Because there is no evidence that eagles have been killed in powerlines on MTNF lands, there would be no additive impact of implementing the Revised Forest Plan.

» ***Eagle/Vehicle Collisions***

The majority of National Forest System roads are dead-end, local roads, suited for high clearance vehicles and have an aggregate or native surface (U.S. Forest Service 2005(a), page 3-239). There have been no reported instances of bald eagle deaths on National Forest System roads that the Forest Service is aware of. Within the proclamation boundary of MTNF, only 51% of the roads are National Forest System roads. MTNF roads comprise about 33% of total miles within the boundary. MTNF roads are among the least likely to have eagle/vehicle collisions because the roads are generally low-speed and low-volume. The remaining roads include:

Table BE-1: Roads within MTNF boundary

Route type	Miles w/in MTNF boundary	% total miles w/in MTNF boundary	Miles on NFS lands	% total miles on NFS lands
Interstate	31	<1%	7	<1%
US Highway	155	2%	28	1%
Missouri Dept of Transportation	1430	20%	628	14%
Missouri Dept of Conservation	15	<1%	3	<1%
County	3206	44%	1559	34%
Town or City	60	1%	0	0%

The highest chance of eagle/vehicle collisions would be on larger rights-of-way, with higher speed vehicles colliding with feeding eagles on the road or roadside. These would primarily be the Interstate and US Highway miles, which are just over 1% of the roads on National Forest lands and just over 2% of all roads within the proclamation boundary. There have been no reported deaths of bald eagles due to vehicle collisions on any roads within the MTNF proclamation boundary that the Forest Service is aware of (Dave Clark, Law Enforcement Officer, Mark Twain National Forest, pers. comm.. 4/8/05 Ryan Houf, Missouri Department of Conservation Agent, pers. comm.. 4/8/05, Theresa Davidson, US Fish and Wildlife Service, pers. comm.. 4/8/05).

» ***Smoke impacts from prescribed or wildfires***

In Missouri, about 58,600 are prescribed burned annually, which does not include private ownerships where burn acres are not reported to an agency. The MTNF contributes about 17% of this total. Average annual state-wide wildfire acres for the agencies which suppress fires in Missouri are about 59,200 (U.S. Forest Service 2005(a), pages 3-167 and 3-172). About 9% of these are on MTNF lands. The actual amount burned in any given year is a function of weather and fuel conditions. Cool, wet years have fewer acres burned, and warm, dry years have more acres burned.

Emission of fine particulate matter (PM 2.5) is expected to increase about 80% over current levels from prescribed fire on MTNF under the Revised Forest plan (U.S. Forest Service 2005(a), page 3-175). PM 2.5 is the greatest danger to human health and presumably also to eagles, and fine particulates make up more than 70% of the matter produced by both prescribed and wildfires (U.S. Forest Service 2005(a), page 3-175).

Assuming all other agencies do not change their annual average prescribed burn acres, the MTNF increase in PM 2.5 (from about 450 tons to about 2325 tons annually) would increase the MTNF's share of total PM 2.5 emissions from about 21% annually to about 59% annually. However, each prescribed burn done on MTNF must have a smoke management plan prepared prior to ignition, where site-specific mitigations are developed to minimize the potential impact of smoke on sensitive receptors (U.S. Forest Service 2005(a), pages 3-176 and 3-177). It is estimated that potential PM 2.5 emissions can be reduced by at least 31%-83% depending on the type of mitigations used (U.S. Forest Service 2005(a), page 3-177). This would reduce the potential for negative impacts from smoke.

As stated in the indirect effects above, the possibility of smoke from MTNF prescribed burns affecting eagles is considered so remote as to be insignificant and discountable. Even considering an increase in the acres of prescribed burning on MTNF under the Revised Forest Plan, the incremental effects would be that a few additional eagle sites may be temporarily affected by minor amounts of smoke. These additional impacts would not be expected to adversely impact either individual eagle survival or reproductive success or that of the population of eagles in southern Missouri.

» ***Other Effects***

On MTNF, there would be no conversion of riparian areas or bottomland forest to other land uses and therefore, no habitat loss or additive impacts. Major rivers are managed to protect the unique qualities of those rivers with limited vegetation management allowed. Old growth would be designated in the ¼ mile corridor adjacent to Lake Wapapello and Table Rock Lakes, reducing the potential for disturbance to eagles that may use these areas, as well as providing large trees as potential roost and/or nest trees. Potential roost and/or nest trees would also be available on other MTNF lands within 2 miles of major waterways. Occupied nest areas on MTNF would be protected from disturbance. Water quality would be protected through application of soil and water standards and guidelines.

Conclusions:

Of the 112 documented eagle nest sites in Missouri, only 5 (4%) are within the MTNF proclamation boundary, and only one (0.9%) of those is actually on National Forest lands. Ninety of the 112 (81%) are outside MTNF watersheds. Forty-five sites (40%)

are on lands owned by a state, federal or local agency, and 66 (59%) are on private ownerships.

The majority of wintering eagles in Missouri stay near the big rivers (Mississippi and Missouri), near Truman Lake and Lake of the Ozarks, or in the National Wildlife Refuges where there are large populations of waterfowl. Only a small percentage of Missouri's wintering eagles are on waterways with significant MTNF ownership.

Since MTNF would continue to provide suitable habitat along the major rivers and lakes, protect occupied nest sites from disturbance, and protect water quality, the effects of implementing Alternative 3 of the Revised Forest Plan, added to effects occurring from activities on other ownerships would be primarily beneficial. The possibility of potential negative effects to individual eagles occurring from activities implementing the Forest Plan are so remote as to be considered insignificant and discountable and would not individually or cumulatively result in a decrease in the recovery of bald eagles in Missouri or in the Northern States Region.

» **Additional measures needed for species conservation and recovery**

There are no additional measures that the Forest Service could take to significantly contribute to continued species' recovery.

» **Effects of additional measures**

Since there are no additional measures needed, there would be no effects.

» **Determination – May Affect, Not Likely to Adversely Affect**

Rationale: Suitable habitat would be available on MTNF, water quality would be protected, and occupied nest sites would be protected from disturbance. Eagles and recreationists have been sharing the rivers and lakes of MTNF and Missouri for decades; and in that time, eagle numbers have steadily increased. The few nesting attempts along MTNF waterways or nearby also indicate that bald eagles can tolerate the type of disturbance caused by canoers and boaters. The current Forest Plan has been in place for 14 years, and eagle numbers along MTNF waterways have tended to be steady or increasing, indicating that water quality and prey availability have not been negatively affected, and that suitable habitat continues to be available.

Gray bat (Myotis grisescens)

» **Life History summary**

Gray bats mate in the fall and the females store sperm until spring when fertilization occurs. One young is born in late May or early June, and young are volant in about 20-35 days. Larger colonies and those closer to foraging areas tend to have higher survival and faster growth rates than smaller colonies or those further from foraging areas (Missouri Department of Conservation 1998, page 34). Annual survival rates for gray bats are about 60%, and they may live up to 20 years or more.

Gray bats forage at night primarily on aquatic insects, although terrestrial insects are eaten, with diet apparently reflecting the availability of prey at the time and habitat occupied by the bats (Missouri Department of Conservation 1998, page 31). Individuals forage over water or along shorelines and normally forage in loose groups. Individuals will become territorial if insect numbers are low (NatureServe 2005). Gray bat summer colonies occupy a home range that may include several roosting caves and up to 45 miles of river or lakeshore (NatureServe 2005).

While most literature states that gray bats will fly up to 12 miles to forage, data from radio-telemetry on MTNF shows that some individuals may travel much further than that in one night (up to 45 miles)(Amelon, pers. comm. 4/12/05). Forested corridors between summer caves and foraging areas provide important protection from predators for both adults and young moving from cave to foraging areas.

Gray bats roost nearly exclusively in caves throughout the year. Winter caves are primarily deep vertical caves with domed rooms and temperatures ranging from 6 to 11 degrees C (Tuttle 1979 as cited in NatureServe 2005). Summer colonies use caves that trap warm air with domed ceilings and temperatures ranging from 14 to 24 C (NatureServe 2005). Summer caves are usually near a stream or river that is the foraging area. Maternity caves often have a stream flowing through them and are separate from the caves used in summer by males (NatureServe 2005). Juveniles and adult males segregate into nomadic summer colonies that tend to roost in different caves than adult females or in different sections of female caves.

There are a few reports of gray bats using non-cave roost sites, such as storm sewers, mines, and buildings (several authors as cited in NatureServe 2005).

Females enter hibernation in fall after mating, followed by males and juveniles several weeks later (most females are hibernating by early October, most others are in hibernation by early November). Adults emerge from hibernation late March to mid-May (Tuttle 1976 as cited in NatureServe 2005).

» **Population status range-wide, in Missouri, and on MTNF**

Rangewide
Gray bat populations throughout the species' range have increased since the 1982 estimate of 1,657,900 to about 2,678,137 in 2002 (Amy Salveter, U.S. Fish and Wildlife Service, pers. comm.. 3/1/05). In fact, the gray bat has been proposed for reclassification to threatened as the current estimated population is up about 62% in the past 20 years. In addition, gray bat populations at 73% of all caves and 71% of Priority 1 maternity caves are stable or increasing (Blake Sasse, AR Game & Fish as quoted by Amy Salveter, US Fish and Wildlife Service, pers. comm. 3/1/05). Other information indicates that the global population of gray bats has exceeded 3 million (Amy Salveter, U.S. Fish and Wildlife Service, pers. comm.. 3/1/05).

Missouri
Over 200 caves in Missouri are known to be used or have been used by gray bats (Steve Samoray, pers. comm. 4/27/05). Thirty-three of these are considered abandoned; 34 are hibernacula; 51 are maternity; 47 are bachelor/transient; and the type use of the remaining caves has not been conclusively established. In Missouri, gray bats are restricted to areas with suitable caves (Missouri Department of Conservation 1988). Gray bats show a loose affiliation into 3 subpopulations in Missouri (Central, East, and Southwest), based geographically and on hibernation caves. In 1988, all three subpopulations appeared to be relatively stable ((Missouri Department of Conservation 1988, page 30).

Missouri has an estimated maximum past population of around 1,250,000 (U.S. Fish and Wildlife Service 1982). In the mid-1980's hibernating population in Missouri approached ½ million gray bats (Missouri Department of Conservation 1988, page 26). Due to difficulties of surveying hibernating bats without excessive disturbance, the Recovery Team recommended discontinuing annual censuses in hibernacula (Missouri Department of Conservation 1988, page 26). During the same time period, the maternity population in Missouri was estimated to be in the range of 300,000 to 400,000 gray bats.

Mark Twain National Forest
MTNF maternity caves may harbor around 53,300 bats annually. We do not have a count for each individual maternity cave in a single year, so it is difficult to estimate total population using survey data from different years. There are an estimated 27,500 additional gray bats which use transient or bachelor caves in the summer. This would put the total MTNF population at about 80,800 in the summer. This is about 3% of the rangewide population and about 20% of Missouri's estimated population.

Caves along the Eleven Point River and in the Salem/Potosi units are included in the East subpopulation. Caves in the Rolla/Houston/Cedar Creek units are included in the Central subpopulation. Caves in the Ava/Cassville/Willow Springs units are included in the Southwest subpopulations (Missouri Department of Conservation 1998, pages 12-14).

Knowledge Gaps
We do not know the type or extent of movements between subpopulations. However, since all subpopulations appear to be stable, this information is not needed to make a reasoned choice between alternatives for the Revised Forest Plan.

» **Causes of past and/or current declines and Limiting factors**

There is no critical habitat designated for the gray bat.

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or range:*** Since the gray bat requires caves of specific temperature year round, only a small percentage of known caves are suitable habitat for this species. This, combined with the colonial roosting behavior, makes gray bat populations very vulnerable to localized disturbances. Flooding, vandalism, and cave commercialization have all resulted in destruction or decrease in gray bat populations in individual caves (Federal Register Vol. 40, No. 77, 4/21/75).

Deforestation of areas near caves and riparian foraging habitat can have negative impacts on gray bats and reduce the amount of available habitat. Forested areas help protect the bats from predators as they are traveling to and from caves and while they are foraging. Forested areas around cave entrances also maintain the cave entrance microclimate and provide resting places for young bats just learning to fly (U.S. Forest Service 1982).

The impoundment of waterways and permanent flooding of occupied gray bat caves is suspected to be a cause of past gray bat declines (U.S. Forest Service 1982). Although reservoirs were originally thought to increase the amount of foraging area for gray bats, but that hypothesis has not been supported by further study (U.S. Fish and Wildlife Service 1982). The presence of an increasing number of recreationists at these reservoirs also makes human disturbance of any remaining gray bat caves more likely.

A possible cause of decline may be decreased availability of aquatic insects caused by siltation or pollution of waterways used by foraging gray bats. Gray bats forage primarily over water and eat a variety of insects, among which are a large number of mayflies, stoneflies and caddisflies (U.S. Fish and Wildlife Service 1982). All three of these insect groups are thought to be very susceptible to aquatic pollution. There is little information on the potential effects of siltation, although studies suggest some siltation may benefit nymphs of two mayfly species, while others suggest that some species cannot survive on silt substrates (U.S. Fish and Wildlife Service 1982).

Cave-ins and natural flooding of caves have also caused gray bat mortality (NatureServe 2005).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes.*** A major factor in the determination to list gray bat was the elimination of colonies through cave commercialization or repeated disturbance of occupied caves by explorers, scientists, or vandals (Federal Register Vol. 40, No. 77, 4/21/75). Listing of the gray bat was made primarily because available evidence indicated that entire breeding populations could be lost when numbers fell below a critical level and the species was vulnerable to disturbance due to its colonial nature (Federal Register Vo. 40, No. 77, 4/21/75).

Gray bats congregate in larger numbers and fewer caves than any other species in North America (U.S. Fish and Wildlife Service 1982). This makes them extremely vulnerable to disturbance in that even one disturbance at a major roost could have

negative impacts on the entire rangewide population. Human disturbance of caves is recognized as a primary cause of decline.

Listing Factor C. ***Disease or predation*** were not considered factors in causing decline of this species in 1975 or at the time of listing in 1978 (Federal Register Vo. 40, No. 77, 4/21/75).

Listing Factor D. ***The inadequacy of existing regulatory mechanisms*** was considered not applicable to gray bat (Federal Register Vo. 40, No. 77, 4/21/75).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Pesticides have been implicated as a possible causal factor in the decline of insect-eating bats in North America (various authors as cited in U.S. Fish and Wildlife Service 1982). A 1978 study documented mortality in a gray bat population as a result of routine insecticide use (Clark et al., 1978 as cited in U.S. Fish and Wildlife Service 1982). Gray bat deaths have been documented as a result of heptachlor residues caused when local farmers changed from aldrin to heptachlor as stocks of aldrin became depleted (Clark et al. 1980 as cited in NatureServe 2005). These deaths are caused when the insecticide is stored in fat and then mobilized during the stress of flight initiation which can cause fatal concentrations of the chemical in brain tissues (Clark et al. 1978 as cited in NatureServe 2005).

» **Causes of past and/or current recovery**

The prime objective of the Gray Bat Recovery Plan is to move the gray bat from endangered to threatened status (U.S. Fish and Wildlife Service 1982, page 14-15).

Gray bats are currently classified as G3, N3, which means that they are at moderate risk of extinction (NatureServe 2005) due to restricted range (gray bats have very specific requirements for cave habitat) or other factors (vulnerability to disturbance due to colonial roosting behavior).

There is general consensus that the primary reason for the increase in gray bat population over the past 20 years has been the protection of important caves from human disturbance, and the restoration of altered cave entrances (U.S. Fish and Wildlife Service 1982). Several major gray bat caves have been purchased by state or federal agencies and appropriate protective structures installed.

» **Occurrence on MTNF, existing and potential habitat**

Critical Habitat

There is no designated critical habitat for gray bat on MTNF.

The Gray Bat Recovery Plan classifies caves of biological significance as Primary or secondary hibernating, maternity or bachelor caves (U.S. Fish and Wildlife Service 1982). There are no Primary hibernating caves (> 25,000 bats) known to be located on MTNF. There are two caves which may qualify as Primary bachelor caves (> 10,000 bats) located on MTNF lands. These are Bear Cave on ACW and possibly Bluehole

Cave on EP. There are three caves that qualify as a Primary maternity caves (>10,000) based on past or present populations. Bat cave in Ozark County qualifies based on recent population, and Mayfield and Cooks caves qualify based on past population numbers.

Five caves qualify as secondary maternity caves (> 1000 but < 10,000), and one possibly as a secondary hibernating cave (> 2000 but < 25,000).

Cave habitat on MTNF

There are 18 caves on MTNF which are known to harbor gray bats during part or all of the year (Missouri Heritage Database 2004). Six of these are known to be used as maternity caves, one is a possible hibernacula and maternity cave, 6 are used as transient or bachelor caves, and type use in 4 is unknown. Some caves may be used for multiple purposes. Two other caves are considered abandoned gray bat caves.

There are over 500 cave entrances and several abandoned mine entrances located on MTNF lands. None of these have been evaluated to determine if they contain the temperature and humidity conditions typically used by gray bats. However, the Cave Research Foundation, in partnership with MTNF, has conducted biological inventories of MTNF caves on over 100 caves since 1991. During these surveys several new gray bat caves were discovered. It is possible that additional caves may be colonized by gray bats, especially if the population continues to increase.

Gray bat cluster
MDC Photo

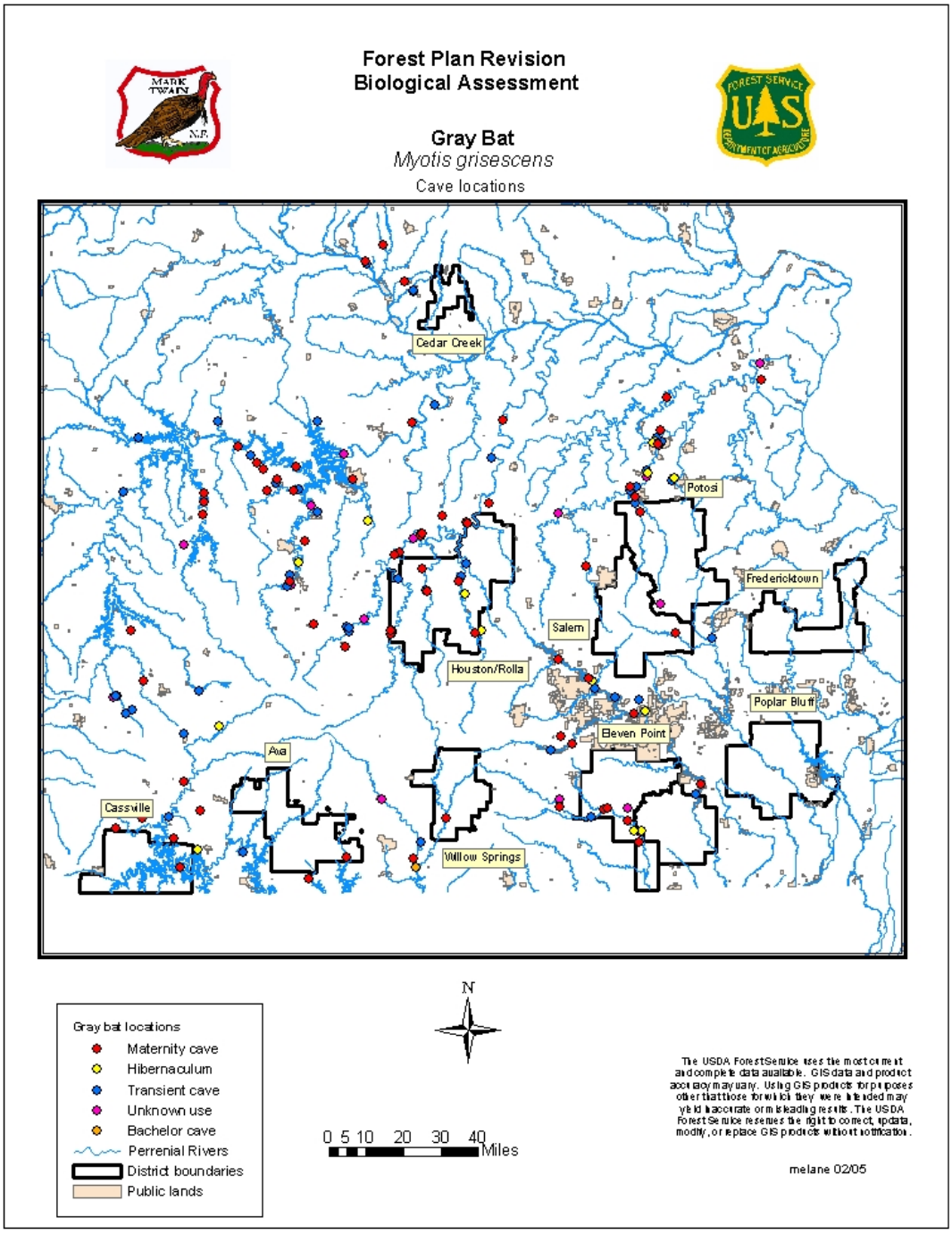
Bat Cave – Ozark County – gate inspection
USFS Photo

Table GB-1 - Gray Bat Caves on Mark Twain National Forest

Cave Name	County	District	Type	Recovery Plan Priority	Historic Population	Current Population	Physical Protection
Peter Hollow	Christian	ACW	T	NL	Unknown	Abandoned	
Bat	Ozark	ACW	M	2	Unknown	19,200 (1989)	Gate-closed year round
Bear	Ozark	ACW	T	NL	Unknown	27,200 (1994)	
Bat	Oregon	EP	M	2	10,000	9800 (2001)	Gate-closed summer
Dead Man	Oregon	EP	M	NL	5300	8150 (2001)	
Thrasher Ford	Oregon	EP	M	NL	8100	6550 (2001)	
Kelly Hollow	Oregon	EP	U	NL	Unknown	1 (1936)	
Bluehole	Oregon	EP	U M?/H?	NL	Unknown	10,000+ (1997)	
Turner Spring	Oregon	EP	M	NL	Unknown	4800 (2001)	Gate-closed year round
Bliss Camp	Oregon	EP	U	NL	Unknown		
River Level	Oregon	EP	T	NL	Unknown		
Boze Mill	Oregon	EP	U	NL	Unknown	5000+ (1997)	
White's Creek	Oregon	EP	T	NL	Unknown	100 (2000)	Gate - closed winter
			H?		Unknown	23 (2003)	
Peninsula	Pulaski	HRCC	U	NL	Unknown	500 (1997)	
Mayfield	Laclede	HRCC	M	2	45,000	0 (1994) 26(2005)	
Davis Cave #2		HRCC	T	4	Unknown	50 (1998)	
Marsh Creek Cave #2	Madison	PF	T	NL	5500	200 (1980)	
Twenty-three degree	Crawford	PF	T	2	7000	0 (1997)	
Cave Hollow		PF	H?	NL	Unknown	11 (2003)	Gate – closed winter
Cooks	Reynolds	Sal	M	2	70,000	4800 (1991)	Gate - closed summer

NL = Not Listed in 1982 Recovery Plan

Figure GB-1: Gray bat locations in and around MTNF



Summer habitat on MTNF

In addition to using caves in the summer, gray bats leave the cave to forage for insects. Foraging is normally done over water, and on MTNF that means rivers and streams. Gray bats are known to forage over the Eleven Point, North Fork, Gasconade, Big Piney,

St. Francois, and West Fork of the Black Rivers, as well as Huzzah, Strother and Roubidoux Creeks and several tributaries of these waterways.

Table GB-2 - Foraging areas associated with known gray bat caves on MTNF

Cave Name	Probable foraging location	Management	Travel corridor from cave to foraging area	Management Prescription Current Plan	Management Prescription Revised Plan
Bat (Ozark)	North Fork River	Non-motorized, limited veg mgmt	Forested – Cave adjacent to river	6.1	6.1
Bear	North Fork River	Non-motorized, limited veg mgmt	On bluff adjacent to river	6.1	6.1
Bat (Oregon)	11 Pt River	Behind closed private gate: OG designated	Forested – OG designated along dry tributary	3.4	2.1
Dead Man	11 Pt River	w/in 11 Pt River Zone	Forested – Cave adjacent to river	8.1	8.1
Thrasher Ford	11 Pt River	w/in 11 Pt River Zone	Forested hillside adjacent to river	8.1	8.1
Kelly Hollow	11 Pt River	General forest 2.5 miles from 11 Pt River	Forested – OG designated	4.1	1.1
Bluehole	11 Pt River	General forest 1/5 miles from 11 Pt River; Old growth designated	Forested – OG designated Panther Springs Hollow to river	3.4	2.1
Turner Spring	11 Pt River	w/in 11 Pt River Zone	Forested – spring branch to river	8.1	8.1
Bliss Camp	11 Pt River	w/in 11 Pt River Zone	Forested – Cave adjacent to river	8.1	8.1
River Level	11 Pt River	w/in 11 Pt River Zone	Forested – Cave adjacent to river	8.1	8.1
Boze Mill	11 Pt River	w/in 11 Pt River Zone	Forested – Cave adjacent to river	8.1	8.1
White's Creek	11 Pt River	Irish Wilderness	Forested - Wilderness	5.1	5.1
Peninsula	Big Piney River	Access through FLW	Forested – in river zone	6.3	6.3
Mayfield	Gasconade River	w/in river zone	Forested – in river zone	6.3	8.1
Davis Cave #2	Roubidoux Creek	Behind locked FLW gate – limited public access	Forested – OG planned	3.5	2.1
Marsh Creek Cave #2	St. Francois River	Rock Pile Wilderness	Forested - Wilderness	5.1	5.1
Twenty-three degree	Huzzah Creek	Within river zone	Forested – OG designated	6.3	6.3
Cave Hollow	Strother Creek	General forest tributary of Strother Creek	Forested – OG designated	3.5	2.1
Cooks	West Fork of the Black River	Sutton Bluff ATV area	Forested – OG designated	6.2	6.2

Knowledge Gaps

We do not know exactly how far from an occupied cave gray bats will travel to forage. We do not know if gray bats regularly travel overland between waterways. We have some evidence from radio-telemetry work on MTNF that gray bats will travel overland, but do not know if it is a regular or rare occurrence.

» **Surveys for gray bat**

Since gray bats live in caves year-round, population surveys have been conducted by surveying both winter and summer populations. From 1954 through 1962, Myers banded over 23,500 gray bats (Myers 1964) in the Missouri Ozarks to study their movements, behaviors, and habitat use.

In 1978-1982, Gene and Treva Gardner were contracted to survey caves on MTNF. Their work resulted in finding eleven caves within the proclamation boundary of MTNF "which are important to Myotis grisescens" (Gardner and Gardner 1982). None of those caves were on National Forest lands at the time of the survey, but three of those caves have since been acquired and are now on National Forest System lands.

Both winter and summer population surveys in MTNF caves are done in cooperation with the Missouri Department of Conservation.

Summer surveys on MTNF are conducted using a combination of mist-netting and acoustic methods from mid-May through late July. Since 1997, MDC (or their contractors) and North Central Research Station personnel have conducted the summer surveys on MTNF. These surveys give us some idea of foraging areas for gray bats.

Mist net and Anabat surveys were conducted for bats on the Mark Twain National Forest between 1997 and 2004. A summary of survey data collected during this period indicates that about 226 gray bats had been captured on National Forest lands. Gray bats were primarily netted over streams and rivers, or at cave entrances.

In two locations, gray bats were by far the most bats caught (56% and 93% of captures). In about 1/3 of the locations where gray bats were captured, gray bats were the third most caught species. In another ¼ of the locations where gray bats were captured, they were the fourth most caught species. These surveys represent over 400 mist net sites and over 2,700 hours of mist netting, plus over 400 Anabat sites and over 4,400 hours of Anabat detection.

» **Consistency of Revised Forest Plan with applicable Recovery Plan Actions**

Since the Recovery Plan was approved in 1982, MTNF has taken many actions to comply with the Recovery Plan, including several provisions to protect gray bat habitat that were incorporated into the 1986 Forest Plan (U.S. Forest Service 1986).

1.1 Public Education; 1.1.2 Interpretive Signs At Caves; and 1.1.3 Ranger-Naturalist Talks: MTNF has placed interpretive signs at several gray bat caves over the past 20 years and biologists have given dozens of talks to schools, civic groups, and

other organizations. There is nothing in the Revised Forest Plan that would prevent us from continuing these activities.

1.2 Prevent Unauthorized Entry; 1.2.1 Erect Warning Signs; 1.2.2 Gate or Fence Cave; 1.2.2.1 Gain control of Roost Site. MTNF has gated five gray bat caves. Several others have been evaluated for gates. Warning signs have been erected in conjunction with gates and at caves without protective structures. At least three gray bat caves have been acquired by MTNF since the 1982 Recovery Plan was approved. The Revised Forest Plan contains standards and guidelines requiring the maintenance of existing gates at occupied gray bat caves (U.S. Forest Service 2005, page 2-10). Priorities for land acquisition have not changed in the Revised Forest Plan. There is also a standard and guideline prohibiting entry to occupied gray bat caves except for regular monitoring or legitimate scientific purposes (U.S. Forest Service 2005, page 2-11).

1.2.2.1.1. Roost Site Evaluation; 1.2.2.1.1.1.1 Identify All Gray Bat Roost Sites; MTNF contracted a survey of all MTNF caves in 1978-1982. Since 1991, MTNF has funded a Challenge Cost Share agreement with Cave Research Foundation to survey and map MTNF caves. There is nothing in the Revised Forest Plan that would change this working relationship. The Revised Forest Plan also contains a standard and guideline requiring all structures placed at cave entrances be designed to permit bats to pass and to maintain airflow. In addition, abandoned mines must be evaluated for bat use prior to permanent closure (U.S. Forest Service 2005, page 2-10).

1.2.3 Monitor Roost Sites; 1.2.4. Monitor Caves by Law Enforcement Agencies; MTNF cooperates with MDC in monitoring populations at maternity caves on MTNF. Our biologists regularly inspect cave gates when opening and closing them each year, and make other unscheduled visits to monitor signs of human visitation. MTNF law enforcement officers also make unscheduled, random visits to caves. There is nothing in the Revised Forest Plan that would prevent us from continuing these actions. In Chapter 4 – Monitoring and Evaluation there is a monitoring item to determine if specialized habitats, including caves, are being protected, maintained, and restored (U.S. Forest Service 2005, page 4-11).

1.3 Prevent Adverse Modification to Roost Sites; 1.3.1 Prevent and Rehabilitate Adverse Modification to the Subsurface, Including Entrances; 1.3.2 Prevent and Rehabilitate Adverse Modifications to the Surface Watersheds Surrounding Important Roost Sites: The 1986 Forest Plan contained standards and guidelines requiring old growth around occupied gray bat cave entrances and designation of a travel corridor between occupied gray bat caves and the adjacent foraging area(s) (U.S. Forest Service 1986). The Revised Forest Plan includes standards and guidelines to designate at least 20 acres of old growth around an occupied gray bat cave entrance and including the area above cave passages, the foraging corridor, ridgetops and sideslopes around the cave. In this area vegetation management is only allowed to reach desired conditions (U.S. Forest Service 2005, page 2-11). An additional 130 acres of mature forest/woodland must be maintained around each occupied gray bat cave and a mature forested corridor of at least 100 feet wide with at least 70% canopy closure must be maintained or restored between an occupied gray bat cave and foraging areas. Vegetation management in this corridor may only occur to restore, enhance, or maintain mature forest or woodland natural communities (U.S. Forest Service 2005, page 2-11). Other Forest management activities are prohibited or limited within 100 feet of a cave entrance including construction of firelines, timber harvest, pesticide use, temporary road construction, road reconstruction and maintenance.

1.3.3. Make Locations of Known Roost Sites Available to Appropriate Fish and Wildlife Service Offices and State Wildlife Agencies: MTNF cooperates with both the

Columbia Ecological Services Field Office of the U.S. Fish and Wildlife Service and with the Missouri Department of Conservation concerning known gray bat locations. The Revised Forest Plan requires that the Forest Service carry out responsibilities for conservation of endangered and threatened species identified through interagency consultation with the U.S. Fish and Wildlife Service (U.S. Forest Service 2005, page 2-5).

2. Maintain, Protect, and Restore Foraging Habitat; 2.2 Prevent Adverse Modification to Foraging Areas and Travel Corridors; 2.2.2 Preserve Water Quality; and 2.2.3 Preserve Forest Cover: See response to 1.3 above. Also, the Revised Forest Plan contains standards and guidelines for soil productivity and water management which are designed to minimize erosion and compaction, and restore soil productivity (U.S. Forest Service 2005, page2-5). The Revised Forest Plan also defines riparian management zones (RMZs) and watercourse protection zones (WPZs) within which management activities are restricted or modified to reduce the potential for soil movement and protect water quality and integrity of watersheds (U.S. Forest Service 2005, pages1-2 and 1-3, 2-2 through 2-5). There are also standards and guidelines prohibiting timber harvest in the RMZ along self-sustaining trout streams, and calling for maintaining canopy closure of 75-100% on all trout streams less than 25 feet wide, and 50-100% on all permanent streams less than 25 feet wide, where possible (U.S. Forest Service 2005, page 2-10).

2.2.4 Monitor Habitat: Chapter 4 of the Revised Forest Plan contains a monitoring item to determine to what extent Forest management is contributing to the conservation of threatened and endangered species and moving toward objectives for their habitat conditions (U.S. Forest Service 2005, page 4-11).

3.1 Monitor Status of Populations in Hibernacula and 3.2 Monitor Status of Populations in Maternity Colonies: MTNF cooperates with MDC in monitoring populations at occupied caves on MTNF. Chapter 4 of the Revised Forest Plan includes a monitoring item for determining population status and trends for endangered and threatened species (U.S. Forest Service 2005, page 4-11).

» **Effects of implementation of the proposed action**

Effects analysis will:

A). identify actions which may affect gray bat individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.

B) describe how those actions impact individuals, the species, or habitat; by

- a) identifying how many individuals would be exposed
- b) which populations are represented by those individuals
- c) identifying specific stressors associated with exposure to the action
- d) identifying where and when exposure would occur
- e) identifying the duration and extent of exposure

C) describe how individuals, groups or habitat would respond if exposed to that an action's effects

D) describe the relationship between the effects of the action and the response of gray bat individuals, groups, or habitat.

E) estimate the risk posed to gray bats by the action

Direct Effects

Direct effects may occur to both individuals of the species or to habitat used by the species. Direct effects may occur to gray bats hibernating in caves located on MTNF (# unknown), to gray bats in summer caves (an estimated 80,800), to gray bats foraging over MTNF waters from spring through fall (# unknown), or to specific habitats being used by gray bats (i.e. occupied summer caves, occupied hibernacula, occupied foraging habitat).

Potential Negative Effects

- ***Disturbance to occupied caves:***

The most likely and potentially most adverse effect on gray bats would occur if human entry to an occupied cave resulted in disturbance of the bats, with a subsequent loss of fat reserves (winter) or mortality of young (summer). It is also possible that a person or persons could enter an occupied cave and deliberately kill roosting bats (U.S. Fish and Wildlife Service 1999). The Revised Forest Plan contains a standard and guideline that prohibits human entry to occupied gray bat caves except for regularly scheduled population monitoring or other legitimate scientific purposes (U.S. Forest Service 2005, page 2-11). Each occupied gray bat cave has a unique physical setting, entrance, and opportunity for visitation. Therefore, each cave must be evaluated individually to determine the most appropriate and effective closure mechanism. Some caves may need gates, fences or other types of physical barriers, while others may only need a sign, or are protected by their location and lack of access. Site-specific evaluation of cave protection needs would be done on a case-by-case basis.

There are no documented hibernacula on MTNF, but at least one cave is suspected of harboring wintering gray bats. This cave has no physical barrier at the entrance, but is difficult to find and has confusing and potentially dangerous passages to traverse. The bats are far back in the cave and would be unlikely to be disturbed by all but the most ambitious of cavers.

There are 7 known maternity caves on MTNF. Four of these are gated and closed during the spring and summer months when gray bats would be present, and minimizing the potential for disturbance. The Revised Forest Plan includes a standard and guideline that requires the maintenance of existing gates (U.S. Forest Service 2005, page 2-11). Two of the four are closed year-round for protection of other resources. The three other maternity caves are ungated, and have varying degrees of potential disturbance.

One has an entrance too small to place a half-gate which is necessary for maternity colonies (Missouri Department of Conservation 1988) and is a flooding hazard. Any type of gate could trap debris and cause the cave to fill up, drowning the bat colony that is hanging on the ceiling about 3-5 feet above normal water level. The Eleven Point District attempted to reduce human visitation by placing a chain and interpretive/warning sign inside the entrance, but the physical barrier was soon rendered ineffective by flooding and lack of maintenance. However, there is little evidence of human visitation at this site since a foot trail leading to the cave was obliterated, and the bat population at last count appeared to be doing well.

One cave is located on a steep hillside and cannot be seen by the casual visitor on the river. There is evidence of some human visitation, but not much. The population in this cave has fluctuated from a high of 9450 in 1988 to a low of 2750 in 1998. The latest survey estimated 6550 gray bats in 2001. There is some potential for disturbance at this cave, but the steep climb in hot weather would discourage most casual visitors from reaching the cave during the time the bats are there.

The third cave is in a very noticeable location near a popular recreation site, and human visitation is heavy. There is a well-worn trail to this cave. This cave was assumed to be abandoned after no bats were found in the 1994 survey. However, in March 2005 an MTNF employee conducting a monitoring trip found 26 gray bats in this cave. While it may be abandoned as a maternity cave, it is obviously still being used for hibernation or by transient bats.

Eleven other gray bat caves on MTNF are considered transient and are used by bachelors or the type of use is unknown for sure. These caves have populations ranging from one gray bat to over 27,000. One of these caves has been gated for protection of Indiana bats and is locked closed during the fall-winter months. Others have varying degrees of human visitation. There is potential for some disturbance in these caves, but the bats which make use of these caves normally move between caves. Disturbance at one cave might cause the bats to temporarily move to another cave, but would be unlikely to cause a reduction in fitness or survival, since the bats are accustomed to using different caves and move from cave to cave as a regular behavior.

The Revised Forest Plan also contains standards and guidelines that encourage the relocation of roads and trails away from cave entrances (U.S. Forest Service 2005, pages 2-22, 2-38, 2-39) and that call for all unneeded roads to be decommissioned (U.S. Forest Service 2005, page 2-40). These measures could help minimize human traffic (both motorized and non-motorized) near occupied gray bat caves and reduce the potential for human disturbance of roosting bats.

In Chapter 4 of the Revised Forest Plan, a monitoring item is to determine if specialized habitats (including caves) are being protected, maintained and restored. In addition, another monitoring item is to determine to what extent Forest management is contributing to the conservation of threatened and endangered species and moving toward their habitat conditions (U.S. Forest Service 2005, page 4-11).

Under the Revised Forest Plan, existing gates would be maintained, and other occupied gray bat caves would be monitored, and protected with appropriate measures to reduce, minimize or eliminate the potential for human disturbance in occupied gray bat caves on MTNF. With the combination of constructed physical barriers and difficult access, the known maternity caves are well-protected and should continue to harbor stable or increasing populations of gray bats. Many of the transient caves are also well-protected by their physical location, and require no additional structures. For all these reasons, the potential for negative effects to gray bats in MTNF caves from human disturbance is small enough to be considered insignificant and discountable.

- ***Smoke from prescribed burning***

The 1999 programmatic Biological Opinion indicated that smoke could be a potential impact to gray bats (U.S. Fish and Wildlife Service 1999, page 21). However, in the past 5 years since the opinion was issued, MTNF has prescribed burned over 50,000 acres

and has not documented any adverse impacts to gray bats (U.S. Forest Service 1999(b), 2000, 2001, 2002, 2003, 2004).

Documentation of the effects of smoke on gray bats is scarce, but monitoring on both the Mark Twain and Ozark National Forests has identified no negative impacts on gray bats from several prescribed burns conducted on those Forests. On April 10, 2003, MTNF conducted a 2750 acre prescribed burn near Council Bluff Lake and monitored smoke at Cave Hollow Cave, approximately 9 miles from the burn. No smoke entered or came near the cave entrance (Lynda Mills, pers. comm. 2003). On February 26, 2004 MTNF conducted a 720 acre prescribed burn south of Winona, about 13 miles from White's Creek Cave. Light smoke was seen and smelled inside White's Creek Cave but the bats did not appear to be disturbed in any way (Keith Kelley, pers. comm.. 2004).

A large prescribed burn was conducted on March 24, 2003 on the Ozark NF. Fire burned to within several feet of the cave entrances. Smoke monitoring was done at one cave within that burn. Levels of carbon dioxide and hydrogen sulfide were elevated for a short time in the one cave that was monitored for these gases. Temperature and humidity were recorded every 15 minutes over a period of several weeks in four caves within the burn unit, in both the twilight and dark zones. Comparing recorded data with data from a nearby airport, changes were as expected with temperature rising slowly and little or no change in humidity detected. The Forest Service was not able to determine that any changes in those parameters were caused by prescribed burn activities. Bats present in the four caves were eastern pipistrelles, big brown bats, and Ozark big-eared bat. All bats that were present in the caves at the start of the burn were there once the burn was completed, and all were still in full hibernation (U.S. Forest Service 2003).

The Fire Effects Information system maintained by the Forest Service does not include any information on bats of any species. The bushy-tailed woodrat, bobcat, black bear and northern raccoon were the only mammal species that use caves. None of the information for these species included potential effects of smoke. Similarly, Effects of Fire on Fauna (U.S. Forest Service 2000) makes no mention of the effects of smoke on cave fauna. However, it does say that adequate ventilation is essential for small mammals to survive in burrows and that burrows with multiple entrances may have better ventilation than burrows with one entrance. Carter et al. (2002) state that smoke impacts depend on a cave's airflow and that most caves used as hibernacula are cold traps that would not be likely to suck air in. Therefore prescribed burns taking place during the hibernation season (about October – April) would be unlikely to have any impact on gray bats within hibernation caves. The majority of prescribed burns on MTNF currently take place between November and early April. Under the Revised Forest Plan, there is an objective to prescribed burn up to 40% of total annual burn acres from September through December (U.S. Forest Service 2005, page 1-4), with the remaining burns taking place primarily from December through early April.

In late spring or summer, gray bats inhabit warm areas of caves. These are the areas that may be likely to draw in smoke (Carter et al. 2002), so prescribed burns taking place from May through September have the most potential to affect gray bats. Under the Revised Forest Plan, there is an objective to prescribed burn up to 20% of the total annual burn acres from May through September (U.S. Forest Service 2005, page 1-4). There are no established toxic smoke levels for bats, so we do not know the threshold for smoke effects in terms of amount or duration.

In the Revised Forest Plan, approximately 60,000 – 80,000 acres would be prescribed burned annually. Twenty percent of this acreage would be about 12,000 – 16,000 acres per year. This is about 0.8-1% of MTNF lands. Standards and guidelines require that prescribed burn plans be written to minimize adverse impacts of smoke (U.S. Forest Service 2005, page 2-18). Occupied gray bat caves are to be treated as smoke sensitive and prescribed burn plans developed to avoid or minimize smoke influences at or near these caves (U.S. Forest Service 2005, page 2-11). Experience with prescribed fires on MTNF shows that most smoke dissipates within 24 hours. Under the Revised Forest Plan, prescribed burn areas are likely to be larger than the current average, and therefore, smoke may take longer to dissipate, but would be expected to take no longer than 24-72 hours to be completely gone. In that time period, there may be some smoke that settles in valleys and river corridors where occupied caves may occur. However, the amount of smoke present and the time period of exposure would make it unlikely that individual or communal gray bats' behavior, fitness, foraging or reproductive success would be negatively impacted in the long run.

While smoke from prescribed fires may be present for short time periods in areas where gray bats are foraging, or roosting, the potential for smoke to cause any change in individual gray bats' behavior, fitness, or reproductive success; their prey; or the gray bat population on MTNF is so remote as to be considered insignificant and discountable.

- ***Wind turbines***:

Recent studies have found that wind turbines located on forested ridgetops are a potentially significant source of bat mortality, although no dead or injured gray bats were found during studies at two eastern wind facilities (Arnett et al 2004). Gray bats are unlikely to be flying regularly on forested ridgetops, but may pass over these sites when moving between caves or between foraging areas. There are currently no wind turbines or wind farms located on or near MTNF; nor are there any outstanding applications for such facilities. The revised Forest Plan states that special uses would be permitted

"only when they comply with standards and guidelines for the management area prescription; do not result in environmental or resource degradation; do not preclude opportunities for ecosystem management; and where locations on non-National Forest System lands are not reasonably available."

Any future application for wind energy structures would be evaluated individually and site-specifically to determine its possible impacts to National Forest resources, including gray bats.

Potential Beneficial Effects

- ***Protection of occupied caves:***

The revised Forest Plan requires existing gates to be maintained (U.S. Forest Service 2005, page 2-11). This minimizes the opportunity for people to enter the cave and disturb roosting bats. There is nothing in the revised Forest Plan that would prevent us from constructing new gates on occupied caves if site-specific analysis determined that was the best method to protect roosting bats. If new gates are constructed, or if any structure is placed at a cave entrance, a standard and guide in the revised Plan requires

it to be a bat-friendly, air-flow design (U.S. Forest Service 2005, page 2-10). This would insure that both the bats and their environment would be protected.

There are also a number of standards and guidelines in the Revised Forest Plan which are designed to minimize the amount and type of physical disturbance occurring near cave entrances or over known cave passages (U.S. Forest Service 2005, pages 2-10, 2-11, 2-14 through 2-17, 2-19, 2-22, 2-28 through 2-29, 2-33, 2-34, 2-37 through 2-40). All these measures would reduce the amount of human influence near cave entrances, and would minimize human presence near occupied caves from management activities. Some of these measures may also reduce the number of recreationists passing nearby occupied gray bat caves, thus reducing the potential for disturbance of roosting bats.

- ***Provide travel corridors & foraging habitat near occupied caves:***

An area of at least 20 acres of permanent old growth will be designated around cave entrances for each gray bat cave, with an additional 130 acres of mature forest or woodland designated for each gray bat cave (Forest Plan page 2-11). These areas would provide forested canopy cover near the cave that could be used as a protected travelway between cave and foraging areas. Vegetation management may be done within this area only to achieve desired conditions for terrestrial natural communities.

- ***Provide foraging habitat:***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). These measures insure that bottomland or riparian forest cover would be maintained on most National Forest lands adjacent to streams and rivers, thereby providing protective cover for bats to forage with reduced risk of predation.

Questionable or Unknown Effects

- ***Pesticide use***

Both herbicides and insecticides are used in relatively low amounts on MTNF. Insecticides are used for “housekeeping” purposes, i.e. controlling infestations of wasps, bees, and hornets at high public use areas. Herbicides are used primarily for control of noxious weeds or conversion of non-native to native plants, and for right-of-way maintenance. Since 1991, MTNF has applied an average of 2.6 pounds/acre/year of active ingredient on about 450 acres/year of MTNF lands (0.03%). From 1996, the average was about 175 acres per year treated. Round-up, Rodeo and Accord (all Glyphosate) were by far the most applied herbicide, with some Krenite (Fosamine Ammonium), and Garlon (Triclopyr Amine and Triclopyr Ester), and very minor amounts of other herbicides.

Pesticides would only be used where their use is clearly demonstrated to be the most effective means to meet management objectives, and would comply with the product label (U.S. Forest Service 2005, page 2-18). The pesticides implicated in gray bat deaths would not be used on MTNF. The least impacting application method is to be used, and all equipment used in the application of pesticides must be washed and rinsed where runoff would not reach surface waters, wetlands or other special habitats (U.S. Forest Service 2005, page 2-18). There are also restrictions on the type and application of pesticides within riparian management zones, watercourse protection zones, and

buffer zones of caves (U.S. Forest Service 2005, page 2-19). With these measures, the potential for pesticide use on MTNF to cause any impact to individual gray bats, their prey, or the population is so remote as to be considered insignificant and discountable.

Indirect Effects

Indirect effects may occur to gray bats or their habitats. Indirect effects may occur if vegetation around an occupied cave entrance is altered so that the microclimate changes or protective cover is removed or gained, if vegetation in occupied foraging habitat is changed, or if sedimentation or water quality decreases result in fewer aquatic insects.

Potential Negative Effects

- ***Removal of occupied foraging habitat:***

If existing forest/woodland natural communities along streams and rivers were removed, the protective cover that gray bats need to successfully forage with little impact from predators would be gone. Gray bats have been known to fly out of their way to stay in forest cover (U.S. Fish and Wildlife Service 1982). The Revised Forest Plan contains standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) that prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). In particular, most timber management is prohibited, as is construction or maintenance constructed wildlife openings and food plots. These measures would insure that existing forest/woodland cover along streams and rivers is maintained or improved and would eliminate the potential for reduction of foraging habitat.

- ***Changes to microclimate of occupied caves:***

Maintaining existing vegetation is important around cave entrances to moderate changes in weather and maintain cave microclimate. If vegetation around an occupied gray bat cave entrance is modified, young bats learning to fly may be easier prey for hawks or owls; airflow in and out of the cave may be altered, changing temperature or humidity at gray bat roosts and requiring them to expend more energy; and cave entrances may be easier to see, making human visitation more likely. All of these events could decrease survival of individual bats and possibly affect the survival and reproductive success of that cave's population. Standards and guidelines in the Revised Forest Plan require that at least 20 acres of permanent old growth be designated around and over occupied gray bat caves, and that an additional 130 acres of mature forest/woodland be maintained around each occupied gray bat cave (U.S. Forest Service 2005, page 2-11). There is also a standard and guideline requiring a forested corridor of at least 100 feet in width and at least 70% canopy closure be maintained between an occupied cave and the nearby foraging area (U.S. Forest Service 2005, page 2-11). With these measures in place, it is highly unlikely that vegetation changes would occur around occupied gray bat caves on MTNF, or that there would be any impact to gray bat individuals or populations as a result of habitat changes around the cave entrance.

- ***Water quality changes***

Gray bats feed on aquatic insects which are sensitive to water quality degradation as a result of sedimentation or pollution. Decreases in water quality of streams and rivers over which gray bats forage could decrease the amount or distribution of available prey

insects. This in turn, could negatively affect the survival or reproductive success of individual gray bats, or potentially, local populations. Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to aquatic insects that gray bats eat as prey.

Potential Beneficial Effects

The most widespread and lasting indirect impact on gray bats would be the protection of forest cover in riparian corridors and adjacent uplands, and the protection of water quality to maintain good foraging opportunities.

- ***Protect water quality and minimize sedimentation***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways, maintain or improve the vegetative communities within these zones, and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to aquatic insects that gray bats eat as prey, and that suitable cover is available to protect bats as they forage.

In addition to standards and guidelines which limit, modify, or direct management activities within the riparian corridors and upland waterways (see paragraph above), there are standards and guidelines designed to reduce, minimize or eliminate soil movement from Forest management activities on upland sites and in or near streams and rivers (U.S. Forest Service 2005, pages 2-5, 2-9 through 2-10, 2-14 through 2-17, 2-18, 2-19 through 2-20, 2-28 through 2-30, 2-31 through 2-34, 2-37 through 2-2-40). Implementation of these measures would reduce the potential for soil to move off-site and reach a water source, and therefore reduce the potential for any adverse effects to occur to the aquatic insects that gray bats eat.

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39). All these actions would minimize the amount of soil moving off-site and help protect area waterways from additional sedimentation.

- ***Restoration of natural communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the natural communities that occur on National Forest lands. The major benefit of restoration of healthy natural communities would be less water runoff to surface streams and increased water filtering into the groundwater system as a result of increased

herbaceous vegetation (Nelson 2005). This change in hydrologic functioning may help buffer the effects of periodic drought on adjacent waterways, and maintain more suitable aquatic insect habitat during dry summer months.

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including riparian corridors (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

Questionable Effects

- ***Illegal ATV use - along rivers/streams/lakesides***

The popularity of riding all-terrain vehicles has grown dramatically in the last 20 years. While ATV use is permitted on Forest System roads under state law, illegal ATV use has also increased across the Forest over the past decade. ATV's traveling through streams and rivers and along riparian corridors may be sources of sedimentation that could affect the distribution and abundance of aquatic insects in those sections of stream. ATV's have also been known to ride directly into caves with large entrances, and allow people easy access to many caves that were previously "off the beaten track", increasing the potential for human disturbance to roosting bats. The Forest Service has recently blocked off illegal ATV trails where they had been developed adjacent to Cooks Cave. We are monitoring this closure to determine how effective it is.

Whether or not there are permanent changes in gray bat behavior or use of a cave or foraging area due to illegal ATV use probably depends on the amount, duration, and intensity of illegal ATV use in an area occupied by gray bats. Forest Service law enforcement officers investigate and warn/ticket individuals engaging in illegal ATV use. There is nothing in the Revised Forest Plan that would be likely to change the patterns of illegal ATV use.

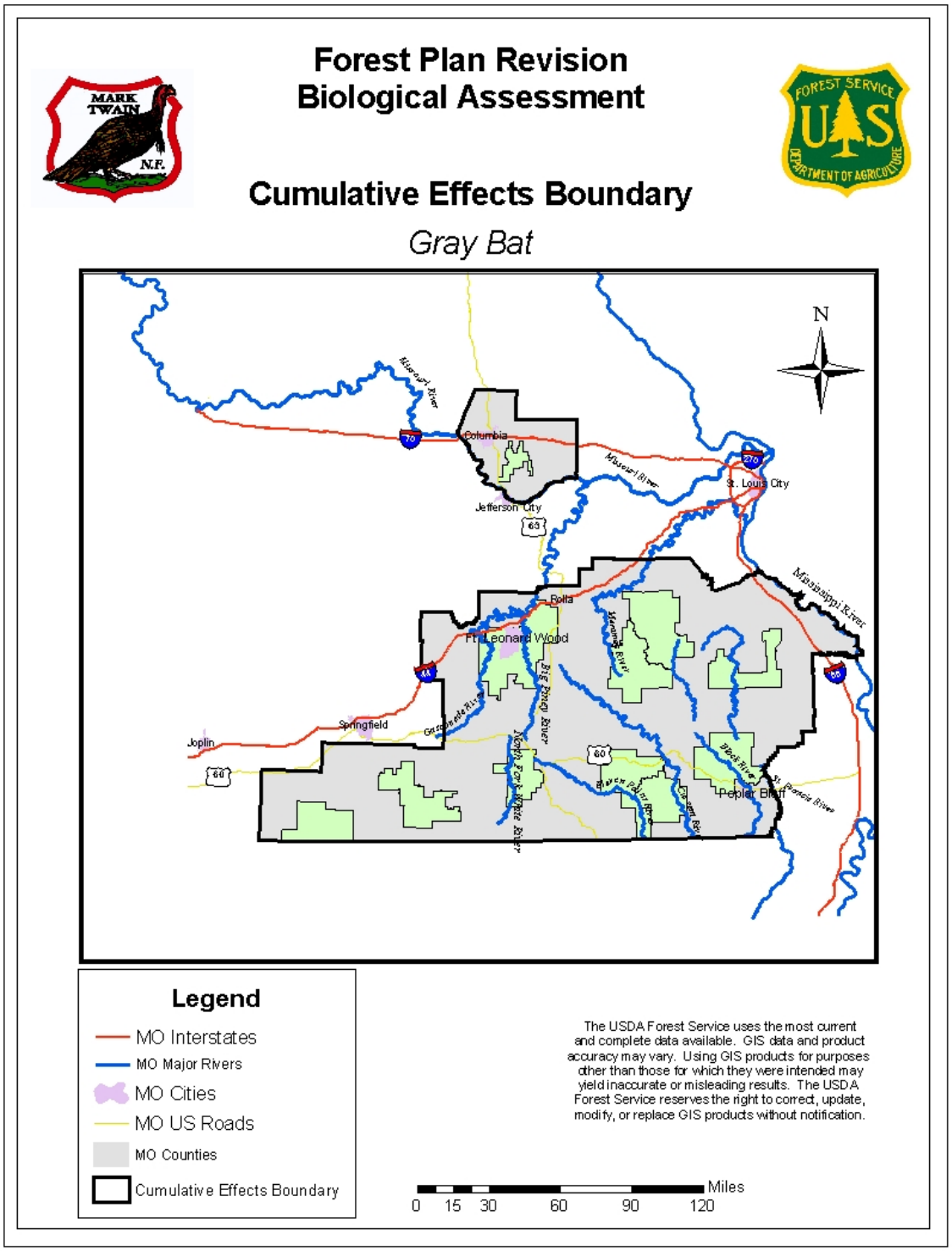
Cumulative Effects

Boundaries:

The spatial boundary for cumulative effects analysis for gray bat is the 29 county area in which all National Forest lands are located.

Turner Spring Cave
Gray bat maternity cave
USFS Photo

Figure GB-2: Cumulative Effects Boundary for Gray Bat



Potential effects from activities on National Forest lands would be human disturbance at occupied caves; smoke entering occupied caves, changes in water quality resulting in aquatic insect changes, and alteration of foraging habitat or cave entrances. Protection

of caves, maintenance of riparian forest cover, and minimizing sedimentation would also be potential impacts of Forest management.

Smoke from prescribed fires may travel outside the proclamation boundary but is unlikely to travel further than the 29 county area. In the rare instances where that may occur, the density, height, and area of smoke would be so dispersed as to be practically unmeasurable, particularly as regards caves. Potential sediment added to waterways from activities on MTNF may also travel outside the proclamation boundary of the Forest, but is unlikely to travel beyond the 29 county area due to the amount and duration of National Forest management activities which may create soil movement, and the distance soil would have to travel to go beyond the 29 county area.

The temporal boundary for cumulative effects analysis for gray bat is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected since that is the amount of time that effects from human disturbance to gray bats could reasonably be expected to be evident.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. Specifically, for gray bats, known occupied caves on MTNF have been evaluated for physical protection and bat-friendly structures have been placed where determined to be necessary and appropriate. Riparian corridors on MTNF are primarily forested and the gray bat population in MTNF caves remains about 20% of Missouri's estimated population.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. In short, past and present actions on MTNF and other ownerships have resulted in most of the largest and most important gray bat caves in Missouri being

protected from disturbance and Missouri's gray bat population remaining about 15% of the range-wide population.

Reasonably Forseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the proclamation boundary of MTNF. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can reasonably be predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section 7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Several highway projects are proposed within the 29 county area for the foreseeable future. The Missouri Department of Transportation website shows projects planned over the next decade (http://www.modot.state.mo.us/plansandprojects/construction_program/stip5year.htm).

Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the 29 counties that contain National Forest lands. However, past trends on private properties within these counties are some indication of reasonably foreseeable trends for the future.

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on gray bats or their habitat include:

- Continued commercial use of some gray bat caves;
- Recreational use of occupied gray bat caves resulting in disturbance to the bats
- Land clearing, overgrazing, road construction, and other uses that may result in soil movement and sedimentation of waterways
- Agricultural use of insecticides

These are the types of activities identified in the Recovery Plan as threats to gray bats.

In addition, private landowners also conduct burns (usually small) on their land and wildfires occur on both National Forest and private ownerships within the proclamation boundary.

Effects Analysis:

» ***Protection of Caves from Human Disturbance***

Entry into occupied caves (either authorized or unauthorized) and human disturbance of roosting gray bats is the primary threat that may occur both on private and public lands. This is also the primary threat identified in the Recovery Plan, the listing rule, and other management plans for gray bats. This type of disturbance may affect only a few bats or tens of thousands of bats, depending on timing, which cave is entered, what activities are conducted in the cave, how many people enter, and how many bats are roosting at that time.

Over half of MTNF gray bat caves are relatively safe from human disturbance. Five of 18 MTNF caves are gated (28%) and 5 others (28%) are somewhat protected from disturbance by their physical location or nature of the cave passages. In Missouri, about ¼ of gray bat caves are in public ownership, and about 70% of those are gated or fenced to exclude human visitation. In total, about 17% of the known gray bat caves in Missouri are gated or fenced, including many of the Priority 1 caves (Steve Samoray, MDC, pers. comm.).

On private ownerships, some gray bat caves are protected with physical structures while others are not. The Missouri Department of Conservation and U.S. Fish and Wildlife Service work with willing private landowners to provide physical protection to gray bat caves currently vulnerable to human entry.

Continuing protection efforts on MTNF caves, added to the continued protection of caves on other federal or state agency lands, and efforts to increase protection of caves on private lands means that the potential for human disturbance at occupied gray bat caves will continue to decrease over time. The additive impact of implementing the Revised Forest Plan on MTNF lands is that the potential for negative impacts to gray bat populations as a result of human disturbance is relatively low.

- ***Water Quality Problems***

Sedimentation or decrease in water quality from pollution may decrease the amount, abundance, or distribution of aquatic insects that gray bats feed on. Sediment may be produced from a variety of activities, and there are a multitude of potential sources of water pollution.

Of the 29 counties which have some land within MTNF proclamation boundary, all have experienced population growth ranging from 7% to 38% from the 1990 to 2000 census, with the exception of two counties that lost less than 1% of their population growth over that 10 year period (U.S. Forest Service 2005b, page 3-277). The fastest growing counties are near Branson (Table Rock Lake area) and Columbia, Missouri (Lake of the Ozarks/Truman Lake area). Average population growth for the 29 counties over the 10 year period was about 19%. These trends are likely to continue into the reasonably foreseeable future.

It is reasonably certain that land development and uses as a result of population growth will result in soil movement to some degree, possibly affecting individual waterways temporarily or for the long term. Whether or not these activities would result in changes to insect populations and subsequent negative effects to gray bats is unknown. The Missouri Department of Natural Resources enforces environmental regulations related to water pollution and soil and water conservation (Missouri Department of Natural Resources 2005).

Sixty-five 5th level watersheds in Missouri contain some National Forest lands. In about half of these, MTNF owns less than 10% of the watershed and has little opportunity to influence water quality through any actions on National Forest lands. In the other half, MTNF owns from 10-57% of the lands in those watersheds. Even in these, much of the land adjacent to waterways is in private ownerships, and MTNF ownership starts far from the water's edge. Standards and guidelines for soil and water protection would minimize the potential for soil to move off-site and into permanent waters. While there is still some potential for sediment to reach area waters from activities on MTNF, the potential is small due to the amount of land affected and protective measures implemented. With the small amount of ownership in most watersheds, the impact of activities on MTNF would not significantly add to water quality problems.

- ***Pesticide Use***

Over the past 15 years, the only insecticides used on MTNF have been commercially available sprays ("bee-boppers"). These are purchased as needed and used in small amounts to kill wasps and bees causing problems in developed recreation areas. To our knowledge, this is the also only type of insecticide used on other federal and state agency lands.

Since 1991, MTNF has applied an average of 2.6 pounds/acre/year of active ingredient of herbicide on about 450 acres/year of MTNF lands (0.03%). From 1996, the average

was about 175 acres per year treated. Round-up, Rodeo and Accord (all Glyphosate) were by far the most applied herbicide, with some Krenite (Fosamine Ammonium), and Garlon (Triclopyr Amine and Triclopyr Ester), and very minor amounts of other herbicides.

The only information available on pesticide use on other ownerships over a large area is the USGS report on water quality of the Ozark Plateaus (Bell et al. 1996) which looked at historical data on pesticide use from 1970-1990. Pesticide use was about 4.2 million pounds per year of active ingredient from 1982-1985 in the study unit, which encompasses approximately 48,000 square miles in parts of northern Arkansas, southeastern Kansas, southern Missouri, and northeastern Oklahoma (Bell et al. 1996). Use was greatest in the Springfield and Salem Plateaus pastureland and in the Mississippi Alluvial Plan croplands. Application rate in counties where MTNF land is located was generally less 0.05 pounds/acre/year, with a few exceptions (Bell et al. 1996, page 9). The most frequently applied pesticide was the herbicide 2,4-D. Organochlorine pesticides were detected in bed sediments and biological tissues (Bell et al. 1996). The conclusion of this report was that pesticides do not pose a widespread or persistent problem in the study area, based on the low number of samples that exceeded established quality criteria or standards (Bell et al. 1996).

The Revised Forest Plan contains standards and guidelines limiting the use of pesticides within RMZs, WPZs, and within 100 feet of sinkholes, sprigs, wetlands, and cave openings (U.S. Forest Service 2005, page 2-19). These measures would help insure that any insecticides used on MTNF in the future do not enter waterways or groundwater. The small amount of insecticide used by the Forest Service to control wasps and bees in developed recreation areas is not likely to have any effects on aquatic insects.

Gypsy moths have not yet been a serious problem in Missouri, although it is anticipated that they will occupy the state by about 2025 unless control efforts are successful in slowing the spread (http://www.fs.fed.us/ne/morgantown/4557/gmoth/spread/). No widespread control measures have yet been instituted in Missouri. The Forest Service does not anticipate needing to use any form of chemical gypsy moth control in the foreseeable future. West Nile virus caused concern in Missouri for several years, but the Forest Service does not propose to use mosquito control measures in the Revised Forest Plan. .

With the very low Forest Service use of pesticides and the USGS conclusion that there is not a pesticide problem in the Salem and Springfield Plateaus (where most MTNF land is located), there would be no cumulative impact to bald eagles from the small amount of use on National Forest lands in Missouri.

- ***Smoke impacts from prescribed or wildfires***

In Missouri, about 58,600 are prescribed burned annually, which does not include private ownerships where burn acres are not reported to an agency. The MTNF contributes about 17% of this total. Average annual state-wide wildfire acres for the agencies which suppress fires in Missouri are about 59,200 (U.S. Forest Service 2005(a), pages 3-167 and 3-172). About 9% of these are on MTNF lands. The actual amount burned in any given year is a function of weather and fuel conditions. Cool, wet years have fewer acres burned, and warm, dry years have more acres burned.

Emission of fine particulate matter (PM 2.5) is expected to increase about 80% over current levels from prescribed fire on MTNF under the Revised Forest plan (U.S. Forest Service 2005(a), page 3-175). PM 2.5 is the greatest danger to human health and presumably also to bats, and fine particulates make up more than 70% of the matter produced by both prescribed and wildfires (U.S. Forest Service 2005(a), page 3-175).

Assuming all other agencies do not change their annual average prescribed burn acres, the MTNF increase in PM 2.5 (from about 450 tons to about 2325 tons annually) would increase the MTNF's share of total PM 2.5 emissions from about 21% annually to about 59% annually. However, each prescribed burn done on MTNF must have a smoke management plan prepared prior to ignition, where site-specific mitigations are developed to minimize the potential impact of smoke on sensitive receptors (U.S. Forest Service 2005(a), pages 3-176 and 3-177). Occupied gray bat caves are considered smoke-sensitive areas and prescribed burn plans must avoid or minimize smoke influences at or near these caves (U.S. Forest Service 2005, page 2-11). It is estimated that potential PM 2.5 emissions can be reduced by at least 31%-83% depending on the type of mitigations used (U.S. Forest Service 2005(a), page 3-177). This would reduce the potential for negative impacts from smoke.

As stated in the indirect effects above, the possibility of smoke from MTNF prescribed burns affecting bats is considered so remote as to be insignificant and discountable. Even considering an increase in the acres of prescribed burning on MTNF under the Revised Forest Plan, the incremental effects would be that a few additional gray bats may be temporarily affected by minor amounts of smoke. These additional impacts would not be expected to adversely impact either individual bat survival or reproductive success or that of the population of gray bats in southern Missouri.

» ***Other Effects***

On MTNF, caves are protected from physical alteration and there would be no conversion of riparian areas or bottomland forest to other land uses. Therefore, no habitat loss or additive impacts would occur. Major rivers are managed to protect the unique qualities of those rivers with limited vegetation management allowed. Water quality would be protected through application of soil and water standards and guidelines.

Conclusions:

Of the 208 documented gray bat caves in Missouri, 18 (9%) are on National Forest lands, and about 20% of Missouri's gray bat population is in caves on MTNF. MTNF caves harbor about 3% of the rangewide population.

Since MTNF would continue to provide suitable habitat in known caves and along known foraging corridors, protect occupied caves from disturbance, and protect water quality, the effects of implementing Alternative 3 of the Revised Forest Plan, added to effects occurring from activities on other ownerships would be primarily beneficial. The possibility of potential negative effects to individual gray bats occurring from activities implementing the Forest Plan are so remote as to be considered insignificant and discountable and would not individually or cumulatively result in a decrease in the recovery of gray bats in Missouri or rangewide.

» **Additional measures needed for species conservation and recovery**

Gray bat populations are stable or increasing across the range and have been proposed for downlisting to threatened. There are no additional measures MTNF could take to contribute further to the recovery and conservation of this species.

» **Effects of additional measures**

Since no additional measures are proposed, there would be no effects.

» **Determination - May Affect, Not Likely to Adversely Affect**

Rationale: While there is some potential for disturbance in caves, such disturbance would be as a result of unauthorized entry into occupied caves, and the potential to occur is small due to physical and legal closures of MTNF caves. Similarly the potential for effects to insect populations from sedimentation of waterways as a result of MTNF activities is extremely low due to modification or avoidance of activities that have potential for soil movement. In addition, the potential for smoke to enter caves and effect roosting bats is extremely low due to the recognition of these caves as smoke-sensitive areas and the requirements for smoke management included in the Revised Forest Plan. While it is possible for these kinds of effects to occur, the potential is so low as to be considered insignificant and discountable.

Indiana bat (*Myotis sodalis*)

» Life History summary (BCI, 2001)

Indiana bats are migratory, hibernating in caves or mines during winter, and flying to deciduous forests in spring and summer. Starting in August, Indiana bats migrate to swarming sites, flying in and out of caves or mines to visit possible hibernation sites. Before entering hibernation, the bats mate, whereupon females immediately enter hibernation. Males continue foraging for about two weeks after mating before entering hibernation. Indiana bats use caves or mines with specific temperature and humidity conditions, so not every cave is suitable.

Female Indiana bats store sperm overwinter and ovulate in the spring as they emerge from hibernation in March and April. After a 60-day gestation period, females give birth to one pup, usually in late June or early July. Pups can fly in about 25-37 days, following their mothers to foraging sites throughout the summer. Pups reach adult size by mid-August. In spring and summer, females congregate in small maternity roosts, using primarily dead trees and living trees with sloughing bark. Indiana bats may live up to 20 years, but most probably survive less than half that. Predators include owls, snakes, feral cats and raccoons.

More specific information on life history can be found in the 1999 Programmatic BO (U. S. Fish and Wildlife Service 1999a), Bats of Eastern Woodlands (Bat Conservation International 2001), and the Agency Draft Recovery Plan (U.S. Fish and Wildlife Service 1999).

Knowledge Gaps

There is much that is not known about Indiana bat life history. We do not know how or why Indiana bats select certain habitats (winter caves and summer roosts/foraging areas) and are not present in others. The factors that make habitat optimum are not certain. We do not know migration patterns, routes, or stopovers. We do not have a good understanding of home range sizes or configurations. We do not know much about interspecific or intraspecific competition for resources with other bats. We do not know whether Indiana bats are accumulating pesticides from prey or direct exposure.

» Population status range-wide, in Missouri, and on MTNF

Population status for Indiana bat is determined using counts or estimates of hibernating winter populations. Indiana bats are congregated in large numbers in hibernating caves, and more than half of the population hibernates in the 9 Priority 1 hibernacula (U.S. Fish and Wildlife Service 1999), making it relatively easy to conduct surveys, and to compare results from year to year. Summer surveys are not used to estimate populations because Indiana bats are dispersed in relatively small groups (or individuals) in thousands of different locations. Their mobility and nocturnal nature make it extremely

difficult to conduct accurate surveys that can be compared from year to year. (U.S. Fish and Wildlife Service 1999, page 20)

Rangewide

The historic population of Indiana bats, based on the earliest known census of hibernacula, or the 1960 hibernacula numbers, is estimated to be about 808,500 (U.S. Fish and Wildlife Service 1999). However, the historic Indiana bat population prior to documented surveys is estimated to be in the millions (Silliman et al. 1851, Tuttle 1997a as cited in BCI 2001).

When the Recovery Plan was approved in 1983, the range-wide population of Indiana bats was estimated at over 550,000, with Missouri's hibernating population estimated at about 282,000 (51% of the entire population) (U.S. Fish and Wildlife Service 1983, page 8). In 1997, the population range-wide was estimated at about 350,000 Indiana bats (U.S. Fish and Wildlife Service 1999, page 52). Range-wide winter population was estimated at 382,299 in 2001 and about 387,306 in 2003/2004. (U.S. Fish and Wildlife Service 2004). Population trends from 1960 to present varied from state to state. Six states showed declines, one state remained about the same, and five states increased (some dramatically). The overall rangewide population of Indiana bats has declined by about 57% since 1960 (Clawson in Kurta and Kennedy 2002).

A recent review of population survey data from 1960 through 2000 found that populations in the northern part of the species' range have been increasing over the past 20 years, while populations in the southern part of the range, including Missouri, have been decreasing since 1980 (Clawson, 2002).

Missouri

The highest estimate of recent Indiana bat populations was 1979 with 353,300 bats (Missouri Department of Conservation 1988).

Missouri's 1997 hibernating population was estimated at less than 50,000, or about 13% of the entire population (U.S. Fish and Wildlife Service 1999, page 52). Using the population estimates from the Agency Draft Recovery Plan, this is a decline of 84.5% in Missouri's hibernating population from circa 1980 to 1995/1997. Missouri's estimated winter population in 2001 was 72, 983 and in 2003/2004 it was 66,805 (or about 17% of the range-wide population) (U.S. Fish and Wildlife Service 2004).

However, Missouri's Indiana bat population is difficult to determine. At the time the Recovery Plan was issued, Missouri had the largest known Indiana bat hibernaculum in the world at Pilot Knob Mine (an abandoned mine near Fredericktown, MO that is listed as "critical habitat" and is a Priority One hibernaculum - currently managed by FWS) (U.S. Fish and Wildlife Service 1983, page 7, 9, IV-12). When estimating population trends for Missouri, a large part of the equation is what number is used for Pilot Knob Mine. In the previous paragraph, Pilot Knob Mine was estimated to have a population of about 50,550 Indiana bats, based on calculated capture rates.

Table IB-1: Indiana Bat Regional and Range-wide Population Estimates

Estimates are based on winter surveys conducted at known hibernacula

FWS Region	State	2001	2003 or 2004	% of Range-wide Pop.	Source
R3	Indiana	173,076	183,332	47.3%	V. Brack et al. 2003 + 34 bats A.King found in Reeve's in 2003
R3	Missouri	72,983	66,805	17.2%	R. Clawson's raw data from "2001 or most recent survey" for the April 2001 I-bat Symposium
R3	Illinois	19,328	30,851	8.0%	R. Clawson's 2003 report for Priority I Hibernacula & e-mail on 9/23/03 with attached Excel table
R3	Ohio	9,788	9,436	2.4%	J. Kath's Memo's dated 1/29/03 and 4/1/03
R3	Michigan	N/A	N/A		BHE 2004 survey data for Lewisburg Limestone Mine on 2/7/04
R3	**All**	**275,175**	**290,424**	**75.0%**	
R4	Kentucky	47,918	41,498	10.7%	T. Wethington letter dated 5/1/03
R4	Tennessee	10,172	8,900	2.3%	B. Currie's data for Priority 2 (7114) in e-mail on 2/26/04 plus (1786) M. Harvey 2001 data in e-mail on 2/26/04
R4	Arkansas	2,476	2,124	0.5%	M. Harvey's data in e-mail on 2/26/04
R4	Alabama	250	317	0.1%	K. Hudson e-mail on 4/4/03
R4	**All**	**60,816**	**52,839**	**13.6%**	
R5	New York	34,888	32,923	8.5%	A. Hicks annual report for April 2002-April 2003
R5	Pennsylvania	707	788	0.2%	C. Butchkoski 2003 data forms
R5	West Virginia	9,744	8,825	2.3%	C. Stihler 2003 data (259, but couldn' t survey Hellhole) + 2001 Hellhole data (8566) from Clawson 2001
R5	Virginia	969	1,081	0.3%	data from the Jan. 13, 2004. Bio. Opn. For the Jefferson N.F. which states the VA pop is 1081.
R5	New Jersey	N/A	107	0.0%	A. Sherer e-mail on 2/25/04; last surveyed in 2002, need new 2004 data
R5	Vermont	N/A	312	0.1%	A. Hicks 2003 data of Aeolus Cave (15), + 297 in Little Skinner Hollow Cave, A. Sherer e-mail on 3/03/04
R5	Maryland	N/A	1	0.0%	last surveyed in 1996
R5	Connecticut	N/A	1	0.0%	last surveyed in 1997
R5	**All**	**46,308**	**44,038**	**11.4%**	
R6	Oklahoma	N/A	5	**0.0%**	Ken Collins, FWS biologist in Tulsa Field Office. E-mail to L. Pruitt on 9/24/04
Range-wide Total:		**382,299**	**387,306**		NOTE: The MO estimate assumes 50,550 bats at Pilot Knob Mine based on previously calculated capture rates by R. Clawson. This assumption has not been validated in recent years.

Pilot Knob Mine had an estimated population of 135,000 in 1975 (USFS 1998 Ibat page 5), or about ½ of Missouri's Indiana bat population. The interior of Pilot Knob Mine is unstable, and ceiling collapses have occurred. In fact, the instability of this hibernaculum and its potential for collapse was one of the "three major reasons for the

Indiana bat's endangered status" (U.S. Fish and Wildlife Service 1983, page 7). By 1980, there had been a major collapse that largely blocked the mine entrance (USFS 1998, page Ibat 26). After that, no population surveys of the interior were done until February 1999 when personnel from Bat Conservation International entered the mine and counted 303 Indiana bats (U.S. Fish and Wildlife Service 1999, page 53). Major parts of the mine are inaccessible to humans, so it is impossible to know how many bats still use this hibernaculum. The best estimate from interpreting capture rates from harp trapping at the entrance is that the Pilot Knob Mine currently has about 50,550 Indiana bats hibernating (R.Clawson, pers. commun. 3/10/05). Adding this to the approximately 14,260 Indiana bats surveyed in other Priority 1 and 2 Missouri hibernacula (and the 4 known MTNF hibernacula) in 2004 & 2005, the estimated Missouri population in 2004 & 2005 would be about 64,800 Indiana bats (or about 17% of the range-wide population) (R.Clawson, pers. commun. 3/10/05).

Mark Twain National Forest

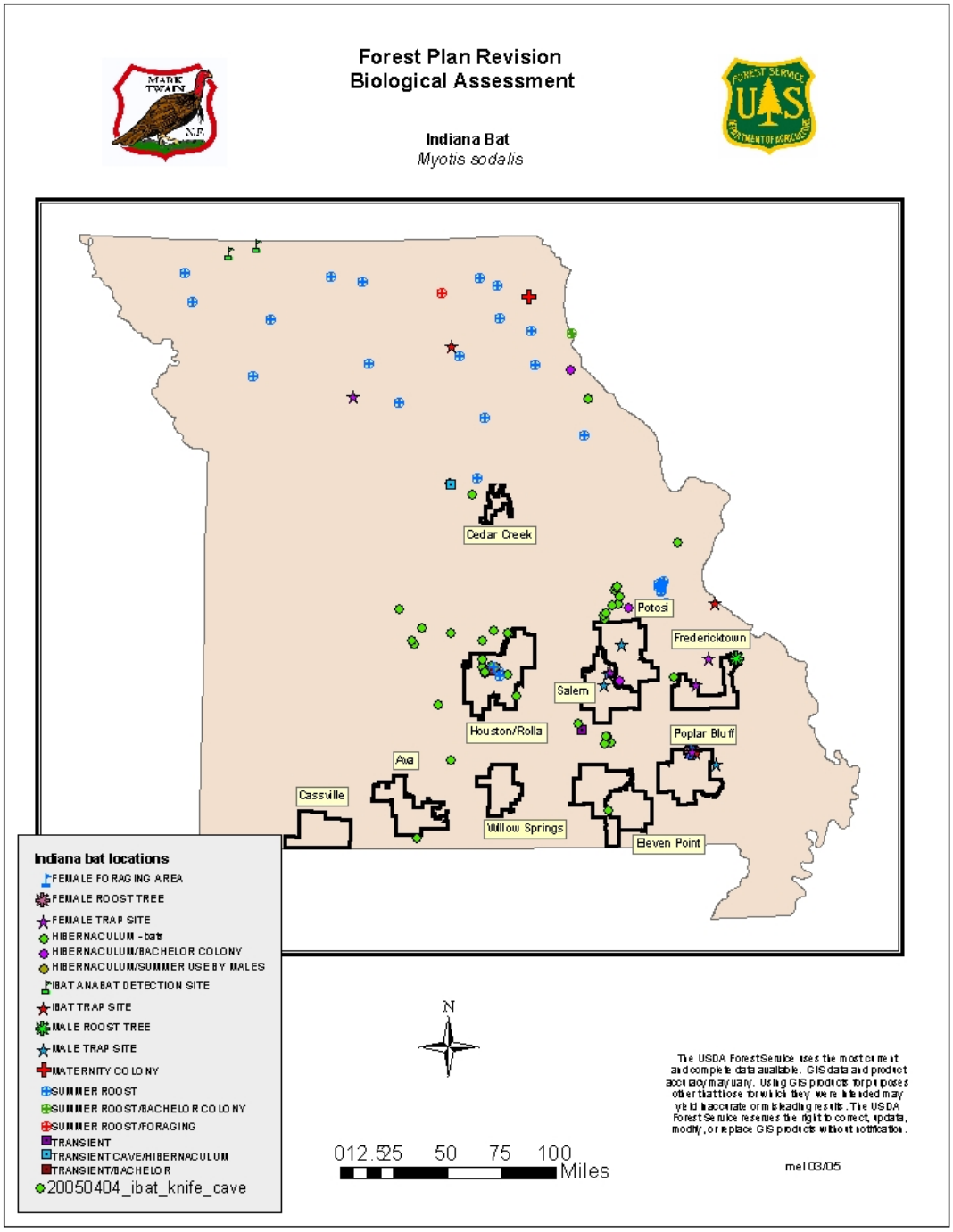
Three hibernacula located on MTNF for which population surveys are available, have experienced population declines since Indiana bats were first discovered using them. Surveys at both caves have been conducted by the same person, the Indiana bat Recovery Team Leader. Whether or not the decreases are statistically significant, or represent normal fluctuations, is unknown.

It appears from these surveys that MTNF caves harbor a fluctuating population of about 275-400 hibernating Indiana bats. This is about 4-6% of Missouri's population and about 0.07-0.1% of the range-wide population.

Table IB-2: Winter population surveys of MTNF Indiana bat hibernacula

Year Surveyed	White's Creek Cave (Oregon County)	Cave Hollow Cave (Dent County)	Davis #2 Cave (Pulaski County)	Knife Cave (Pulaski County)
1988		250		
1990	39			
1996			37	
1997			20	
1998	21	79		
2001	1	5		
2004	33	150	26	
2005				67

Figure IB-1: Indiana bat locations in MIssouri



Knowledge Gaps

We do not know the long-term temperature and humidity regimes of any of the known hibernacula on MTNF. However, having this knowledge would not change management of any of these caves. The caves which are gated have bat-friendly air-flow designs and

there have been no other physical modifications to any entrances. We do not know if the same bats return to these caves each year or if different individuals use them from year to year. We do not know if swarming occurs at any of these caves.

» Causes of past and/or current declines and Limiting Factors

Causes of decline and limiting factors have not changed significantly since the Agency Draft Recovery Plan was written in 1999 (U.S. Fish and Wildlife Service 1999, pages 15-19). Information gathered since then on habitat use and life history has refined our knowledge of these limiting factors, but has not resulted in a new or dramatically altered understanding of the factors affecting Indiana bat populations.

Listing Factor A. ***The present or threatened destruction, modification, or curtailment of its habitat or*** range is a suspected factor in the past and continued decline of Indiana bats. Land use changes have dramatically altered the Indiana bat's maternity range from pre-settlement conditions (U.S. Fish and Wildlife Service 1999).

Conversion of riparian corridors (of big rivers to small prairie streams) to agriculture and urban development has altered or eliminated suitable roosting and foraging habitat across the range. Conversion of tall grass prairie to agriculture has simplified ecological systems and changed insect composition, abundance and distribution (U.S. Fish and Wildlife Service 1999) particularly in areas where maternity colonies are located. Land use changes have fragmented forest blocks in the east and Midwest. Heavy harvesting in the late 1800's and early 1900's across the Indiana bat range have resulted in forests that are just now starting to reach maturity and old growth stages. The exclusion of fire from fire-adapted ecological systems has resulted in more dense and "cluttered" forests in the Ozarks (U.S. Fish and Wildlife Service 1999) and may be less suitable today than historically.

Alteration of cave habitats through the installation of improper cave gates is a documented cause of past declines (U.S. Fish and Wildlife Service 1999). However, replacing improper gates with appropriately designed gates can restore cave microclimates and Indiana bat populations (U.S. Fish and Wildlife Service 1999).

One suggested cause of recent declines is unacceptable temperature deviation in hibernacula due to human-caused physical changes to entrances which affect air flow. Indiana bats need roost temperatures of less than 10°C on arrival and between 3°C and 6°C during mid-winter (Bat Conservation International 2001). Populations roosting at temperatures between 37° F and 45°F appear to be more likely to grow, while populations roosting at temperatures below 37°F or above 45°F tend to decline (U.S. Fish and Wildlife Service 1999).

Listing Factor B. ***Overutilization for commercial, recreational, scientific, or educational purposes*** has been a factor in past declines, and disturbance during hibernation is still a serious concern. Disturbance of hibernating Indiana bats by people entering caves is a serious cause of past declines (U.S. Fish and Wildlife Service 1999). Vandalism causing the death of thousands of Indiana bats has also been documented (U.S. Fish and Wildlife Service 1999). Indiscriminate collection, as well as handling and

banding by biologists have also been documented sources of decline (U.S. Fish and Wildlife Service 1999).

Listing Factor C. ***Disease or predation*** has not been considered a causal factor in the decline of Indiana bats. While Indiana bats are subject to parasitism and predation, these factors are not considered to be limiting factors (U.S. Fish and Wildlife Service 1999). Other factors which cause stress may exacerbate effects of normal parasite loads and adversely affect individuals or populations. Improperly designed gates may increase the potential for predators to successfully take bats as they fly through the gate.

Listing Factor D. ***The inadequacy of existing regulatory mechanisms*** is not a factor in the continued decline of Indiana bat across its range. The Indiana bat has been listed as a federal endangered species since 1967. Federal agencies with Indiana bat populations or habitat (as is MTNF) are subject to the requirements of the Endangered Species Act, as amended, particularly Sections 2 and 7 (ESA 1973). In Missouri, the Indiana bat is listed as endangered and importation, transportation, sale, purchase, taking or possession of any endangered species, or hides or other parts thereof, or the sale or intent to sell any article made from any part of an endangered species is prohibited (Missouri Department of Conservation 2005).

However, because this is a migratory species with a very large range, much of the land on which habitat occurs is in private ownership. Endangered Species Act Sections 9 and 10 cover prohibited acts and permits for other than federal lands (ESA 1973). After spending 5 years studying Indiana bats, as well as other forest bats, in Missouri, LaVal and LaVal stated “There is no way government conservation agencies can acquire enough foraging habitat to guarantee the survival of bat populations. Instead, the byword must be … cooperation and encouragement of private and public landowners willing to modify projects to protect bat foraging habitat.” (LaVal and LaVal 1980).

Listing Factor E. ***Other natural or manmade factors affecting its continued existence***. Several factors have been documented or are suspected of contributing to past and present declines of Indiana bat. These include natural hazards, such as flooding or freezing of bats in hibernation, or collapse of cave/mine ceilings (U.S. Fish and Wildlife Service 1999). Indiana bats may also be adversely affected by severe weather when strong winds and hail strip bark from or otherwise damage or destroy occupied roost trees (Gardner as cited in U.S. Fish and Wildlife Service 1999).

The effect of pesticides on Indiana bats has not been studied. However, there is evidence that other bats are exposed to significant amounts of agricultural chemicals that do have biological effects (U.S. Fish and Wildlife Service 1999). Pesticides have been implicated in the decline of several species of insectivorous bats in North America (several authors as cited in U.S. Fish and Wildlife Service 1999). Guano and tissue samples from five bat species on Fort Leonard Wood, Missouri were found to have concentrations of several chemicals (BHE Environmental, Inc. 1999 as cited in U.S. Fish and Wildlife Service 1999).

Knowledge Gaps

The most serious constraint on managing to recover Indiana bats is that we do not know which factor or combination of factors is primarily responsible for the continued decline of the Indiana bat. Clawson (2002) states “the top priority of the recovery effort is

research to determine the cause or causes of the decline in population." We do not know if the population increases in the northern part of the range are truly increases in numbers, or just a shift in the population. We also do not know where the point of no return is with this species, i.e. we do not know the lowest population number which can be reached before extinction is inevitable and recovery is not possible.

There is consensus among Indiana bat researchers and experts that hibernacula need protection from human disturbance and from physical alteration, and that microclimate of the hibernacula is important. There is also consensus on the need for a continuous suppy of quality roosting and foraging habitat across the range. However, experts do not always agree on what constitutes quality habitat, nor on what kinds or amounts of habitat change is acceptable. There is also no consensus on the potential impacts of climate change on the survival of this species.

There is no clear consensus on the relative importance of each of these limiting factors as contributing causes in the continued decline of the species.

» Causes of past and/or current recovery

While the range-wide population of Indiana bat continues to decline, there are differences in trends between the north and south parts of the range (Clawson in Kurta and Kennedy 2002). Populations in the south part of the range (including Missouri) have declined by about 80% over the past 40 years. However, populations in the north part of the range have increased by about 30% (Clawson in Kurta and Kennedy 2002). This is encouraging, but was not enough to offset losses in the southern states.

During early years of surveying, about 74% of the Indiana bat population lived in the southern states; but by 1990, the ratio of southern to northern bats was about even, and in 2001, the majority of Indiana bats were in the northern states (Clawson in Kurta and Kennedy 2002).

Whether this represents a start toward recovery or simply a shift in species' location is unknown at this time.

» Surveys for Indiana bat

Mark Twain National Forest Surveys

Surveys for Indiana bats are done in all seasons on MTNF. Survey strategies have changed over the years and are summarized in Appendix E. Winter surveys are population counts at the two known hibernacula, and are conducted in cooperation with the Missouri Department of Conservation. Since 1988, winter population surveys at the two MTNF hibernacula have been conducted by Indiana bat Recovery Team leader Richard Clawson of MDC. Results of these surveys are shown in the Population Status section above.

In 1978-1982, Gene and Treva Gardner were contracted to survey caves on MTNF. Their work resulted in finding two Indiana bats in Hanley Cave, the only record we have

for that cave. No other MTNF caves searched by the Gardners had Indiana bats. Hanley cave was revisited in winter 2000 by the Cave Research Foundation, and no Indiana bats were found during that visit (CRF 2001).

Summer surveys on MTNF are conducted using a combination of mist-netting and acoustic methods from mid-May through late July. Since 1997, MDC (or their contractors) and North Central Research Station personnel have conducted the summer surveys on MTNF.

Mist net and Anabat surveys were conducted for bats on the Mark Twain National Forest between 1997 and 2004. A summary of survey data collected during this period indicates that about a dozen Indiana bats had been captured on or near the National Forest and 5 captured on the National Forest. The five captures on MTNF were all in 2003 and 2004. No Indiana bats had been captured (other than at cave entrances) on MTNF prior to 2003. These surveys represented over 400 mist net sites and over 2,700 hours of mist netting, plus over 400 Anabat sites and over 4,400 hours of Anabat detection. This works out to about 540 hours of effort to capture one Indiana bat. Capture of Indiana bats during field surveys is very uncommon, which indicates that Indiana bats are not abundant (or not present) in the areas that were surveyed on the MTNF. As Brack et al (2002) reasoned, it is unlikely that Indiana bats will be equally abundant in all parts of its range because optimal or even suitable habitat conditions are not found equally across the landscape.

Spring (March-April) and fall (August-October) surveys on MTNF have been primarily conducted by fall harp-trapping at hibernacula entrances. All harp trapping on MTNF has been conducted by NCRS personnel. In September – October 1998, 3 male Indiana bats were captured in 40 hours of harp-trapping at Cave Hollow (1 male Ibat) and White's Creek (2 male Ibats) caves (USFS 1999). In 2001, no Indiana bats were caught during harp trapping at Cave Hollow Cave.

In April, 2005, 5 male Indiana bats were harp-trapped at Knife Cave, and 2 were fitted with radios. The first was tracked for two weeks. The second bat was tracked only the night of capture, and its signal was never found after that night.

In late May 2005, 5 Indiana bats (3 males, 2 females) were captured and fitted with radios. Two of the males were captured at the entrance to Cave Hollow Cave. The other three were captured at a pond on National Forest lands about 6 miles from Cave Hollow Cave, where 2 Indiana bats had been captured in 2004. Radio-tracking of these bats and additional survey efforts are still being conducted in this area as of June 1, 2005.

Other Indiana bat Surveys in Missouri

Surveys for Indiana bats in Missouri outside MTNF have been and are still being conducted in all seasons.

One of the earliest records of Indiana bats in Missouri was from Mary J. Guthrie who observed seasonal behaviors of Indiana bats (among others) from the fall of 1930 through July 1932 in the vicinity of Columbia, Missouri in Boone County (Myers 1964). MTNF's Cedar Creek Unit lies just east of Columbia, with some land in Boone County.

Richard Myers conducted studies on three Ozark myotis, including *Myotis sodalis,* from 1954 to 1962. During his study, he banded over 21,000 Indiana bats. He found Indiana bats hibernating in seven caves scattered throughout the Ozarks, and with entrances ranging in size from small cracks to large openings. Roosts were almost always located in between two entrances where airflow was evident. Myers took temperature and humidity in these caves and found that in general, Indiana bats were found in cooler areas of the cave than other hibernating species. Mean temperature in Indiana bat caves was 46 degrees Fahrenheit (7.8 degrees Celsius). Most of the movements Myers recorded were of individual bats moving between hibernacula, some during the same winter and some changing caves from one winter to another. Myers' bats showed a definite tendency to move north in the summer, some being recovered in north central Missouri and one in Iowa. However, Myers still concluded that most males stay near the hibernacula in summer. In addition, during the time of his study, Myers documented a dramatic decline in some hibernacula populations. He attributed these declines to human disturbances in those caves (Myers 1964).

From 1975-1980, LaVal and LaVal surveyed in the Meramec River area in eastern Missouri (early years) and throughout Missouri (later years). About 12,000 Indiana bats were banded during this study (LaVal and LaVal 1980). The LaVals gained valuable information on Indiana bat movements, cave use, food habits, and habitat use.

Missouri Department of Conservation has conducted winter population surveys in Priority #1 and some Priority #2 and #3 caves for over 20 years.

Contractors and students from several Missouri Universities have conducted Indiana bat surveys on other ownerships, including Fort Leonard Wood, COE lands near Lake Wappapello, as well as some private lands. Of particular interest to MTNF are surveys that have taken place adjacent to MTNF lands or within MTNF proclamation boundary.

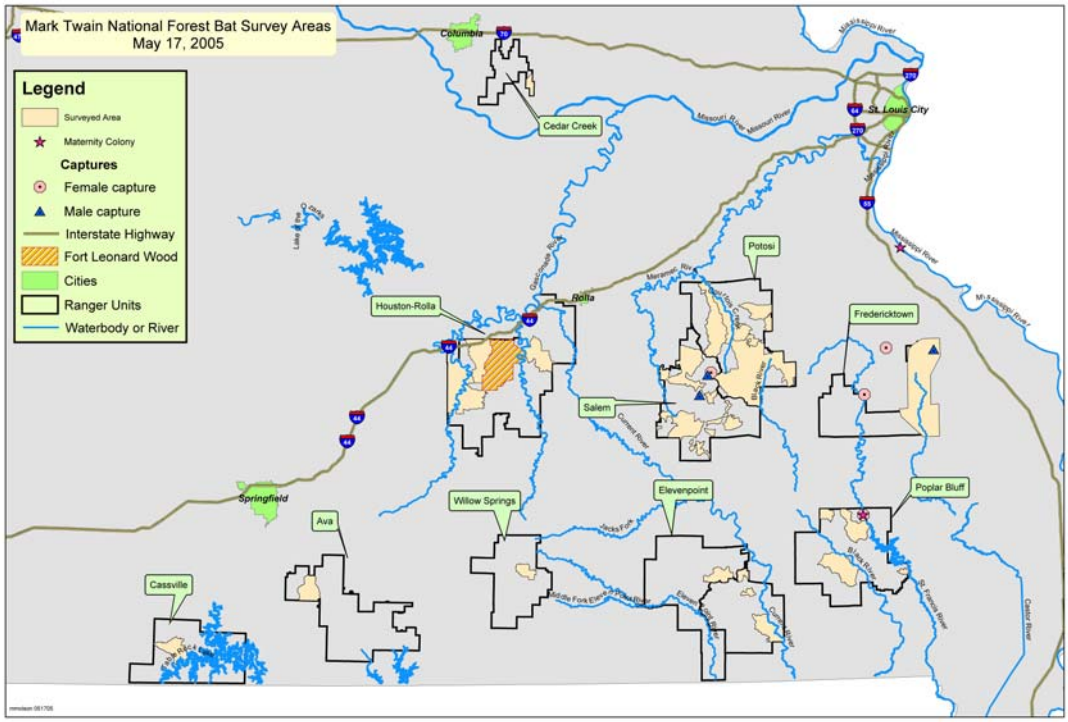
From 1998-2002, BHE, a private contractor, mist-netted sites on Fort Leonard Wood along with reference sites on nearby MTNF lands of the Houston/Rolla and Potosi units. In 4 years of work, only one adult male non-reproductive Indiana bat was captured (May 12, 1998. No other Indiana bats were captured on either MTNF lands or Fort Leonard Wood.

In 2000, the Missouri National Guard contracted mist-net and acoustic surveys of several training sites, including one south of Lake Wapapello. There were no Indiana bats captured or recorded during this survey.

Between 2002-2003, the Army Corps of Engineers contracted mist-net surveys of ACOE lands at Lake Wapapello. In September 2002, 2 adult females and 2 unknown Indiana bats were captured on the northeast side of the Lake. In July 2003, 2 lactating female Indiana bats were captured along Lake Creek. One adult male was captured in mid-August at the same location Indiana bats had been captured in 2002.

Researchers have also studied Indiana bat maternity colonies in northern Missouri (Callahan 1993; Callahan et al. 1997; Clawson 1986; Clawson 1996; Miller 1996)

Figure IB-2: Indiana bat surveys & capture locations on MTNF



Knowledge Gaps

We still know very little about where most Indiana bats spend the summer in Missouri. With the extremely low capture rate experienced by most surveyors in Missouri, it will be many years, perhaps decades, for this information to be gathered by mist-net surveys. And that may be too late for this species.

More importantly for MTNF and other land management agencies than finding out where the bats are is to answer the question, "What are the effects of management actions on Indiana bats?" This question can only be answered through a focused research effort. MTNF in cooperation with NCRS, MDC, and USFWS has initiated such a study in 2005. The answer to this question will help us design forest management projects which have the least negative and greatest positive impact on Indiana bat habitat in the Ozarks.

» Occurrence on MTNF, existing and potential habitat

Critical Habitat

There is no designated critical habitat for Indiana bat on MTNF. There are no Priority One or Two hibernacula located on MTNF lands.

Areas of influence (AOI) have been designated as Management Prescription 3.5 in the current Forest Plan for National Forest lands within 5 miles of a hibernacula entrance. Approximately 77,200 acres of National Forest lands are included in these AOI's. These

areas were designated to "protect Indiana bats and their habitat in and around known hibernacula and known sites of reproductively active females…" (USDA Forest Service 2002). The primary purpose of this designation is to "emphasize management of the habitat most likely to be used as foraging habitat by male Indiana bats in the summer", "provide a continuous supply of suitable roost trees and preferred foraging habitat" and "to protect Indiana bat hibernacula and known sites of reproductively active females." (USDA Forest Service 2002).

Existing Winter habitat and Occurrence on MTNF

After banding over 21,000 Indiana bats over a 9 year period, Myers (1964) concluded that the major portion of Indiana bats in Missouri hibernated in the eastern half of the Ozarks, with the center at Pilot Knob Mine, with a second and smaller population centered in mid-Missouri (Pulaski, Camden, and Laclede Counties) (Myers 1964). The eastern center would include the Salem/Potosi/Fredericktown Districts of MTNF today, and the mid-Missouri center would include the Rolla/Houston District of MTNF today. Myers found few Indiana bats in southern Missouri or northwestern Arkansas, which would include the Ava/Cassville/Willow Springs and Eleven Point Districts of MTNF today.

In February 1979, two Indiana bats were recorded in Hanley Cave (Gardner and Gardner 1982), but there are no other records for that cave that we know of. After that record, Indiana bats were not known to hibernate in caves on Mark Twain National Forest until 1988, when a small colony of hibernating Indiana bats was discovered in Cave Hollow Cave. Populations in this cave have ranged from a high of 250 in 1988 to a low of 5 in 2001. The latest count was 150 Indiana bats in February 2004.

In 1990, Gene and Treva Gardner, under contract to the Forest, discovered a small hibernating colony in White's Creek Cave on the Eleven Point (then Doniphan) District. Populations have ranged from a high of 39 in 1990 to a low of 1 in 2001. The latest count was 33 Indiana bats in February 2004.

Today, there are four caves on MTNF which are known Indiana bat hibernacula. None of these caves was known as a hibernaculum when the original Recovery Plan was approved. All of the known hibernacula on MTNF qualify as Priority 3 caves (<500 hibernating bats) (U.S. Fish and Wildlife Service 1999).

Indiana bat cluster – Knife Cave – 115/05
(Photo by Cave Research Foundation)

The most recent discovery of an Indiana bat hibernacula was on January 16, 2005 when the Cave Research Foundation found a cluster of what they thought might be Indiana bats during a scheduled visit to map and inventory Knife Cave in Pulaski County. During this visit about 25 Indiana bats were found in one cluster. On a February 10, 2005 field visit, Rick Clawson (MDC) confirmed that these are Indiana bats and counted a total of 67 in Knife Cave.

Davis Cave #2 which is also known as an Indiana bat hibernaculum, has a small entrance on MTNF and a larger entrance on the border between Fort Leonard Wood and MTNF. However, the majority of cave passage lies under MTNF. The highest population known from that cave is 37 in 1996 and the lowest is 20 in 1997. The latest survey for this cave in 2004 found 26 Indiana bats.

Two of the known hibernacula have been gated and are locked closed during winter to protect hibernating bats from human disturbance. In 1988, an air-flow gate was constructed across the entrance to Cave Hollow Cave, which is also locked closed from about September 15 to about April 30 annually. This gate has received some vandalism over the years, but we are unaware of any disturbance to the bats as a result. In December 2004, a routine monitoring trip found the lock cut completely through. A new lock was placed on the gate and District personnel are researching more effective closure methods.

In 1991, an air-flow gate was constructed across the entrance to White's Creek Cave. This gate is locked closed on or about September 15 annually and locked open on or about April 30 annually. The gate has been tampered with several times, but we have no evidence of disturbance to the bats as a result.

Davis Cave #2 has one small entrance on MTNF, with the major entrance on the border of MTNF and FLW. However, most passage is under MTNF. Fort Leonard Wood has signed their entrance to Davis #2 Cave, and the entrance located on MTNF is so small as to be virtually unnoticeable to the casual visitor. Rick Clawson's surveys of this cave have found 37, 20 and 26 hibernating Indiana bats.

Knife Cave is not gated or signed, but the entrance is small and not easily noticeable.

Potential Winter habitat on MTNF

There are over 500 cave entrances and several abandoned mine entrances located on MTNF lands. None of these have been evaluated to determine if they contain the temperature and humidity conditions typically used by hibernating Indiana bats. However, the Cave Research Foundation, in partnership with MTNF, has conducted biological inventories of MTNF caves on over 100 caves since 1991. During these surveys no new Indiana bat hibernacula were discovered until 2005 when one cave was discovered with 67 hibernating Indiana bats (see section above).

Winter occurrence adjacent to or near MTNF

There are over 5000 known cave entrances in Missouri. There are 45 known Indiana bat hibernacula (caves & mines) in Missouri (Missouri Natural Heritage Database 2005). Nine are located within the MTNF proclamation boundary. Other than the 4 known hibernacula on MTNF, these caves are located on Fort Leonard Wood, Missouri Department of Conservation lands, lands managed by U.S. Fish and Wildlife Service, Ozark National Scenic Riverways (managed by the National Park Service), and in private ownership. The population in caves other than MTNF is about 64,400 or 99% of the Missouri population. Thirteen Indiana bat hibernacula on other ownerships are within 5 miles of National Forest land (Missouri Natural Heritage Database 2005).

While not adjacent to or near MTNF, it is worth noting that the abandoned Magazine Mine in Tamms, Illinois was gated by its owner, UNIMIN Specialty Minerals Inc., between 1995 and 2001. In 1996, there were 100 Indiana bats hibernating there. By 2003, there were about 26,000 Indiana bats hibernating in the mine. In fact, the numbers have increased faster than the species breeds, indicating that the mine is attracting bats from other areas (Chadwick 2004). It is possible that this mine may harbor more Indiana bats than any other hibernacula known (Tuttle as quoted in Chadwick 2004). This hibernaculum is located about 60 miles from the closest MTNF land, about 56 miles from the capture site of a male at East Fredericktown, about 70 miles from the Poplar Bluff maternity site, and about 83 miles from Pilot Knob Mine.

Existing Summer habitat and Occurrence on MTNF

There are no historic records of Indiana bats using MTNF for summer habitat. However, Myers (1964) banded over 21,000 Indiana bats in central and eastern Missouri from 1954-1960 and found Indiana bats in caves in Crawford, Franklin, Laclede, Pulaski, Shannon, and Iron Counties, among others. All these are counties in which National Forest lands are located. Most of Myer's information comes from banding and recovery at caves, but some information was obtained outside of caves. We cannot be sure that any of the bats he tracked outside the caves were on National Forest lands, but it seems likely that at least some may have been.

LaVal & LaVal banded approximately 12,000 Indiana bats from 1976-1980 in the Meramec River area and radio-tracked or followed bats banded with luminescent tags. Their study found Indiana bat males foraging in both riparian floodplain forest and dense upland forest (LaVal and LaVal 1980).

During summer surveys from 1998 through 2004, only 5 Indiana bats were captured on MTNF. All of these were found on the Salem and Potosi/Fredericktown Districts in east central Missouri. Three were males and two were females (one pregnant and the other post-lactating). Four of these bats were radio-tracked and information gained about roost trees and foraging habitat. In late May 2005, 5 Indiana bats were captured on the Salem and Potosi Districts. Three of these bats were males, and two were females. All were radioed, and four have been tracked to several roost trees and foraging areas near Cave Hollow Cave. As of June 1, 2005, five maternity roost trees have been identified, and simultaneous exit counts at three of these showed at least 49 bats emerging on May 27, 2005. Seven male roost trees have been located.

While not captured on MTNF, two pregnant females captured on COE lands in southeast Missouri in May 2004, were radio-tracked to a roost tree located on MTNF. Exit counts at this tree found a maximum of 30 bats emerging on June 2, 2004.

There is so little data on Indiana bat summer habitat use in southern Missouri that it is difficult to say with certainty what existing summer habitat is on MTNF. However, in 2004, several captures of Indiana bats led to a small amount of information regarding summer habitat use by both male and female Indiana bats, and the information already gained in 2005 is adding to our knowledge of summer habitat.

Summer habitat consists of three primary components which must be present in the home range of the bats – 1) roost trees; 2) foraging habitat and 3) drinking water sources (U.S. Fish and Wildlife Service 1999). The type and arrangement of these components can be different for male and female Indiana bats (Menzel et al. 2001).

Maternity Roost Trees – Until May, 2005, the only maternity roost tree discovered to date on MTNF was a 14-16" shortleaf pine snag that is about 70 feet tall, and is located in a canopy gap on a slight northeast facing slope. The tree had almost no bark left, and the bats were under a slab of bark about 2/3 the way up the tree. The stand the roost tree is in had been commercially thinned in 1992, and has a moderate stocking of relatively large hardwood and shortleaf pine trees. The stand in which the roost tree is located is composed of relatively large trees, and the surrounding area contains an abundance of large snags in varying stages of decay (personal observations Jody Eberly 6/9/04). An area of influence (AOI) has been designated around this tree and is being managed to protect and provide a sustained supply of roost trees and foraging habitat (USDA Forest Service 2004a). This tree is located on the Poplar Bluff District. (See Appendix F – Photos).

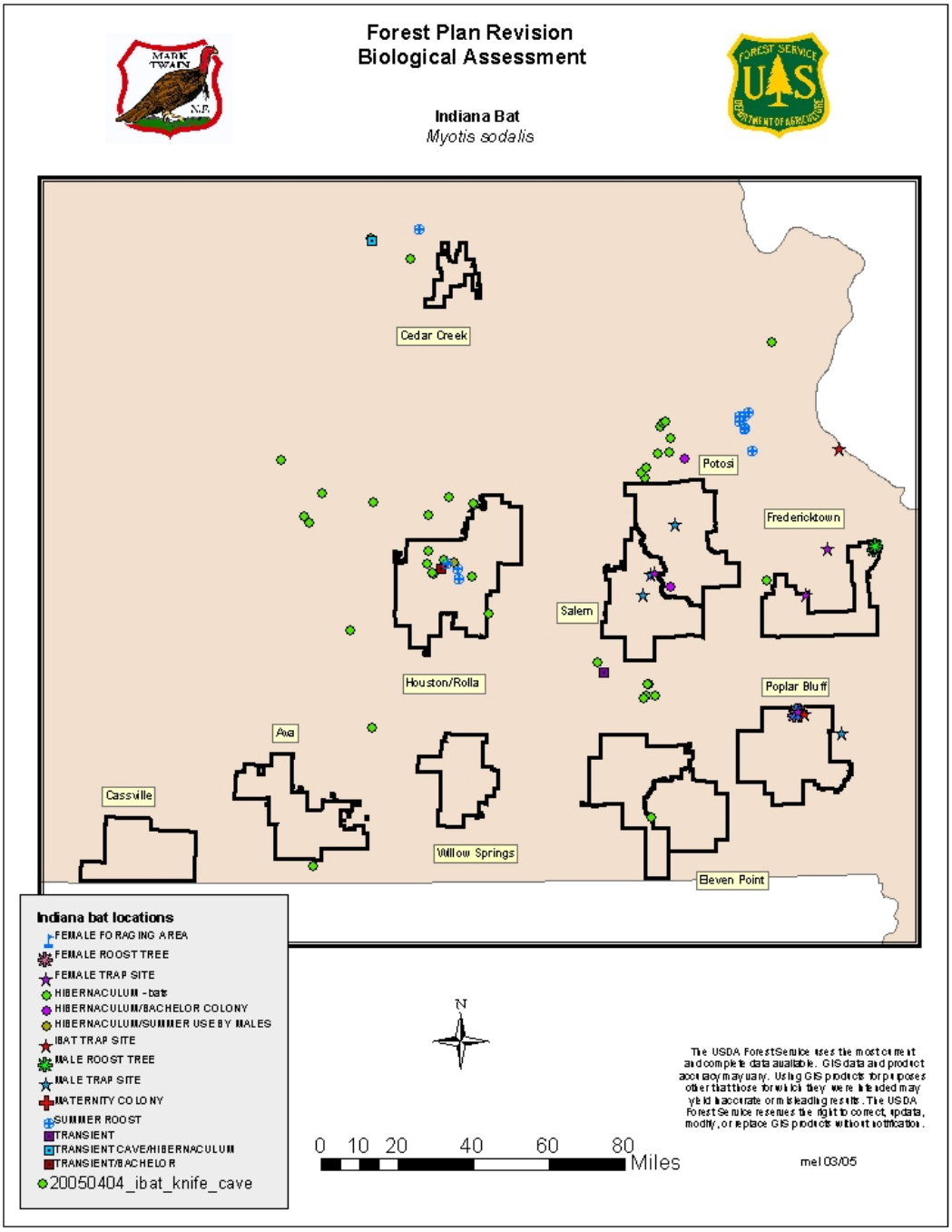
During the week of May 23, 2005, five maternity roost trees were located on the Salem and Potosi Districts. Four of these are on MTNF lands, and one is on private land. All five trees are dead snags, ranging in size from about 9"-20" dbh. Three are shortleaf pine, one is a post oak and one is an oak. One is located in a 10 year old seedtree harvest, and the one on private land is located in a recently cutover area. The other three trees are located in mature forest of moderate to dense canopy, but all the trees are exposed to the sun. All of these trees are currently located in the Area of Influence designated for the Cave Hollow Cave hibernaculum.

Each of the radioed females has used one tree for several consecutive nights (each female used a different tree). Each radioed female left that tree on Friday night (when it rained) and used two different roost trees. An exit count at one of the alternate trees found nine bats emerging at dusk. Both females were found back at their original trees the next night. One female has also used a third roost tree for at least one night.

The area in which these maternity trees are sited is one of the most intensively managed areas of MTNF for wood products, as well as being located within the Viburnum Trend, the largest lead-producing area in the U.S. There is one active timber sale unit that is just at ¾ mile from one of the maternity roost trees. Within ¾ mile of at least one of the maternity roost trees are two active lead mines, tailings ponds, air shafts for the mines, the sewage disposal pond for the town of Bixby, a large powerline, a sawmill, and two state highways. The noise from the vent shaft and mine at the primary roost tree for female #1257 is extremely loud (Sybill Amelon, pers. comm. 6/6/05).

Male Roost Trees - Ten male roost trees were discovered by radio-tracking captured males in the summer of 2004. These trees were all dead oak or shortleaf pine snags, with varying amounts of flaking bark, and ranged from 6" dbh to about 14" dbh. One of these trees had no bark, and the bat was roosting in a crack in the tree bole. Some of these trees were used by a single bat more than once. Almost all male roost trees were within 1 mile of their capture site, with one roost tree being about 3.5 miles from the capture site. All male roost trees were on the Salem and Potosi/Fredericktown Districts. (See Appendix F – Photos).

Figure IB-3: Indiana bat locations in and near MTNF



One of the two males radio-tracked in April 2005 at the entrance of Knife Cave was tracked to five different roost trees (4 shortleaf pine snags and 1 black oak/blackjack oak hybrid snag). Three pine snags were located in small group in a dense pine plantation (basal area about 200 sq ft/acre) and were within about 200 feet of each other. These

trees were also within about 100 yards of a constructed wildlife waterhole on National Forest lands. The fourth pine snag was about 150 yards from the other three. The dead oak roost tree was located about 0.12 miles from the others. All of the roost trees were within about ½ -3/4 mile from Knife Cave. The snags ranged in size from 10" dbh to 16" dbh and from 30 feet to about 70 feet tall. The oak snag was located in an area which had been "high-graded" (all the good timber trees had been removed in a harvest operation) in the past, and the bat had to cross an open area of about 30-40 yards to reach the snag.

Seven male roost trees have been located at the end of May 2005. One male bat was tracked to 5 separate roost trees, all within 0.3 miles of each other, and within 1.3 miles of Cave Hollow Cave. This bat foraged along a nearby Forest Road. His roost trees were two 4" maple snags in year old shelterwood harvest units, two 8" pine snags, and one 10" pine snag. The other male bat was initially tracked to 2 roost trees. The two trees (12" and 20" oak snags) are about 0.9 miles apart, about 4 miles from CHC, and about 0.8 miles from the capture pond. This male was tracked to one additional roost tree on June 1. It is a 7" red maple snag in a drainage located on Doe Run lands. This male stayed in this tree for three nights.

Night Roosts – Indiana bats use both tree roosts and artificial roosts at night between foraging bouts. Indiana bats (juveniles, reproductively active females and adult males) roosted communally under a concrete bridge in Indiana (Kiser et al. 2002). No night roosts have been documented on MTNF. There is an abundant supply of potential night roosting trees on MTNF, but structures are limited. MTNF has some old buildings on lands acquired from private owners, but has no concrete bridges. There are a few low water crossings constructed with one or more box culverts, but these are low enough that they would present a flooding hazard and are not considered suitable night roosts.

Foraging Habitat – The females in the Poplar Bluff maternity colony foraged along a riparian corridor about 1 mile north of the MTNF roost tree. There were several other roost trees located within this corridor (off National Forest lands). The corridor consisted of the permanent stream with some forest and some open grasslands along the stream. The Salem female foraged primarily in upland forest on both private and National Forest lands. She also foraged over a tailings pond owned by Cominco, and over property owned by The Doe Run Company in the vicinity of a lead recycling facility (Sarah Bradley, pers. comm. 2004). (See Appendix F – Photos)

The two females captured in May 2005 foraged in the general vicinity of their roost trees, but specific data is still being analyzed.

The three males tracked in summer 2004 foraged in a variety of locations. One male seemed to forage primarily over the nearby stream and occasionally up and down the Forest Road through the middle of the pine plantation in which he was roosting (Lynda Mills, pers. comm. 2004). This male stayed within about 1 mile of his capture site. One male foraged primarily in upland forest near his capture site, on private forested lands nearby, and over an old tailings pond about 3.5 miles from his capture site. He also foraged in the same general area as the Salem female described above, including around the lead recycling facility (Sarah Bradley, pers. comm. 2004). The third male foraged primarily over NFS lands in upland forest and over old fields on both NFS and private lands (Sarah Bradley, pers. comm. 2004).

One of the males radio-tracked from Knife Cave foraged in an upland drainage for much of the first night. No further information was gained about foraging.

One of the males tracked in May 2005, foraged along a Forest Road about 0.3-0.6 miles from the roost trees. No information has yet been obtained from the other male regarding his foraging behavior.

Water sources – Insectivorous bats, such as the Indiana bat, typically get about 20-26% of their daily water requirement by drinking water (Kurta 2004). There are approximately 5,460 miles of permanent streams and rivers on MTNF, as well as about 3000 constructed ponds, waterholes and lakes and dozens of natural ponds that can provide drinking water for Indiana bats. Four of the five Indiana bats caught on MTNF in 2003 & 2004 were captured in nets set up over woodland ponds or streams. (See Appendix F – Photos). The two female Indiana bats and one of the male Indiana bats captured and radioed in May 2005 were captured at the same pond as a male and female captured in 2004. About 92% of MTNF lands are within ¼ mile of a permanent water source (not including ponds on private lands or large lakes such as Table Rock or Wapapello).

Distance to Hibernacula - Existing studies of summer occurrences of Indiana bats show that males who stayed near hibernacula generally stay within 3 miles of a hibernacula in summer and up to 5 miles from the hibernacula in fall (U.S. Fish and Wildlife Service 1999, LaVal and LaVal 1980). Indiana bats caught on MTNF during the summer of 2004 were found at further distances than these other studies. Capture locations ranged from 5.75 miles to the nearest hibernaculum (Salem female) to 36.5 miles from the nearest known hibernaculum (Poplar Bluff females). Males ranged from 6 to 29 miles from the nearest known hibernaculum. All of the captures were over 10 miles from Pilot Knob Mine, the largest hibernacula in Missouri, and the next closest hibernacula for the three captures for which it was not the closest.

Table IB-3 - 2003/2004/2005 Indiana bat captures in relation to nearest hibernacula and to Pilot Knob Mine (largest hibernacula in Missouri)

Bat	Capture site	Nearest hibernacula	Distance (miles)	Distance to PKM (miles)
1 female 2004	Salem MTNF	Cave Hollow Cave	5.75	30
1 male 2004	Salem north MTNF	Cave Hollow Cave	6	30.75
1 male 2004	Salem south MTNF	Cave Hollow Cave	7.5	33
1 female 2003	Silver Mines MTNF	Pilot Knob Mine	11	11
1 male 2004	East Fredericktown MTNF	Pilot Knob Mine	29	29
2 females 2004	Poplar Bluff COE	Pilot Knob Mine	36.5	36.5
1 female (non NF)	Fredericktown Pvt	Pilot Knob Mine	17.7	17.7
2 males 2005	Knife Cave entrance	Knife Cave	0	88
2 males 2005	Cave Hollow Cave entrance	Cave Hollow Cave	0	20
1 male 2005	Salem MTNF	Cave Hollow Cave	5.8	24
2 females 2005	Salem MTNF	Cave Hollow Cave	5.8	24

There are also existing hibernacula in the neighboring states of Illinois, Arkansas and Oklahoma. Summer capture sites for Indiana bats on MTNF are over 100 miles from hibernacula in Arkansas and Oklahoma. The Magazine Mine hibernaculum in Illinois is about 60 miles from the nearest capture site on MTNF, and over 60 miles from the remaining capture sites.

Potential Summer habitat on MTNF

Taking the data from the 2004, limited information from early 2005 captures, and considering summer habitat descriptions from other parts of Missouri and the Midwest, summer habitat can consist of a variety of landscapes and cover types (including urban and agricultural areas), and a variety of structural stages of forest cover (Menzel et al. 2001). Roost trees are commonly found in mixed hardwood and hardwood-pine upland forest, in riparian and bottomland forest, in wetlands, and in pine-dominated forest, and have been documented in grazed and ungrazed pastures, a clearcut, hog lots, shelterwood harvest units, and burned areas for red-cockaded woodpeckers (Menzel et al. 2001) and in a developing subdivision (Belwood 2002). Foraging has been documented in riparian areas, in woodlots, upland forests, over ponds, and at the edges of pastures, old fields, and forest/stream edges (Menzel et al. 2001).

About 5% of MTNF is in openland (pasture, old fields, glade, warm-season grasses) and 95% is in forest cover. The current composition of MTNF is about 3% regenerating forest (0-9 years old), 18% young forest (10-49 years old), 55% mature forest (50-89 years old), and 18% old growth (>= 90 years old). Most of the Forest is composed of oak-hickory forest (66%), with a substantial portion in oak-pine (14%) and pine (9%). The remaining forest cover is cedar/cedar-hardwood (4%) and various kinds of other hardwoods (i.e. bottomland hardwoods, maple) (1.5%).

MTNF lands are interspersed with other ownerships, including other agency and private lands. These ownerships are also a combination of forest of varying ages and types, and openlands.

It would appear from descriptions of summer habitat across the range that almost all of the MTNF would be suitable summer habitat – either for roosting or foraging or both. However, this may not be the case. Summer capture rate for mist-netting Indiana bats on MTNF is extremely low. Acoustic surveying of MTNF has also resulted in very few Indiana bat call files. This indicates that either Missouri's Indiana bats are much better at evading mist-nets than Indiana bats in other parts of the range where capture rates are much higher, or that Indiana bat use of MTNF lands is, in reality, very low.

The reasons for this are unclear, but LaVal and LaVal (1980) suggested that one reason Indiana bats migrate to unglaciated regions in summer is due to competition for food from gray bats. Gray bats eat primarily insects with aquatic larval stages. In the southern part of the range, terrestrial insects are over 90% of Indiana bat diet (Brack and LaVal 1985 as cited in Murray and Kurta 2002), while in the northernmost sites in Michigan (where gray bats and eastern pipistrelles are absent), aquatic insects make up the majority of Indiana bat diet. Competition with gray bats for larger aquatic insects and with eastern pipistrelles for smaller aquatic insects may be the reason Indiana bats eat primarily terrestrial insects in the southern parts of the range. It may also explain why female Indiana bats in the large hibernating colonies migrate north for the summer

(Gardner and Cook 2002, Whitacker and Brack 2002). Whether or not interspecific competition is occurring on MTNF is unknown, but gray bats are the third most captured species and eastern pipistrelles are the fourth most captured in six years of mist-net surveys on MTNF (Sybill Amelon pers. comm. 2005). Red bats are the most commonly captured species, followed by northern long-eared bats.

The range of the Indiana bat is very large, but this tree bat in summer is most common in parts of its range with large, open, unforested areas and is typically not common in heavily forested regions (Brack et al. 2002). Brack et al (2002) state that "There is no evidence that the Indiana bat was ever common in the eastern United States, despite vast forests that seemingly could be used by a tree-dwelling bat and caves that could be used for hibernation. Obviously, many other factors affect distribution, abundance, and reproductive success of the species; climate, on a larger scale, and weather, on a more local scale, are notable examples. We believe that a unique association of summer and winter temperatures, a combination that is lacking over much of the range of the Indiana bat, accounts for substantial, geographic differences in abundance of this endangered species." They also conclude that "it is unlikely that the species was or will be equally abundant in all parts of its range." Whether or not these are factors operating in southern Missouri and the reason for low summer capture rates is also unknown.

However, it seems clear that Indiana bats are not abundant in southern Missouri in the summer, and may never have been. Arkansas also has a similar situation, although the hibernating population (about 2000 Indiana bats) is much less than in Missouri. Summer mist-netting at 126 sites in Arkansas on 178 nights from 1996-1998 resulted in the capture of over 1000 individuals of 13 species of bats, but only 15 Indiana bats were caught (about 1% of the total captures) and all were males (Harvey 2002). Although Indiana bats have been recorded from three counties in Oklahoma, most records involve less than 10 individuals and no regular hibernacula surveys are conducted (US Fish and Wildlife Service 1999, page 8).

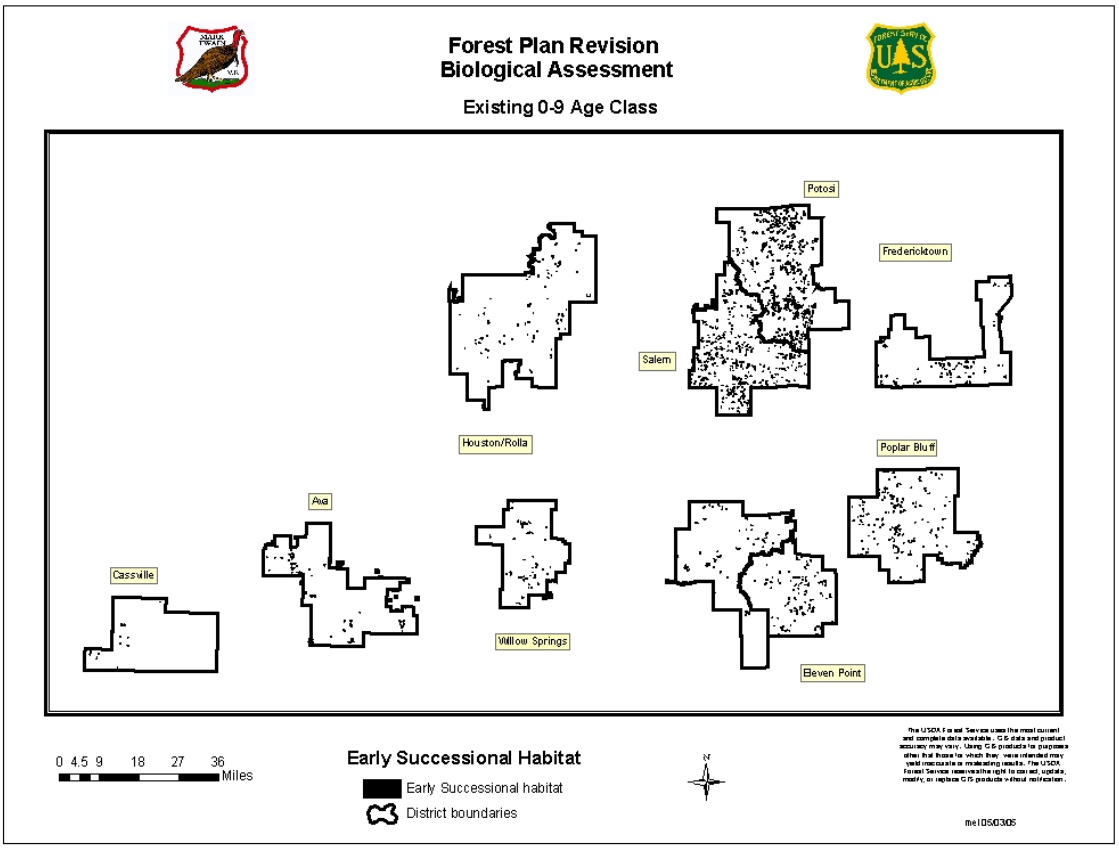
Maternity Roost Trees - Studies done on maternity colonies have found that female Indiana bats roost primarily in relatively large, dead or near dead trees with some flaking, exfoliating bark (Kurta 2004, Menzel et al. 2001). Although some female Indiana bats have been found roosting in living shagbark and shellbark hickory or other living trees with naturally curling bark, some researchers feel that living trees are only used if suitable dead trees are not available (Carter 2003 as cited in Kurta 2004). Most trees favored as roosts by maternity colonies are greater than 9" dbh (Kurta 2004). All maternity roost trees discovered on MTNF to date are dead trees at least 10" dbh or larger.

On MTNF, about 1 million of the 1.5 million acres (74%) are in forest cover greater or equal to 50 years old. Most of this acreage would have tree diameters of 9" dbh or greater.

Maternity colonies typically choose roost trees that are exposed to solar radiation for a good part of the day (Menzel et al. 2001, page 6; Kurta 2004, page 4), which means that many roost trees are located at the edge of an opening or in a canopy gap. All of the maternity roost trees discovered to date on MTNF are in open canopy situations or in canopy gaps where they are exposed to the sun.

Approximately 3% of MTNF is in regenerating forest which would provide canopy gaps ranging from a few acres in size to 40 acres in size, dispersed across the Forest (see 0-9 age class Map below). Other canopy gaps of varying size exist where natural tree mortality has occurred.

Figure IB-4: Distribution of 0-9 Age Class on MTNF 2005



Most of the documented maternity colonies are from areas in the Midwest that were historically prairie (unlike MTNF), and are now primarily agricultural. Rangewide, in counties that contain documented maternity colonies, 76% of the land is non-forested (Gardner and Cook 2002). Gardner et al (1991) evaluated landscape settings of Indiana bat maternity habitats and found their study area contained 65% cropland or old fields, 2% other agriculture, 33% forested, and 0.1% impounded water. From this information, it would appear that MTNF does not fit the classic description of maternity habitat, since most of MTNF is not in historically prairie landscapes, and current land cover is about 95% forested.

There are some recently documented maternity colonies from more forested regions in the southern Appalachian Mountains of North Carolina and Tennessee. Wayne County, Missouri, in which a maternity colony was discovered on MTNF in 2004, is composed of about 80% forest cover, 16% row crops or grassland, 0.4% bottomland forest, and 3% water or wetland (MORAP 2005). Iron County, in which a maternity colony was

discovered on MTNF in 2005, is composed of 85% forest cover, 15% row crops or grassland and less than 1% of water and urban area. The Cave Hollow Cave Area of Influence is 91% forest cover, 8% row crop or grassland, and 1% water. Both the Wayne County and Iron County maternity colonies are located in significantly more forested landscapes than the classic maternity colonies of northern Missouri, Illinois and Iowa prairie landscapes.

Male Roost Trees - Menzel et al. (2001) state that "Roost trees occur in many habitat types with different stand structures". Male Indiana bats on MTNF have almost exclusively used dead trees as roosts, and most have been relatively large trees (>= 10 dbh). Literature from other parts of Indiana bat range indicates that males may use a variety of size trees, including relatively small ones (Kurta 2004 In Press). The location of several of the male roost trees have been in dense shortleaf pine plantations, a habitat not normally considered optimum for Indiana bats. However, although the males roosted in dead pine trees, they foraged in more open upland forest and along nearby riparian corridors.

About 95% of MTNF is forested with trees in various densities and of various diameters which could provide potential roost trees for male Indiana bats.

Foraging Habitat – Indiana bats forage in a variety of habitats, including upland and riparian forest with canopy closures from 30%-100%, over clearings, along the edges of cropland, wooded fencerows, and over farm ponds in pastures (U.S. Fish and Wildlife 1999, page 12). Indiana bats have also been documented foraging in recent harvest units (Gardner et al. 1991). Foraging distances probably depend upon habitat quality and insect abundance, and have been documented to be from about ½ mile to about 5 miles from roosts for females and about ½ mile to about 2 miles from roosts for males. In the fall, these distances may be greater.

There is speculation that the best foraging habitat is composed of a diversity of forest and non-forest types since emergence of arthropods upon which Indiana bats feed is likely asynchronous among various cover types, presumably resulting in a continuous supply of insects throughout the summer (Farmer et al. 2002). Food-producing cover types used for a habitat suitability index model for the "core" maternity range of northern Missouri, southern Iowa, Illinois, southern Michigan, Indiana, and western Ohio, include: row crops, pasture, hay field, wetlands, water, early successional habitat, upland deciduous forest, riparian/floodplain deciduous forest, and coniferous forest (Farmer et al. 2002). The best foraging area was considered to be where at least four of these types (comprising at least 10% of the area) are found within a 1.2 mile landscape (Farmer et al. 2002). Others believe perfect foraging habitat includes forested streams interspersed with grasslands, croplands, or shrublands, and that open habitats such as agricultural fields and old fields are critical maternity foraging habitat in heavily forested landscapes (Sparks et al. In Press).

Currently, MTNF is about 5% open habitats, 3% regenerating forest, about 18% pole sized forest, about 55% mature sawtimber sized forest, and about 18% sawtimber sized forest greater than 90 years old. Canopy closures are generally dense, with some areas with moderate to low canopy closure. About 90% of MTNF has forest cover with canopy closures from 30%-100%.

The oak weevil was a frequent and sometimes dominant part of the diet of Indiana bats at the Indianapolis International Airport study area, leading to the speculation that Indiana bat may be an important biological control agent for this species (Sparks et al. In Press).

Summer occurrence adjacent to or near MTNF

Because the ownership pattern of MTNF ranges from 17% at Cedar Creek to about 71% on the Eleven Point District, occurrences adjacent to or near MTNF can give us valuable information about potential habitat use on MTNF.

Contractors for Fort Leonard Wood captured 1 adult non-reproductive male Indiana bat on MTNF lands and none on FLW lands during surveys from 1998-2002.

Contractors for the ACOE at Lake Wappapello in southeast Missouri captured 2 lactating female Indiana bats and 2 Indiana bats not sexed or aged during the summer of 2002. In this same location, 1 adult male was captured in mid-August 2003. An additional 2 lactating females were captured at a separate location in July 2003.

On August 2, 2004, Mark Yates captured an adult non-reproductive female Indiana bat near Farmington, Missouri. The bat was captured on private land, about 5.5 miles from National Forest land. The net was set up over a stream and the surrounding habitat was hayfields mixed with bottomland, swampy forest with lots of snags.

An Indiana bat maternity colony is located in Ste. Genevieve County at the Holcim Cement Company site. This colony is located about 24 miles from the nearest National Forest System land on the Fredericktown Unit. This colony was discovered through survey and radio-tracking by contractor WDH Ecological Services in March – October 2001. Female Indiana bats were captured and radio-tracked to several roost trees. At least one of these roost trees was across the Mississippi River in Illinois. One roost was in a power pole on the Holcim site. The main roosting area was located on an island in the Mississippi River. This colony was estimated to contain about 230 Indiana bats. It is not clear where these bats spend the winter, or in which direction they migrate to their hibernacula. The colony is about 40 miles east of Pilot Knob Mine, the largest hibernacula in Missouri, and about 80 miles from the Magazine Mine hibernacula in southern Illinois.

Male Indiana bats were also captured on the Holcim site and radio-tracked to 3 roosts in dead silver maple trees.

All of these captures and known locations reinforce information in other published literature about habitat use and behaviors of Indiana bats, except that the captured males were further from hibernacula than expected.

Existing Migrating habitat on MTNF (Spring & Fall)

Migrating corridors or patterns for Indiana bat are essentially unknown, as is Indiana bat habitat use or behavior during migration (Menzel et al.2001). There are some data from banding records showing migrating paths to and from specific caves, but there is no clear overall picture of where and when Indiana bats migrate (U.S. Fish and Wildlife Service 1999). The only two sources for information regarding migration in Missouri show movement between hibernacula, north from Ozark hibernacula to summering areas in northern Missouri and southern Iowa (U.S. Fish and Wildlife Service 1999, LaVal and LaVal 1980), and from maternity colonies in Illinois to hibernacula in Missouri (Gardner and Cook 2002). Recent radio-tracking efforts in New York and Pennsylvania showed an Indiana bat traveled 60 miles in one night and 35 miles another night (Sybill Amelon, pers. comm. 4/26/05). The furthest known migration is 330 miles from a hibernacula in Kentucky to a maternity area in Michigan (Kurta and Murray 2002).

Since the Ozarks contains all of Missouri's major hibernacula, and most documented maternity sites are in areas north and east of the Ozarks, the Forest Service assumes that migrating Indiana bats must be using some Forest habitat during migration. However, it is not clear if habitat needs during migration are the same as in summer maternity or male sites, or are different.

Existing migrating habitat is not known, but we assume that any of MTNF could be potential migrating habitat, and that Indiana bats may roost in dead trees or living trees with flaking bark during the day, and forage in riparian and/or upland forests during the night.

More information is needed about migrating paths, habitat use during migration, and timing of migration.

Existing Swarming habitat on MTNF (Fall)

Harp trapping at both White's Creek and Cave Hollow Caves in the fall captured only one and three Indiana bats respectively. Harp trapping has not been done in the fall at Davis #2 or Knife Caves. We do not know if any of the 4 hibernacula on MTNF serve as swarming sites, or if the bats using these caves swarm and mate in a different location before moving to MTNF caves. Regardless, the bats which use MTNF caves for hibernation most likely use some area around the entrance of the caves for foraging and roosting in the days leading up to hibernation.

The best scientific information available indicates that during fall swarming, the size of area used is probably correlated with the size of the colony using the cave. At Fort Leonard Wood, Missouri, Indiana bats' mean home range was about 1650-2450 acres and the farthest distance traveled from the cave was about 3.3 miles (Romme 2002). In Kentucky, Indiana bats foraged in uplands in the fall (Kiser and Elliott 1996).

All four MTNF hibernacula are surrounded by primarily forested cover in various stages of succession. White's Creek Cave is within the 16,500 acre Irish Wilderness and adjacent to the 44 mile Eleven Point National Scenic River, which is primarily mature forest and where management activities are strictly limited (U.S. Forest Service 2005, pages 3-17 through 3-24 and 3-43 through 3-47). The population using this cave is about ½ and ¼ that of two of the other hibernacula that are located in managed forest.

Knowledge Gaps
While much has been learned about Indiana bat habitat use over the past 15 years, much still remains unknown. Still, much more is currently known about Indiana bat habitat use and life history than is known for some other species of forest bats in the eastern U.S.

We now know that there are at least a few maternity colonies located in unglaciated parts of Missouri. However, we do not know the extent of this use, or whether habitat selection and use is different in the more heavily forested parts of the range than the prairie regions.

We still know almost nothing about migration paths, timing and habitat use along the way.

» Consistency of Revised Forest Plan with applicable Recovery Plan Actions

Although an Agency Draft Recovery Plan was prepared in March 1999, it has never been officially approved by U.S. Fish and Wildlife Service. The 1983 Indiana Bat Recovery Plan (U.S. Fish and Wildlife Service 1983) is the only plan approved by U U.S. Fish and Wildlife Service (Theresa Davidson, U.S. Fish and Wildlife Service, pers. comm.. 1/11/05). Therefore, the Recovery Actions listed in that plan will be used in this section; recognizing that they are in need of updating.

Recovery Action ***1.1 Prevent Disturbance to Important Hibernacula*** does not particularly apply to MTNF, since both known hibernacula on MTNF are classed as Priority 3 hibernacula. However, since Indiana bats are still declining in numbers in Missouri, the Forest Service feels that any hibernacula should be protected from disturbance, no matter how small the hibernating population is. Therefore, actions to prevent disturbance have been taken at both known hibernacula on MTNF. The revised Forest Plan contains a standard prohibiting human entrance to hibernacula except for legitimate monitoring or scientific needs (USDA Forest Service 2005, page 2-11). See section on Standards and Guidelines above.

1.1.1 Erect Warning Signs - Signs have been posted at both caves, although they are difficult to keep up due to vandalism. There is nothing to prevent us from signing additional caves as needed.
1.1.2 Gate or Fence Cave – Both caves have had air-flow gates installed, which are locked closed from about September 15 through April 30 of each year. Each cave gate periodically been vandalized, but it is unknown whether or not that led to disturbance of wintering Indiana bats. The revised Forest Plan contains a standard requiring maintenance of existing gates (USDA Forest Service 2005, page 2-11). There is nothing preventing us from constructing additional protective structures if new Indiana bat hibernacula are found on MTNF. If additional structures are proposed, there is a standard and guideline in the revised Plan requiring that it must permit bats to pass freely and not alter airflow in the cave (Forest Plan page 2-10).
1.1.3 Monitor Hibernacula - Both gated hibernacula are visited sporadically to check gate conditions

1.1.5 Discourage Human Access – White's Creek Cave is located in the Irish Wilderness, where no vehicle traffic is allowed. Only foot travelers can reach this cave, either by a 7-9 mile walk, or a ½ mile hike from the Eleven Point National Scenic River. A hiking trail is located just outside the cave entrance. This cave has been a recreation destination for decades. One of the factors when deciding whether to gate the cave was how a gate and closure would impact the long-standing tradition of recreationists visiting the cave. District personnel have discussed re-routing the trail at various times, but no action has been taken. The revised Forest Plan has a guideline which encourages re-location of trails to at least 100 feet away from a cave entrance (USDA Forest Service 2005, page 2-11).

Cave Hollow Cave has a system road within ¼ mile of the cave entrance. There are no plans to close this road, so it would remain open for vehicle traffic.

Knife Cave is located near an old road that is not accessible except on foot (3/4 mile walk) or by ATV. The cave entrance is not visible from the old road, making it less likely that casual hikers would enter the cave. The opening is a single crack approx. 3' high by 10 feet wide. On February 10, 2005 we found evidence that there is some visitation, but not much.

Davis #2 Cave is accessed through a locked gate on Fort Leonard Wood. The general public has no way to get to this cave. The cave entrance is located less than ¼ mile from a woods road.

Other Recovery Actions that are applicable to MTNF include:

1.2 Prevent Adverse Modifications to Winter and Fall Roost Sites:
There have been no subsurface or adverse surface modifications to either White's Creek or Cave Hollow Caves (***1.2.1 and 1.2.2***). The revised Forest Plan contains a standard requiring at least 20 acres of permanent old growth around occupied Indiana bat cave entrances, and an additional 130 acres of mature forest or woodland (USDA Forest Service 2005, page 2-11).

1.2.3 Make locations of Hibernacula Available to Appropriate Fish and Wildlife Service Offices and State Wildlife Agencies. The Forest Service cooperates with both U.S. Fish and Wildlife Service and Missouri Department of Conservation on actions related to both caves. All known hibernacula locations and data are known to U.S. Fish and Wildlife Service and MDC. The revised Forest Plan contains a standard that requires listed species be managed in accordance with approved recovery plans (USDA Forest Service 2005, page 2-11).

1.3.1 Identify all Indiana Bat Winter and Fall Roost Sites – Many caves on MTNF have been surveyed for the presence of Indiana bats. The Cave Research Foundation, in cooperation with the Forest Service, conducts bioinventory of caves on MTNF each year (see Survey Section above). To date, no additional roost sites have been discovered. The Forest Service is actively involved in looking for additional winter or fall roost sites. There is nothing in the revised Forest Plan that would prohibit us from continuing this activity

2.1.1 Determine Habitat Requirements (Foraging Areas and Nursery Roost Habitat) **-** This action relates to surveys to identify foraging and nursery habitat, and locating potential summer habitat. MTNF, in cooperation with NCRS, has conducted summer

surveys on each District (see Survey Section above). As a result of these surveys, we have gathered some additional information on male roost trees, male foraging habitat, female maternity roost trees and female maternity foraging habitat. However, much still needs to be done. In 7 years of mist-netting surveys, only 5 Indiana bats have been captured on MTNF lands. The revised Forest Plan contains a guideline suggesting radio-tracking of females to identify roost trees where possible (USDA Forest Service 2005, page 2-6). There is nothing in the revised Forest Plan that prevents us from continuing habitat surveys as deemed appropriate.

2.1.2 Preserve Water Quality – Indiana bats forage on a variety of insects, some of which are aquatic and depend upon good water quality. The revised Forest Plan has redefined riparian and watercourse protection zones to make management of watershed conditions more consistent across the Forest. There are standards and guidelines which protect the physical and biological characteristics of riparian corridors and which limit or restrict activities to minimize soil erosion and resulting sedimentation of streams.

2.1.3 Restore and Preserve Forest Cover along Rivers and Streams – This action suggests replanting riparian vegetation where riparian forest is removed as a result of a project. MTNF does not normally "remove" riparian vegetation to accomplish project objectives. The revised Forest Plan has standards and guidelines which restrict activities that can occur within the Riparian Management Zone (RMZ) (USDA Forest Service 2005, page 2-3 through 2-4). These restrictions are designed specifically to maintain healthy, functioning riparian vegetative communities. The revised Forest Plan also has standards and guidelines which restrict activities that can occur in upland stream reaches, designated Watercourse Protection Zones (WPZ) (USDA Forest Service 2005, page 2-4 through 2-5).

2.1.4 Monitor Habitat – Until 2003, no Indiana bats had been captured on MTNF, and therefore it was impossible to monitor specific habitats the bats may have been using. However, MTNF has monitored several items related to Indiana bat habitat as part of our annual report to U.S. Fish and Wildlife Service on implementation of the 1999 programmatic BO. In addition, many proposed site-specific projects use a computerized program which identifies, based on published literature, potential habitat in that project area for Indiana bat. This program also predicts site-specific changes in Indiana bat habitat based on proposed activities (USDA Forest Service 2005(a)).

3.1 Monitor Status of Populations in Hibernacula – MTNF cooperates with Missouri Department of Conservation to survey winter populations in both White's Creek and Cave Hollow Caves. (See Survey and Population Status Sections above). The revised Forest Plan has a standard which allows for regularly scheduled population monitoring at occupied Indiana bat hibernacula in the fall through spring (USDA Forest Service 2005, page 2-11). Chapter 4 of the revised Forest Plan identifies monitoring and evaluation needs, including population status and trends for TES (USDA Forest Service 2005, page 4-11).

3.2 Monitor Status of Populations in Summer – During 7 years of summer mist-net surveys, MTNF has only captured 5 Indiana bats, and that was in the last 2 years. It is clearly not possible to effectively monitor summer Indiana bat populations on MTNF using mist-net surveys. We do not know if there is a statistically valid, effective method for monitoring status of summer Indiana bat populations on MTNF, with the obviously low numbers and scattered nature of summer populations on MTNF. Chapter 4 of the revised Forest Plan identifies monitoring and evaluation needs, including population status and trends for TES (USDA Forest Service 2005, page 4-11).

4.3 Warning Signs at Caves – can be used to help educate and inform the public. Signs with information about hibernating Indiana bats have been placed at both MTNF hibernacula. There is nothing in the revised Forest Plan that would prevent us from continuing to place educational signs at Indiana bat hibernacula.
4.6 Ranger-Naturalist Talks - MTNF wildlife biologists have put on hundreds of endangered bat programs over the past 20 years for schools and civic groups. There is nothing in the revised Forest Plan that would prevent us from continuing such programs.

5. Research Needs – The MTNF is not a research agency. However, we work closely with the research arm of the Forest Service, North Central Research Station in - Columbia, Missouri, to identify needed research studies. MTNF partially funded a study designed to 1) describe microclimate of hibernacula on MTNF; 2) Describe age & sex of Indiana bats using MTNF hibernacula; 3) describe habitat use on MTNF by roosting and foraging male Indiana bats during summer and fall and 4) describe movements and home ranges of reproductively active females on or near MTNF (Amelon 1998).

As a result of the 2004 discovery of a maternity colony on MTNF, we are cooperating with NCRS to further study habitat use of this colony starting summer 2005 (***5.1 Summer Habitat Requirements***). In addition, MTNF is cooperating with NCRS, MDC, and U.S. Fish and Wildlife Service to determine effects of forest management activities on forest bats, and Indiana bat in particular (USDA Forest Service, 2005(b)) Chapter 4 of the revised Forest Plan identifies monitoring and evaluation needs. One of the monitoring questions is: "To what extent is Forest management contributing to the conservation of threatened and endangered species and moving toward objective for their habitat conditions?" (USDA Forest Service 2005 page 4-11). The proposed study will help answer that question.

» Effects of implementation of the proposed action (Alternative 3)

Effects analysis will:

A). identify actions which may affect Indiana bat individuals, groups, or habitat in negative or positive ways. It will also identify which actions would have no effect and which actions have effects which are questionable or unknown.
B) describe how those actions impact individuals, the species, or habitat; by
- a) identifying how many individuals would be exposed
- b) which populations are represented by those individuals
- c) identifying specific stressors associated with exposure to the action
- d) identifying where and when exposure would occur
- e) identifying the duration and extent of exposure

C) describe how individuals, groups or habitat would respond if exposed to that an action's effects
D) describe the relationship between the effects of the action and the response of Indiana bat individuals, groups, or habitat.
E) estimate the risk posed to Indiana bats by the action

There are no studies or published research on the effects of forest management practices on Indiana bats, and very few studies on the effects of forest management on

any species of forest bat in North America (Miller et al. 2003; Menzel et al 2001). Those studies which have been done have reached a variety of conclusions. Miller et al. 2003 state that of the papers they reviewed, 80% of those conducted in areas without recent timber harvest concluded that harvest is detrimental to forest bats; while 80% of studies conducted in areas with active timber management concluded that harvest was beneficial or neutral as long as adequate roost structures were maintained (Miller et al. 2003). . Studies of habitat use by Indiana bats have also indicated that some types of harvest, including regeneration harvest, may have limited adverse impacts and may have some beneficial impacts on bat habitat if snags and potential roost trees are retained (Menzel et al. 2001, page 8; Grindal & Brigham 1998; Humes et al 1999; Patriquin & Barclay 2003). Most roost trees in a Kentucky study were in one of four core areas dominated by oak/hickory/pine and areas of disturbance from natural causes or timber harvest activities (Gumbert et al. 2002).

Researchers who have been studying colonies of female Indiana bats or summering males have also reached a variety of conclusions regarding their habitat needs. However, the fact is that Indiana bat summer colonies and individual summering males have been found in a wide variety of habitat conditions, from suburban neighborhoods to major airport, to highly fragmented agriculture/woodlot matrix, to dense forest suggests that Indiana bats “may be more tolerant of limited disturbance of the roosting area” (Menzel et al. 2001), that Indiana bats “may, in fact, respond positively to habitat disturbance” (U.S. Fish and Wildlife Service 1999), and that “the Indiana bat may be a more adaptable species than previously thought” (U.S. Fish and Wildlife Service 1999).

In spite of the ambiguity over effects of forest management, there is no question that roost trees, foraging habitat, and hibernacula are the primary habitat components vital to survival of Indiana bats. In order to provide these components on MTNF, the revised Forest Plan was designed to:

- Protect occupied roost trees (standards and guidelines)
- Protect possible roosts and foraging habitat near occupied roost trees(standards and guidelines)
- Provide a continuous supply of suitable roost trees for both male & female Ibats well-distributed over the entire MTNF over the short and long term (Management Prescription goals and desired conditions; standards and guidelines)
- Provide suitable foraging habitat well-distributed across MTNF through restoring and perpetuating natural communities in patterns approximating historic distribution, structure, composition and disturbance patterns (Management Prescription goals, Desired Conditions).
- Protect occupied hibernacula from human disturbance (standards and guidelines)
- Protect and maintain microclimate around cave entrances (standards and guidelines)
- Provide suitable roost trees and foraging habitat around known hibernacula and swarming sites (standards and guidelines)

Direct Effects

Direct effects may occur to both individuals of the species or to habitat used by the species. Direct effects may occur to Indiana bats hibernating in caves located on MTNF (<400 bats), to Indiana bats roosting or foraging on MTNF lands from spring through fall (# unknown), or to specific habitats being used by Indiana bats (i.e. occupied roosts, occupied hibernacula, occupied foraging habitat).

We have no accurate estimate of how many Indiana bats use MTNF lands for roosting and/or foraging during spring through fall, but can assume that it would be something less than 64,800 (the number of bats estimated to winter in Missouri caves & mines in 2004/2005). We know that some of the Indiana bats which hibernate in Ozark caves and mines fly to northern Missouri, southern Iowa, and western Illinois (U.S. Fish and Wildlife Service 1999) for the summer, so not all of the 64,800 Indiana bats which winter here will stay here. We also know that there are Indiana bats using private ownerships or other agency lands in the Ozarks. It is also possible that some Indiana bats wintering in Illinois, Arkansas or Oklahoma may forage or roost in southern Missouri.

For this analysis, I am *assuming* that approximately ½ of the hibernating Indiana bats in the Ozarks stay in southern Missouri and that approximately ½ migrate to northern or eastern summer sites outside of the Missouri Ozarks. I base this assumption on a sex ratio in Indiana bats of about 50:50 (Myers, 1964; LaVal and LaVal 1980) and that the current state of knowledge suggests that many females and some males migrate north from hibernacula (U.S. Fish and Wildlife Service 1999). Therefore, the maximum number of Indiana bats which may be affected by activities which alter their summer habitat would be about 32,400 and the majority of these would be males.

I am also *assuming* that as Indiana bats move from hibernacula to summer sites, any of those bats could spend some time on MTNF lands roosting and/or foraging during migration. Therefore, activities which impact spring or fall habitat have the potential to affect a maximum of about 64,800 Indiana bats.

The MTNF is comprised of about 1,496,000 acres. About 95% is in forest cover, ranging from regeneration to old growth and comprised primarily of oak-hickory, oak-pine and pine forest types.

The recent summer captures of Indiana bats on and near MTNF have taken place in the eastern and southeastern counties of the Forest, despite surveys being undertaken on all parts of the Forest. Recent captures by other surveyors have also been concentrated in the eastern part of Missouri, as were the majority of captures by Myers in the late 1950's and early 1960's (Myers 1964). This information leads us to believe that the most likely locations for exposure to effects described here would be on the eastern and southeastern districts of the Forest (i.e. Salem, Potosi/Fredericktown, and Poplar Bluff). In addition, although no captures of Indiana bats have occurred recently, the Houston-Rolla District is also considered fairly high probability of having summering males due to the number of hibernacula which are on or near MTNF lands. Districts considered low probability for exposure to effects include Ava/Cassville/Willow Springs and Eleven Point due to their distance from recent captures, scarcity and distance from major hibernacula, and differences in landscape conditions. The Cedar Creek Unit, north of the Missouri River, is between the major hibernacula areas and major maternity areas in northern

Missouri/southern Iowa, and is considered a moderately likely location for maternity colonies and migrating bats.

Potential Negative Effects

- ***Disturbance to occupied hibernacula:***

Potentially the most adverse effect on Indiana bats would occur if human entry to an occupied hibernacula resulted in arousal of the bats, causing a loss of crucial fat reserves (U.S. Fish and Wildlife Service 1999). Depending on the severity and extent of disturbance, one entry may be enough to result in mortality of one or more bats. Or several entries of less severity could also result in enough fat reserves being depleted that individual bat(s) may not live until spring. It is also possible that a person or persons could enter an occupied hibernacula and deliberately kill hibernating bats (U.S. Fish and Wildlife Service 1999).

The most likely scenario is a single unauthorized disturbance to one of the occupied hibernacula during a winter, with arousal of bats, but no long-term adverse impact to the individual bats or the group in that cave. This scenario could affect from about 25 to 250 Indiana bats (0.037%-0.37% of Missouri's population). However, two of the four caves are gated, and one other is being proposed for gating. The fourth cave entrance is so small and inconspicuous that the probability of people entering is extremely low. Even with minor vandalism occurring at both gates we have, populations in the last survey were higher than previous count. It does not appear that people are getting into the caves, or if they do, it does not appear to have caused harm or affected the use of the cave by Indiana bats.

The worst case scenario would be that one or more of the MTNF hibernacula would be vandalized and that up to 400 Indiana bats could be killed or die as a result of disturbance. This would be about 0.6% (67,000) of Missouri's hibernating population; and about 0.1% of the range-wide population.

The four hibernacula known to be located on MTNF lands have a total of less than 400 Indiana bats at their highest populations, and less than 300 bats at the latest survey. Two of the caves are gated and locked closed from September through April, although both gates have been vandalized occasionally in the past. Even so, populations at both caves have declined, and have then rebounded somewhat. However, all three caves (2 gated, 1 not gated) for which we have data show a similar trend. We do not know if the gate vandalism has resulted in adverse impacts to the bats, or if there is a regular fluctuation in populations this small. Ungated Davis Cave #2 has shown a similar pattern of population fluctuation over approximately the same time period as the two gated caves. Knife Cave was only discovered as a hibernaculum this year, so we have no trend data for its population. Currie (2002) documented similar results (i.e. declines in populations of gated and ungated caves) in Priority 1 and 2 caves across the range, indicating that something other than disturbance must be a factor.

There are over 5000 known cave entrances in Missouri and over 500 known cave entrances on MTNF. The two gated hibernacula on MTNF are fairly well-known caves, and until recently, were shown on topography maps given out to the public. However, White's Creek Cave is located deep in the Irish Wilderness and cannot be accessed by vehicle. It requires boating across the Eleven Point River and hiking ½ mile, or hiking 7-

9 miles in from the other end of the Wilderness. Cave Hollow Cave is relatively easy to access with a road within ¼ mile of the entrance.

The other two caves are less well-known with little evidence of visitation. The MTNF entrance to Davis #2 cave is very difficult to see and is very small. It does not invite visitors to enter. Davis #2 cave has a rather large entrance on Fort Leonard Wood that personnel from the Fort monitor regularly. There has been little or no human entrance to this cave over the past several years. Knife cave does not have an obvious entrance until you are close to it, and there was little evidence of human visitation inside the cave. However, at this cave the bats are roosting just inside the entrance, and have potential to be greatly disturbed by any amount of disturbance.

The revised Forest Plan requires existing gates to be maintained (U.S. Forest Service 2005, page 2-11) and periodically monitored to detect unauthorized entry. This minimizes the opportunity for people to enter the cave and disturb hibernating bats. Standards and guides also require periodic assessment of Indiana bat hibernacula to determine if there is a need to construct a physical barrier (U.S. Forest Service 2005, page 2-11). If new gates are constructed, or if any structure is placed at a cave entrance, a standard and guide in the revised Plan requires it to be a bat-friendly, air-flow design (U.S. Forest Service 2005, page 2-10). These measures would make it difficult for anyone to gain unauthorized entry and would minimize the potential for disturbance to Indiana bats.

The potential for disturbance at the two gated caves is so remote that I consider it to be insignificant and discountable, particularly considering the consistent population trend patterns at the three caves for which we have data. The potential for disturbance of the ungated caves is slightly more. Knife Cave has been proposed for gating, and once gated, the potential for disturbance there would also be so small as to be insignificant and discountable. For Davis #2, I consider the probability of people entering to be so remote as to be insignificant and discountable due to the hidden and forbidding nature of the entrance on MTNF. It is possible that people could enter the larger entrance to Davis #2 on FLW and disturb hibernating bats, but that is not a result of implementation of the Revised Forest Plan. The potential for all four caves to be affected at once is so remote that I consider it insignificant and discountable.

Based on the physical protection of known hibernacula, the low probability of entry, and the consistent population fluctuations at both gated and ungated caves, we do not expect that Indiana bats in MTNF hibernacula would be disturbed by human entry during the hibernation season. This meets the criteria for a discountable effect and is consistent with a Not Likely to Adversely Affect determination.

- ***Noise:***

Studies of effects of noise outside caves on hibernating bats and of noise on foraging bats were conducted at Fort Leonard Wood, Missouri. The evaluation included noise sources from smoke generators, blasting, small firearms, mines/grenade detonation, and construction equipment. The study concluded that the type and intensities of noise created during ongoing Department of Defense training was unlikely to adversely affect either hibernating or foraging Indiana bats. Exposure to a variety of types, intensities, and durations of sound caused no noticeable arousal of hibernating bats, and bats

continued to forage in and near night-firing exercises (U.S. Fish and Wildlife Service 1997).

Sounds created by activities implementing the Revised Forest Plan, such as chainsaws, vehicles, boat motors, recreationists, hunters, and other types of noise, are unlikely to surpass in intensity or duration the sounds evaluated in the Fort Leonard Wood study. In addition, the limestone geology of most of MTNF is similar to that of Fort Leonard Wood, where it was found that the geology tends to absorb ground vibrations (U.S. Fish and Wildlife Service 1997). For example, noise from Doe Run's Buick lead mine can be heard near the entrance of Cave Hollow Cave, but it is inaudible just inside the cave entrance (Jody Eberly, personal observation).

With at least 20 acres of permanent old growth and an additional 130 acres of mature forest/woodland surrounding hibernacula entrances, most noise-generating activity would take place far enough from cave entrances to prevent disturbance to bats inside. With the buffer zone in place, it is highly unlikely that routine noise would be heard within the caves or that any disturbance to the bats would occur. The likelihood of negative impacts from noise is so small as to be considered insignificant and discountable.

While there is no documented research into arousal of bats in summer due to noise during the daytime, anecdotal evidence suggests this is not a problem. There are numerous maternity roost trees that have been found in areas where noise from human activities is prevalent (Belwood 2002). One of the primary maternity roost trees discovered in May 2005 on the Salem/Potosi Unit is within ¾ mile of an active lead mine, and noise from the mine is clearly audible at the roost tree (Sybill Amelon pers. comm. 6/6/05). A radioed female roosted in that tree 9 of 10 nights she was tracked, and on various nights, exit counts found 21 bats, 9 bats, 31 bats, and 26 bats emerging from the tree. Obviously, the noise from the mine is not preventing these bats from utilizing an otherwise suitable roost tree.

» ***Removal of occupied roost trees:***

The revised Forest Plan contains several standards and guidelines preventing the removal of occupied roost trees.

- If occupied Indiana bat maternity roost trees are discovered, protect them from physical disturbance until they naturally fall to the ground. Designate an area of use based on site conditions, radio-tracking or other survey information, and best available information regarding maternity habitat needs. Minimize human disturbance in the foraging and roosting areas of the maternity colony until the colony has left the maternity area for hibernation. The character of the site should be maintained or enhanced year-round by (1) maintaining an adequate number of snags, including known roost trees; (2) maintaining large live trees to provide future roosting opportunities; and (3) maintaining small canopy gaps (and/or opening the mid-story) to provide a continual source of foraging habitat.

- Within the area of use (foraging and roosting) determined for each maternity colony, conduct prescribed burning only during the hibernation season.

- If occupied Indiana bat male roost trees are discovered during the summer season (not migration), protect them from physical disturbance by designating a 75-foot radius buffer zone around the tree(s). Within the buffer zone, no ground-disturbing activity or timber harvest shall occur. Prescribed burning may be done within the buffer zone if a fireline is manually constructed no less than 25 feet from, and completely around, the tree to prevent it from catching fire. The buffer zone shall remain in place until hibernation season begins (around November 1.)

- Protect known male roost trees from physical disturbance until they naturally fall to the ground.

- Within the 20 acres of old growth and 130 acres of forest or mature woodland surrounding an Indiana bat hibernacula, avoid prescribed burning and removal of suitable roost trees between September 1 and November 1 (swarming period) and between March 15 and April 31 (staging period).

With these standards in place, the possibility that a known, occupied Indiana bat roost tree would be removed during the time the tree may be occupied is so remote as to be insignificant and discountable.

However, it is possible that an occupied roost tree would be inadvertently disturbed by some forest management activities because it was not known to be an occupied roost tree. Activities which could disturb or remove an unknown, occupied roost tree include timber harvest; prescribed burning; removal of hazard trees in recreation areas, on trails or along roads; mineral exploration and development, special uses; range management; and road reconstruction or maintenance. These types of activities may occur at anytime during the year.

Three standards and guidelines in the Revised Forest Plan would reduce the chances of inadvertent removal of a roost tree at any time of the year. One encourages radio-tracking of females to determine where other roost trees are located (U.S. Forest Service 2005, page 2-6); a second encourages identification and removal of hazard trees between November 1 and April 1 when possible which would be when bats were hibernating and not using roost trees (U.S. Forest Service 2005, page 2-6); and the third encourages the retention of all standing dead trees, cavity or den trees during vegetation management activities (U.S. Forest Service 2005, page 2-13).

If an occupied, but unknown, roost tree was inadvertently removed during the time bats may occupy the tree, the most likely scenario would be that a single adult male was roosting in a dead tree that was being removed as a hazard tree or during timber salvage operations. It is possible that the bat would arouse during the disturbance and would fly to another previously scouted roost tree. This effort would expend some energy that would otherwise not be spent, but it is unlikely to result in negative impacts to the individual's survival, fitness, or reproductive success since Indiana bats have evolved with natural disturbances that may cause them to move during the day. Since Indiana bats use dead trees as roosts, and all dead trees eventually fall (often suddenly and without warning), Indiana bats must be aware of suitable replacements in case of emergency (Kurta et al. 1996, 2002).

A less likely scenario would be inadvertent removal of a roost tree occupied by a maternity colony. The colony may consist of pregnant adult females or of adult females and their young. Young bats may be volant (able to fly) or non-volant (unable to fly). Most maternity colonies consist of less than 100 bats, although some may have several hundred bats (U.S. Fish and Wildlife Service 1999). The tree may be a large dead snag being removed as a hazard tree, or it could be a living tree (with exfoliating bark) being removed during timber harvest, road maintenance or reconstruction, or other forest management activities. One of several things could occur in this scenario. In the best case, the female and young would arouse and fly from the tree to an alternate roost in their territory. Alternately, the females would arouse and carry their non-volant young to an alternate roost in their territory (Belwood 2002). Carter et al. (2002) suggests that the ability to arouse quickly in summer, and the ability to carry young in flight, combined with the behavior of using multiple summer roosts could offset negative impacts of snag roosts being destroyed by fire.

It is possible that some of the females would not be able to remove their young in time, or that some individuals could be crushed when the roost tree fell. However, it has also been documented that at least some females and young stayed in a tree as it fell, and then the females removed their young to an alternate roost tree (Belwood 2002). In all these cases, there would be stress on both adults and young, which may or may not result in slower growth rates, higher mortality of young, spontaneous abortion by pregnant females.

In addition, the alternate roost tree may not provide the thermal benefits of the occupied tree, causing additional energy expenditure for both adults and young, also potentially resulting in reduced growth rates or higher mortality of young.

In order to quantify the risk of these events occurring, North Central Research Station personnel determined the statistical probability that an occupied roost tree would be removed through MTNF management activities which implement the Revised Forest Plan. The odds of removing an occupied roost tree through timber harvest (April-September) are 1 in 363,779 (Shifley 2005). The odds of removing an occupied roost tree through prescribed burning impacts are 1 in 3,167,219 (Shifley 2005). These are not the odds of harming a bat, they are simply the odds of removing an occupied roost tree. Therefore, the chances of killing or wounding an Indiana bat through the removal of potential roost trees during the maternity season are very unlikely. (NOTE: For comparison, the odds of being murdered in the United States are 1 in 19,334 and the odds of getting killed in a car accident are 1 in 7,123 (http://www.unitedjustice.com/stories/stats.html).

If it is true that male Indiana bats which stay around hibernacula in summer are concentrated within 3-5 miles of the hibernacula entrance, the odds of removing an occupied male roost tree would increase somewhat as activities are conducted in that area. There are about 78,820 acres of National Forest land included in the Areas of Influence for hibernacula (5% of MTNF). Summer survey work on MTNF has found male Indiana bats roosting and foraging from about 1 to 29 miles from the closest known hibernacula entrance. Only three of the eight males tracked in 2004/2005 were within 3-5 miles of the hibernacula entrance, and one of these was tracked for just a few days in April when bats were starting to disperse from the hibernacula. It is possible that this male since flew further from the cave or has stayed near the cave.

Even if the odds of removing a male roost tree doubled as activities are conducted within 5 miles of a hibernacula (and it is doubtful the increase would be anywhere close to double), there would still be merely a 1 in 182,000 chance of cutting an occupied roost tree, or a 1 in 1,583,610 chance of affecting an occupied roost tree through prescribed burning. These odds are still high enough that a reasonable person would conclude that the event would be extremely unlikely to occur, cannot be meaningfully measured, detected, or evaluated, and would not be expected to occur.

The two maternity colonies that are known on MTNF are about 34 miles and about 2 miles from the nearest known hibernacula. None of the literature suggests that maternity colonies are concentrated near hibernacula entrances, so the potential for removal of maternity roost trees would not increase with closer proximity to hibernacula entrances.

Even if an occupied roost tree was cut, the probability of harming a bat or bats would be extremely low since bats are able to arouse quickly in summer and females can carry their young for some time after birth, making escape from potentially dangerous conditions possible (Carter et al. 2002). Therefore, **removal of an occupied roost would not necessarily result in death or injury** to the bat(s) roosting there. Indiana bats use an ephemeral source as roost trees. All roost trees eventually become unsuitable. This can occur naturally over time, as bark falls off the tree, or suddenly in a windstorm or other event. Indiana bats use a variety of roost trees in a summer, possibly to determine the suitability of alternate roost trees (Kurta et al. 2002).

If the tree is occupied by a single adult or juvenile male bat, it is fairly likely that the bat would arouse at the first indication of disturbance, fly from the tree and not be harmed. It is less likely that he would stay in the tree and be crushed as it falls.

If the tree is occupied by a maternity colony, there is some potential for direct harm (death or injury) to young bats, particularly if they are non-volant. However, it is still possible that all bats or a majority of bats would escape unharmed if an occupied maternity roost tree were removed (Carter et al. 2002; Belwood 2002).

In other words, there is no meaningful way to measure direct or indirect take (by killing, injuring, harming or harassing) to Indiana bats from inadvertent removal of an occupied roost tree and therefore, it is an insignificant effect. In addition, the odds of this event occurring on MTNF are so small as to constitute a discountable effect.

Missouri biologists tend to agree that forest management will not harm Indiana bats. The Missouri Department of Conservation also calculated the odds of accidentally destroying an Indiana bat maternity roost tree through tree clearing activities (Missouri Department of Conservation 2003). They estimated a 1:1582 chance of encountering an occupied roost for each potential roost tree felled (using the 5 most preferred roost tree species in Missouri). Using these odds, which are considerably lower than those calculated for MTNF, the Missouri Department of Conservation concluded that restricting harvest to the hibernation season was not warranted given the low risk and rarity of captures of reproductively active Indiana bats (Missouri Department of Conservation 2003).

» ***Alteration of occupied foraging habitat:***

Most foraging occurs in and around tree canopies in forested habitats and along edges of streams, old fields, pastures, and forest canopy gaps (Menzel et al. 2001). Indiana bats appear to avoid foraging in completely open areas, although some have been documented foraging over open water and over pastures or old fields (Menzel et al. 2001). Indiana bats do appear to exhibit some degree of site fidelity to foraging areas (Menzel et al. 2001).

Activities on MTNF which would be likely to alter the vegetative structure of occupied foraging areas include timber harvest, prescribed burning and road reconstruction. These activities could occur at any time of year. Timber harvest in a sale area normally occurs over a period of several years, with alternating periods of activity and inactivity in any one location. Prescribed burning normally occurs in a 1-2 day period, and may reoccur on the same unit every 2-10 years. Road reconstruction takes place over a period of several weeks to months with some inactive times during that period. Harvest and road reconstruction would only occur during daylight hours when bats are roosting. Prescribed burning is normally done during daylight hours, but the burning period in many cases lasts through the night. Fire behavior is generally less intense and less active during the night.

The most likely scenario for altering occupied foraging habitat is where there is a male foraging territory that the Forest Service is unaware of, and a timber harvest is planned in that area. In the Revised Forest Plan, approximately 10,000 acres per year would be selectively harvested, where only individual trees are cut, and the stand remains fully forested after harvest is complete (U.S. Forest Service 2005, Appendix D). The only impact to foraging habitat in these areas would be a reduction in tree density and temporarily reduced canopy closure. These changes might improve foraging habitat, rather than affect it negatively. In a study conducted in Alberta, Canada, results suggested that thinning has minimal short-term impacts on habitat use by bats (Patriquin and Barclay 2003). In Illinois, Indiana bats foraged in selectively harvested areas (Gardner et al 1991b as cited in Menzel et al. 2001).

Approximately 11,250 acres per year would be regenerated, where most trees in a stand are removed in order to facilitate growth of new, young trees. It is these regeneration acres which would remove most of the canopy and create areas of several acres to 40 acres that have canopy closure less than 35%, which some feel is unsuitable as foraging habitat. The average stand size on MTNF is about 15 acres. However, even in these harvest units, 7-10% of the area would be retained as wildlife reserve trees (in groups or singly, as opportunities exist) (U.S. Forest Service 2005, page 2-8). Menzel et al. (2001) states that “Practices such as even-age and uneven-age management can be used provided they include provisions for snag retention and favor oaks and shagbark hickories.” Reserve trees in even-aged regeneration harvests are to consist of the largest, longest-lived species on the site (pine, white oak, post oak, hickory, black gum), standing dead trees (snags) and cavity or den trees (U.S. Forest Service 2005, page 2-8).

The area of MTNF affected by even-aged regeneration is relatively small (0.7% MTNF each year or 7% over the 10 year plan period) and is dispersed across the Forest, so that each area is surrounded by a large matrix of forest cover of different ages. With the provision for 7-10% of the harvest unit in reserve trees or groups, and average stand size of 15 acres, much of the harvest unit would still be safely accessible for foraging by

Indiana bats. This would be especially true where reserve trees were located along upland drainages and connected to other reserve groups in the interior of the unit, which is a common practice on MTNF. However, there could be some part of even-aged regeneration harvest units that may not be utilized by Indiana bats for foraging that previously was usable.

NOTE: According to the Society of American Forester's Dictionary, even-aged management as practiced on MTNF is actually two-aged management because of the amount of reserve trees retained in each harvest unit (U.S. Forest Service 2005, Appendix D-1).

Indiana bat foraging areas in various studies ranged in size from very small (4 acres for a maternity colony in Indiana; (Sparks et al. In Press)) to very large (1544 acres for a male (Menzel et al. 2001)). Male home ranges in Indiana were 143 acres to 988 acres with a mean of 375 acres (Whitaker and Brack 2002). At Fort Leonard Wood, Missouri in spring, male home ranges averaged 630 acres (Romme et al 2002) ranging from 150 to 900 acres. Foraging distances also vary, ranging from about 0.6 miles to 6 miles.

With home ranges in the hundreds or thousands of acres, even in an area with a large (up to 40 acre) regeneration harvest unit, it is unlikely that a foraging Indiana bat would have to move far, if at all, to continue successful foraging, given the published sizes of foraging areas, and the forest mosaic in which harvest activities occur on MTNF. In a British Columbia study, summer bat activity increased in harvest units (Grindal and Brigham 1998). Foraging bats in Pennsylvania used some residential sites and a US Highway (Butchkoski and Hassinger 2002). In an Illinois study, timber harvest did not "discourage bats from continuing to forage in one harvested area…" (U.S. Fish and Wildlife Service 1999). In an Alberta, Canada study, harvesting that created a mosaic of patches with different tree densities was considered more likely to satisfy the needs of more forest bat species than a system with less diverse harvest styles (Patriquin and Barclay 2003). Gumbert et al. (2002) suggest that managers should "work to create numerous areas of mixed-forest types, ages, and stand conditions near hibernacula..". All of these studies point to the conclusion that alteration of foraging habitat of the type and on the scale practiced on MTNF would not necessarily result in any change in behavior of individual Indiana bats or local populations.

Prescribed burning may occur on areas of several acres to several thousand acres. There can be several different objectives for prescribed burning, but there is never an objective to conduct a burn so intense that all trees would be killed. A large prescribed burn (particularly in the growing season) may result in some large trees (>6" diameter) being killed where the fire is more intense (such as on south or west facing slopes), and these areas would provide small canopy gaps, and potential roost trees, across the landscape. However, the majority of prescribed burn units would retain tree canopy of at least 30-40% (the only exception would be in savannas which are a very small percent of MTNF) (U.S. Forest Service 2005, Appendix A-2). So, although somewhat changed from existing, Indiana bats would still find suitable foraging habitat on most prescribed burn units. In fact, there may be beneficial impacts as ground vegetation increases in abundance and variety, thus providing additional food sources for insect prey (Robbins and Myers as cited in USDA Forest Service 2000, page 30).

Road reconstruction may remove some trees and widen the road corridor from what exists. However, the width of the opening would seldom exceed 20 feet, and would still provide a protected flyway or corridor that Indiana bats may forage in. Two of the male

Indiana bats captured on MTNF in 2004, foraged along roadways, one through a dense pine plantation. In the British Columbia study, bat activity increased after a road was constructed (Grindal and Brigham 1998). This study suggested that the linear corridors created by roads may function as flight corridors or navigational references for bats (Grindal and Brigham 1998). Indiana bats in Pennsylvania included US Highway 22 in their main and minor foraging areas (Butchkowski and Hassinger 2002). These studies and experience on MTNF suggest that management of the transportation system on MTNF does not negatively alter foraging habitat for Indiana bats.

While management activities on MTNF will result in changes to the structure, age, and sometimes species composition of forest cover across the Forest, the changes would be well within the range of conditions used by Indiana bats for foraging (with the possible exception of even-aged regeneration harvests that would affect about 0.7% of MTNF each year). Even if some parts of even-aged harvest units were not usable foraging habitat, it is unlikely that such units would encompass all or even a major part of any individual bat's foraging area. Therefore, the presence of such areas scattered throughout the Forest would be extremely unlikely to cause any individual bat to significantly change its foraging area or behavior patterns, or result in any decrease in survival or fitness. Therefore, any potential effect of altering foraging habitat would not result in incidental take as defined by FWS, would not be measurable in any meaningful way, and would constitute an insignificant and discountable impact.

- ***Smoke from prescribed burning***

The 1999 programmatic Biological Opinion indicated that smoke could be a potential impact to Indiana bats (U.S. Fish and Wildlife Service 1999, page 62). However, in the past 5 years since the opinion was issued, MTNF has prescribed burned over 50,000 acres and has not documented any adverse impacts to Indiana bats (U.S. Forest Service 1999(b), 2000, 2001, 2002, 2003, 2004).

Documentation of the effects of smoke on Indiana bats is scarce, but monitoring on both the Mark Twain and Ozark National Forests has identified no negative impacts on Indiana bats from several prescribed burns conducted on those Forests. On April 10, 2003, MTNF conducted a 2750 acre prescribed burn near Council Bluff Lake and monitored smoke at Cave Hollow Cave, approximately 9 miles from the burn. No smoke entered or came near the cave entrance (Lynda Mills, pers. comm. 2003). For example, on February 26, 2004 MTNF conducted a 720 acre prescribed burn south of Winona, about 13 miles from White's Creek Cave. Light smoke was seen and smelled inside White's Creek Cave but the bats did not appear to be disturbed in any way (Keith Kelley, pers. comm.. 2004).

A large prescribed burn was conducted on March 24, 2003 on the Ozark NF. Fire burned to within several feet of the cave entrances. Smoke monitoring was done at one cave within that burn. Levels of carbon dioxide and hydrogen sulfide were elevated for a short time in the one cave that was monitored for these gases. Temperature and humidity were recorded every 15 minutes over a period of several weeks in four caves within the burn unit, in both the twilight and dark zones. Comparing recorded data with data from a nearby airport, changes were as expected with temperature rising slowly and little or no change in humidity detected. The Forest Service was not able to determine that any changes in those parameters were caused by prescribed burn activities. Bats present in the four caves were eastern pipistrelles, big brown bats, and Ozark big-eared bat. All bats that were present in the caves at the start of the burn were

there once the burn was completed, and all were still in full hibernation (U.S. Forest Service 2003).

The Fire Effects Information system maintained by the Forest Service does not include any information on bats of any species. The bushy-tailed woodrat, bobcat, black bear and northern raccoon were the only mammal species that use caves. None of the information for these species included potential effects of smoke. Similarly, Effects of Fire on Fauna (U.S. Forest Service 2000) makes no mention of the effects of smoke on cave fauna. However, it does say that adequate ventilation is essential for small mammals to survive in burrows and that burrows with multiple entrances may have better ventilation than burrows with one entrance.

Carter et al. (2002) state that smoke impacts depend on a cave's airflow and that most caves used as hibernacula are cold traps that would not be likely to suck air in. However, caves with more than one entrance might actually pull smoke into the cave through the chimney effect. Of the four known hibernacula on MTNF, two (Cave Hollow and White's Creek) have only one known entrance and would be unlikely to pull smoke in. Davis #2 cave has two known entrances, with the entrance on MTNF being considerably smaller than the entrance on FLW. The two entrances are at nearly the same elevation and may facilitate airflow, but may not create a chimney effect. Knife cave has not been completely mapped, but may or may not connect to several other entrances located nearby. Smoke from prescribed burns nearby may have more potential to enter these two caves.

Davis #2 has large passages and rooms. Any potential impact from smoke may be reduced because of the volume of the cave. Knife cave has much less volume and any smoke entering it would tend to stay in the area where the bats hibernate. This is based on the information currently available about Knife cave, which could change as the cave is explored and mapped further.

Prescribed burns taking place during the hibernation season (about November – April) would be unlikely to have any impact on Indiana bats within Cave Hollow or White's Creek caves. Smoke from prescribed burns from November to April has more potential to be pulled into Davis #2 and Knife Cave (with populations of about 70 and 30 Indiana bats respectively) because of their entrance configurations. If smoke entered these caves when the bats were present, potential effects may range from none to death of one or more bats. I know of no documented mortality of cave bats from smoke impacts of prescribed burns or wildfires. There are no established toxic smoke levels for bats, so we do not know the threshold for smoke effects in terms of amount or duration.

To minimize the potential for smoke to enter an occupied hibernacula, occupied Indiana bat caves are to be treated as smoke sensitive areas and site-specific prescribed burn plans would be developed to avoid or minimize smoke influences at or near these caves (U.S. Forest Service 2005, page 2-11) considering the entrance configuration, wind direction, mixing height and other relevant factors.

The majority of prescribed burns on MTNF currently take place between November and early April. Under the Revised Forest Plan, there is an objective to prescribed burn up to 40% of total annual burn acres from September through December (U.S. Forest Service 2005, page 1-4), with the remaining burns taking place primarily from December through early April.

In the Revised Forest Plan, approximately 60,000 – 80,000 acres would be prescribed burned annually. This is about 4-5% of MTNF lands. Standards and guidelines require that prescribed burn plans be written to minimize adverse impacts of smoke (U.S. Forest Service 2005, page 2-18).

Experience with prescribed fires on MTNF shows that most smoke dissipates within 24 hours. Under the Revised Forest Plan, prescribed burn areas are likely to be larger than the current average, and therefore, smoke may take longer to dissipate, but would be expected to take no longer than 24-72 hours to be completely gone. In that time period, there may be some smoke that settles in valleys and river corridors where occupied caves may occur. However, the amount of smoke present and the time period of exposure would make it unlikely that individual or communal Indiana bats' behavior, fitness, foraging or reproductive success would be negatively impacted in the long run.

While smoke from prescribed fires may be present for short time periods in areas where Indiana bats are foraging, or roosting, the potential for smoke to cause any change in individual Indiana bats' behavior, fitness, or reproductive success; their prey; or the Indiana bat population on MTNF is so remote as to be considered insignificant and discountable.

- ***Smoke and fire effects on young roosting bats***

The 1999 programmatic Biological Opinion indicated that smoke could be a potential impact to Indiana bats (U.S. Fish and Wildlife Service 1999, page 62). However, in the past 5 years since the opinion was issued, MTNF has prescribed burned over 50,000 acres and has not documented any adverse impacts to Indiana bats (U.S. Forest Service 1999(b), 2000, 2001, 2002, 2003, 2004). There is no data in the Fire Effects Information System nor in Fire Effects on Fauna concerning potential impacts of fire or smoke on non-volant young roosting tree bats. There are no established toxic smoke levels for bats, so we do not know the threshold for smoke effects in terms of amount or duration.

The concern is that prescribed fire in an area used by a maternity colony (that was not known to USFS) could potentially catch the roost tree(s) on fire and harm or kill young bats that could not fly away or crawl elsewhere on the tree to escape the fire. Dead trees that have sloughing bark are susceptible to catching on fire, particularly if on steep slopes with fire coming uphill, or in pockets of heavy fuel. Another concern is that smoke could concentrate in the area of a roost tree(s) and asphyxiate or cause respiratory distress in the young that could not fly out of the smoke.

In the Revised Forest Plan, approximately 60,000 – 80,000 acres would be prescribed burned annually. This is about 4-5% of MTNF lands. Standards and guidelines require that prescribed burn plans be written to minimize adverse impacts of smoke (U.S. Forest Service 2005, page 2-18).

Experience with prescribed fires on MTNF shows that most smoke dissipates within 24 hours. Smoke generally clears quickly from ridgetops and slopes where occupied roost trees might occur. Under the Revised Forest Plan, prescribed burn areas are likely to be larger than the current average, and therefore, smoke may take longer to dissipate, but would be expected to take no longer than 24-72 hours to be completely gone. In that time period, there may be some smoke that settles in valleys and river corridors where

occupied roosts may also occur. However, the amount of smoke present and the time period of exposure would make it unlikely that individual or communal Indiana bats' behavior, fitness, foraging or reproductive success would be negatively impacted in the long run.

Roost sites for Indiana bat have been documented to occur in areas repeatedly burned to provide habitat for red-cockaded woodpeckers (Menzel et al. 2001). This is anecdotal evidence that Indiana bats have developed adaptations to surviving periodic fire events. Red-cockaded woodpecker habitat is prescribed burned about every 2-5 years, and Indiana bats are known to exhibit site fidelity to roost areas. Carter et al. (2000) suggest that the use of multiple summer roosts, combined with the ability of females to carry young in flight might offset the liability of roosting in snags that are susceptible to fire.

While smoke from prescribed fires may be present for short time periods in areas where Indiana bats are foraging, or roosting, the potential for smoke or fire to cause any significant or long-term change in individual Indiana bats' behavior, fitness, or reproductive success; their prey; or the Indiana bat population on MTNF is so remote as to be considered insignificant and discountable.

» ***Alteration of swarming or staging habitat***

Swarming and staging habitat consists of caves and the areas around those caves used by Indiana bats in the late summer through early fall for swarming and reproduction and in spring as they prepare to leave hibernacula. In September through early November, the bats must put on enough fat to last through the winter and get them to their summering areas. This is also the time when reproduction occurs. Therefore, the presence of easily accessible, abundant insect prey is important for individual survival and reproductive success. As the bats prepare to leave in the spring (March-April), the presence of easily accessible, abundant insect prey would enable them to expend less stored energy, may lessen energetic stresses and increase reproductive success. During these times, the bats may roost in the caves or may roost in areas outside the caves. Therefore, it is also important that suitable roost trees are available in close proximity to the cave, and that disturbance inside the cave is minimized.

If foraging or roosting habitat is not available in close proximity to the hibernacula in the fall and spring, Indiana bats would be forced to expend stored fat reserves that may be in critically short supply (spring) or may not be able to store enough fat to last through the winter (fall). The use of fat reserves may decrease reproductive success or survival of individuals.

Standards and guidelines in the Revised Plan prohibit human entrance to hibernacula during the swarming and staging periods (U.S. Forest Service 2005, page 2-11), and gates on two of the four MTNF hibernacula are locked closed, thereby reducing the potential for disturbance during these critical times. A third cave is proposed for gating and would also be protected from disturbance during these times.

There is also an area of 150 acres designated around each Indiana bat hibernacula to minimize physical disturbances around the cave entrances, and provide roosting and foraging habitat immediately adjacent to hibernacula entrances. See also discussions of potential impacts to foraging and roosting habitat across the Forest.

This 150 acres is designated a smoke sensitive area, and site-specific prescribed burn plans would be developed to minimize smoke impacts. This would be particularly important in the spring, when many of the Forest's prescribed burns are conducted. See also the section of potential impacts of smoke to hibernacula above.

- ***Alteration of migration habitat***

Little is known of migration timing or patterns, other than that most Indiana bats are gone from hibernacula by the end of March, and in general movement is to the north and east from Missouri hibernacula. Therefore, we must assume that any part of MTNF could be used during migration. It is more likely that central and eastern parts of the Forest would be used by Indiana bats, but it is also possible that bats from Arkansas and Oklahoma are moving to and from Missouri and are using south and west portions of the Forest.

Not much is known about habitats used during migration, but it can be assumed that migrating bats still forage some at night and rest in roost trees during the day. Bats emerging from hibernacula in Pennsylvania were tracked to summer roosts and traveled from 35-60 miles per night (Sybill Amelon, pers. comm.). If Missouri bats travel approximately the same distances per night, bats leaving the four known hibernacula on MTNF could be at their summering areas (on or off MTNF) in 1-5 nights. The same type of habitat described for summer roosting and foraging is likely used in similar ways by migrating Indiana bats.

Effects to migrating habitat would be similar to the discussions regarding potential effects on foraging and roosting habitat.

- ***Removal of potential nightroost structures (concrete bridges, buildings)***

The Revised Forest Plan contains a standard requiring evaluation of any buildings or bridges for the presence of Indiana bats prior to any decision about their removal (U.S. Forest Service 2005, page 2-6). If no Indiana bats were found during evaluation, removal of these structures could occur and would have no impact. If Indiana bats were found during such an evaluation, the Forest Service would consult with US Fish and Wildlife Service to determine the appropriate, site-specific protective measures needed. These could include modification of the project or abandoning the proposed removal. With these measures in place, it is highly unlikely that a structure used as a night roost on MTNF would be removed. The chance of this occurring is so small as to be considered insignificant and discountable.

Potential Beneficial Effects

- ***Protection of occupied hibernacula (including swarming & staging periods):***

The revised Forest Plan requires existing gates to be maintained (U.S. Forest Service 2005, page 2-11) and periodically monitored to detect unauthorized entry. This minimizes the opportunity for people to enter the cave and disturb hibernating bats or bats during the swarming and staging periods in fall and spring.. Standards and guides also require periodic assessment of Indiana bat hibernacula to determine if there is a need to construct a physical barrier (U.S. Forest Service 2005, page 2-11). If new gates are constructed, or if any structure is placed at a cave entrance, a standard and guide in the revised Plan requires it to be a bat-friendly, air-flow design (U.S. Forest Service

2005, page 2-10). These measures would make it difficult for anyone to gain unauthorized entry, would minimize the potential for disturbance to Indiana bats, and .insure that both the bats and their environment would be protected.

» ***Provide roosts & foraging habitat near occupied hibernacula:***

An area of at least 20 acres of permanent old growth will be designated around cave entrances for each Indiana bat cave, with an additional 130 acres of mature forest or woodland designated for each Indiana bat cave (U.S. Forest Service 2005, page 2-11). These areas would provide a sustained supply of suitable roost trees near the cave, as trees mature, die, and develop flaking bark or cracks & crevices that may be used by Indiana bats as roost sites. The area would also provide foraging habitat. In an Alberta, Canada study, harvesting that created a mosaic of patches with different tree densities was considered more likely to satisfy the needs of more forest bat species than a system with less diverse harvest styles (Patriquin and Barclay 2003). Gumbert et al. (2002) suggest that managers should "work to create numerous areas of mixed-forest types, ages, and stand conditions near hibernacula..." Vegetation management may be done within the 150 acre area around hibernacula to achieve desired conditions, including a variety of canopy closures and densities of understory which would provide a wide range of potential foraging situations for Indiana bats within close proximity to occupied hibernacula. This would also provide easily accessible foraging habitat for Indiana bats in spring during staging, and fall during swarming, reducing the need to use stored fat, and potentially increasing reproductive success and individual survival. Foraging and roosting habitat would also be available to migrating Indiana bats as they emerge from and return to hibernacula.

» ***Protect roost trees:***

The revised Forest Plan requires that known, occupied maternity and male roost trees be protected from disturbance until they naturally fall to the ground (U.S. Forest Service 2005, page 2-6). Standing dead trees are to be retained in all vegetation management activities whenever possible (U.S. Forest Service 2005, page 2-13). Old growth is to be designated for groups of trees 175 years of age or greater, around cave entrances, and in varying amounts in Management Prescriptions 2.1, 6.1, and 6.2. Old growth in Management Prescription 1.1 and 1.2 would be provided through restoration of natural communities to include the full range of age and size conditions typical of each community. These measures, along with the lack of vegetation management in Wilderness and some 6.3 and 8.1 Management Areas, ensure that a variety of sizes and conditions of potential roost trees would be available across the Forest through time, for bats that stay during the summer and for bats as they are migrating.

» ***Provide potential night roosting structures***

The Revised Forest Plan encourages new or reconstructed bridges to be designed of concrete with girders or chambers suitable for bat roosting (U.S. Forest Service 2005, page 2-6). This measure would ensure that any new or replaced bridges were suitable for night-roosting.

» ***Provide foraging habitat:***

Foraging habitat consists of a variety of forest ages, sizes, and types. Currently, MTNF is about 3% regenerating forest, about 18% in pole sized forest, about 55% in mature sawtimber sized forest, and about 18% in sawtimber sized forest greater than 90 years old. Canopy closures are generally dense, with some areas with moderate to low canopy closure. Under the Revised Forest Plan, balancing age classes would be

replaced as an objective with restoring and enhancing the characteristic components of the various natural communities that make up the MTNF landscape. Desired conditions for canopy closures would range from 30-70% in open woodland to 80-100% in upland and bottomland forest (U.S. Forest Service 2005, Appendix A-2 & A-3). A variety of conditions would be distributed across the Forest in type and amount more similar to historic conditions than what exists now. Particularly in Management Prescriptions 1.1 and 1.2, more of MTNF lands would be open woodland (oak, mixed oak-pine, and pine) than what currently exists. Potential summer and migration foraging habitat would be available on most of MTNF in both the short and long term, including areas near hibernacula that are important during the swarming and staging periods.

- ***Provide water:***

MTNF currently has about 3000 constructed waterholes, ponds, and lakes distributed throughout the Forest. This is about 1.3 water sources per square mile. Distribution of these water sources is not even across the Forest. In addition, there are about 5,460 miles of permanent streams and rivers running through MTNF. About 92% of MTNF lands are within ¼ mile of a water source on National Forest lands (not including private ponds or large lakes such as Table Rock or Wapapello.

The revised Forest Plan emphasizes maintaining existing water sources, rather than creating new ones (U.S. Forest Service 2005. page 2-13). There is also a guideline encouraging the construction of temporary pools at the end of outlet ditches when roads are being constructed or reconstructed (U.S. Forest Service 2005, page 2-38). All these water sources would be available for Indiana bats.

Indirect Effects

Potential Negative Effects

- ***Removal of potential roost trees (large tree removal)***

Most studies of Indiana bat roost trees are consistent in that maternity colonies, in particular, tend to select large, dead trees or large, living trees with exfoliating bark as roosts and that the presence of these large, dead snags are the best indicator of potential maternity colony occurrence (Kurta In Press; Menzel et al. 2001; U.S. Fish and Wildlife Service 1999; Kurta et al. 2002). Even male bats captured on MTNF have made use of fairly large snags (most >10” dbh). Therefore, the removal of large, dead trees or of large living trees with exfoliating bark may reduce the number of available roost trees to select from. Whether this reduction would be enough to impact Indiana bats to the point of incidental take (significant habitat modification resulting in death or injury) or negative impacts to Indiana bat individuals or populations is questionable, at best.

All roost trees eventually become unsuitable, either by falling down, or by losing all their bark. This may occur naturally over a period of time, or suddenly (as in a wind or hail storm). Indiana bats use a number of different roost trees during summer, possibly as a way of determining the suitability of potential roost trees in their summering area.

When Indiana bats emerge in spring, they are energetically stressed after living off fat reserves during hibernation, then migrating to summer areas. Finding an appropriate roost tree is important to ensure successful reproduction for females, and continued

fitness for males. Also, since Indiana bats exhibit site fidelity, they tend to return to the same general area each year.

Activities implementing the Revised Forest Plan that may remove individual large trees with exfoliating bark or large dead trees include: hazard tree removal along roads, trails, and in recreation sites; road maintenance, reconstruction or construction; special use permit maintenance (particularly powerlines and roads); prescribed burning and timber harvest (particularly salvage harvest). These activities may occur at any time of year and individual activities may take a few hours to several years to complete.

The Revised Forest Plan encourages the maintenance of trees with characteristics of suitable roosts and the retention of standing dead trees wherever possible with regard for public safety and accomplishment of overall resource goals and objectives (U.S. Forest Service 2005, pages 2-6 and 2-13). The Revised Plan encourages locating firelines to minimize the need for snag removal before, during and after prescribed burns (U.S. Forest Service 2005, page 2-14).

This means that in most vegetation management activities, large, living trees with exfoliating bark and large snags will be retained. Activities in which large, dead trees are likely to be removed include hazard tree removal in recreation areas and along roads, snag removal for safety reasons along firelines, and salvage or sanitation harvest to address forest health issues. In hazard tree removal or fire management, individual trees are removed from a wide area, but other dead trees that are not safety hazards are retained in these same areas. Removal of one or a few potential roost trees would be similar to natural attrition of roost trees and would not be an unexpected situation, and would not result in significant disruption of normal behaviors. Suitable roost trees would still be available in areas affected by hazard tree removal.

Only in salvage harvest or in the case of a catastrophic event (flood, fire, late frost, drought) that killed a large number of trees in a recreation area might there be more than a few large dead trees removed in one area. Even then, the areas involved may or may not be large enough to encompass the roosting area of an individual bat or bats. If **all** potential roost trees were removed from such an area, the returning bats would have to spend additional energy searching for appropriate roost trees in a different area and could result in significant additional stress on individual bats or local populations resulting in incidental take.

During salvage and sanitation harvest, only recently dead trees would be removed, and these are the trees least likely to have flaking bark, and least likely to be suitable roost trees. Once dead trees start losing bark and become suitable roost trees, they also start losing economic value and are not likely to be marked for sale or cut by timber purchasers. Dead trees that already exhibit flaking bark would be retained even in salvage and sanitation harvests, unless individual trees pose a safety hazard.

An estimated 400,000 acres (27%) of MTNF is at moderate to severe risk of oak decline (USDA Forest Service 2005(a), page 3-38). In these areas, which are predominately black and scarlet oak, many of the trees reaching 60-70 years old and about 14” dbh or greater are dying, providing a continual supply of potential roost trees across the landscape. Even with salvage operations of about 2400 acres/year (0.2% MTNF), there would still be abundant naturally occurring roost trees across MTNF.

It is also estimated that even with active management on much of MTNF, about 130,000 acres (9%) of MTNF will be in forest cover aged 100 years or greater in 10 years, and about 263,000 acres (18%) will be aged 100 years or older by the year 2025, due to the current age class distribution (Charley Studyvin, Forest Silviculturist, Mark Twain National Forest, pers. comm.). Within these areas, there would be continual, gradual mortality of older trees that would be available as suitable roost trees.

Biologists in Missouri generally concur that there are more suitable roost trees in the state than could be used by the entire range wide population of Indiana bats. Using FIA data, and calculating mortality rates for the 5 most preferred species of roost trees in Missouri, it is estimated that there are at least 1.5 million potential roost trees in Missouri (Missouri Department of Conservation 2003). In counties in which National Forest land is located, there would be over ½ million potential roost trees. Assuming that 20 roost trees are used by each maternity colony in a year, Missouri forests could support about 75,000 maternity colonies (MTNF could support 25,000), and with an average of 50 adult females per colony, there are enough potential roost trees in Missouri to support a population of about 3.7 million reproductively active Indiana bats (Missouri Department of Conservation 2003) (1.25 million bats on MTNF). Since there are only an estimated 64,800 Indiana bats hibernating in Missouri, and about ½ those are females, it is clear that there are many times more suitable roost trees existing in Missouri than there are Indiana bats to use them.

Brack et al. (2002) when considering potential climatic influences on Indiana bat distribution and abundance and as a potential causal factor in continued declines states "It seems implausible that managing for more trees (i.e. roosts) across the southern and southeastern United States will have a significant effect on recovery of the species."

With these measures in place, and the large number of dead and dying trees on MTNF, it is highly unlikely that removal of some large trees outside of known maternity or male roosting areas would reduce the number of available roost trees to the point that there would be any negative impact on the behavior, fitness, or reproductive success of Indiana bats on MTNF.

- ***Alteration of potential foraging habitat***

See evaluation of effects under Direct Effects - ***Alteration of occupied foraging habitat*** and discussion of potential ***Landscape effects of harvest*** under Questionable/Unknown Effects.

- ***No action***

In some cases, taking no action may have effects on species. In the case of Indiana bat in Missouri, doing nothing may have some negative impacts to individuals and local populations.

Farmer et al (2002) state that the best maternity habitat probably contains a diversity of habitats. Roost trees for both males and females have been found in a variety of habitats from closed forest to grazed pastures (Menzel et al 2001). Foraging habitats also include a variety of habitat types from riparian forest to old field edges. Canopy closures for roosting and foraging habitats have ranged from 20-100%. Roosting and foraging have been documented in areas that have had a variety of natural and anthropogenic disturbances, from timber harvest to flooding.

Some of the roost trees discovered on MTNF in 2004 were in areas that had been commercially thinned or had been subject to wildfire in the recent past.

The current condition of MTNF is that a large part of the Forest is overstocked with trees (U.S. Forest Service 2005(c), page 3-21), which reduces their growth rate and considerably lengthens the time for individual trees to increase in diameter. In many cases, the overstocking is so bad that the trees may take decades, if ever, to reach diameters preferred by roosting bats. In addition, lack of fire through the decades has reduced the variety and abundance of herbaceous ground cover throughout the Forest (U.S. Forest Service 2005(c), page 3-10), reducing potential food sources for terrestrial insects that Indiana bats feed on. Actions taken to reduce tree density and encourage growth of ground cover would enable remaining trees to grow faster and increase potential food sources for insects.

- ***Water quality changes***

Indiana bats feed on a variety of insects, including aquatic insects which are sensitive to water quality degradation as a result of sedimentation or pollution. Decreases in water quality of streams and rivers in which aquatic insects reproduce could decrease the amount or distribution of available prey insects. This in turn, could negatively affect the survival or reproductive success of individual Indiana bats, or potentially, local populations. Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to aquatic insects that Indiana bats eat as prey.

Potential Beneficial Effects

The most widespread and lasting impact on Indiana bats would be the movement of current vegetative conditions toward desired future conditions more reflective of the ecological communities inhabited by Indiana bats for centuries prior to the major landscape alterations of the 20th century.

- ***Restoration of natural communities***

Timber harvest and prescribed burning would be used primarily as tools to restore species composition and structure and natural disturbance patterns to the natural communities that occur on National Forest lands. The major benefit of restoration of healthy natural communities would be more diverse vegetation, particularly ground cover, and more potential food sources for insects that Indiana bats may prey on. In addition, the natural range of variability enhanced by restoration would make a variety of potential foraging habitats available across the Forest.

The conditions provided through natural community restoration would also provide easy access to roosts and foraging habitat for Indiana bats migrating to and from hibernacula. This would help reduce energy expenditures and maximize energy intake at times when fat reserves are low, thereby increasing chances for survival and successful reproduction.

Standards and guidelines for the planning and administration of timber sales are designed to provide protection of water and soil quality and of other sensitive resources, including riparian corridors (U.S. Forest Service, 2005, page 2-25 through 2-30). Standards and guidelines for prescribed burning are also designed to minimize soil loss and protect water quality and other sensitive resources (U.S. Forest Service 2005, pages 2-13 through 2-15).

» ***Protection of potential roost trees***

Standing dead trees are to be retained in all vegetation management activities whenever possible (U.S. Forest Service 2005, page 2-13). Old growth is to be designated for groups of trees 175 years of age or greater, around cave entrances, and in varying amounts in Management Prescriptions 2.1, 6.1, and 6.2. Old growth in Management Prescription 1.1 and 1.2 would be provided through restoration of natural communities to include the full range of age and size conditions typical of each community. These measures, along with the lack of vegetation management in Wilderness and some 6.3 and 8.1 Management Areas, ensure that a variety of sizes and conditions of potential roost trees would be available across the Forest through time.

» ***Protect water quality and minimize sedimentation***

Standards and guidelines for Riparian Management Zones (RMZs) and Watercourse Protection Zones (WPZs) prohibit certain activities and limit or modify the use of others within these zones (U.S. Forest Service 2005, page 2-2 through 2-5). The implementation of these measures would reduce the potential for soil movement into adjacent waterways, maintain or improve the vegetative communities within these zones, and help maintain good water quality in the adjacent waterways. This in turn would insure that there are no negative impacts to aquatic insects that Indiana bats eat as prey, and that suitable cover is available to protect bats as they forage.

In addition to standards and guidelines which limit, modify, or direct management activities within the riparian corridors and upland waterways (see paragraph above), there are standards and guidelines designed to reduce, minimize or eliminate soil movement from Forest management activities on upland sites and in or near streams and rivers (U.S. Forest Service 2005, pages 2-5, 2-9 through 2-10, 2-14 through 2-17, 2-18, 2-19 through 2-20, 2-28 through 2-30, 2-31 through 2-34, 2-37 through 2-2-40). Implementation of these measures would reduce the potential for soil to move off-site and reach a water source, and therefore reduce the potential for any adverse effects to occur to the aquatic insects that Indiana bats eat.

While roads are by their very nature potential sources of sediment movement, consistent road maintenance can reduce that potential by maintaining adequate drainage and a stable running surface. Standards and guidelines for reconstruction and maintenance provide for revegetation of disturbed surfaces, installation of appropriate drainage features to prevent soil movement off-site, and scheduling work during favorable weather conditions. (U.S. Forest Service 2005a, page 2-37 through 2-39). All these actions would minimize the amount of soil moving off-site and help protect area waterways from additional sedimentation.

Questionable or Unknown Effects

» ***Landscape effects of harvest and other forest management***

One of the acknowledged needs for Indiana bat conservation and recovery is to determine the effects of forest management on Indiana bat habitat, individuals, and populations (Menzel et al. 2001).

The MTNF is approximately 95% forest cover. Almost 90% of the Forest has been available for timber harvest in the past 20 years. Even-aged silviculture is the primary management tool for MTNF according to the existing Forest Plan (page IV-37). Since 1988, MTNF has averaged about 15,000 acres of timber sold per year.

The percent of even-aged regeneration has ranged from a high of about 70% of sold acres in 1988 to a low of about 19% in 1995 and 2002. The percent of sold acres in uneven-aged management has ranged from a low of 0.9% in 1988 to a high of about 46% in 1995. Other selective harvest has ranged from a low of 27% in 2003 to a high of 62% in 2002. In other words, the proportion of harvest in even-aged regeneration has been cut about in half, while the proportion of individual tree harvest on MTNF has increased substantially over the past 16 years.

The Indiana bat maternity colony found in 2004 on MTNF is in a stand of trees that was commercially thinned in 1992, and is within ¾ mile of 6 other clearcut units harvested since 1980. The male bats captured on the Salem/Potosi unit used trees killed in wildfires as roost trees, as well as one dead tree standing in a lead mine tailings pond. More bats were captured on the Salem/Potosi unit than any other unit on the Forest, and that is the unit with the highest amount of timber harvest activity over the past 15 years.

All of these factors point to the need to have a better understanding of the relationship between forest management activities and Indiana bat habitat use. Other sections of this document have discussed potential effects of individual actions, but we really don't know the long-term implications of forest management as practiced on National Forests in Indiana bat range compared to other more likely factors in the decline of this species.

» ***Additional drinking water sources***

Drinking water is an important habitat component for Indiana bats, although it has not been documented or suggested as a possible factor in the continued decline of the species. MTNF currently has over 3000 constructed waterholes, ranging from 1/10 acre "teacup" ponds to large impoundments such as Council Bluff Lake. Most of the waterholes and ponds are within forested settings, although some are located in pastures and open fields. There are also over 2500 miles of permanent streams running through MTNF lands. Most of these are available drinking water sources for Indiana bats. Ponds that are completely in the open are probably not used due to danger of predation when crossing open areas. The Revised Forest Plan calls for constructing new waterholes only where natural or human-made water sources are lacking and for managing and rehabilitating existing waterholes as a priority over constructing new ones (U.S. Forest Service 2005, page 2-13). Also, when reconstructing or constructing roads, construction of temporary pools at the end of outlet ditches is encouraged as a way to provide drinking water sources as well as amphibian breeding habitat (U.S. Forest Service 2005, page 2-38). About 92% of MTNF is already within ¼ mile of a permanent

water source, so it is uncertain if the construction of temporary pools at road outlets would provide any additional benefit to Indiana bats.

» ***Pesticide use***

Pesticides would only be used where their use is clearly demonstrated to be the most effective means to meet management objectives, and would comply with the product label (U.S. Forest Service 2005, page 2-18). The pesticides implicated in bat deaths would not be used on MTNF. The least impacting application method is to be used, and all equipment used in the application of pesticides must be washed and rinsed where runoff would not reach surface waters, wetlands or other special habitats (U.S. Forest Service 2005, page 2-18). There are also restrictions on the type and application of pesticides within riparian management zones, watercourse protection zones, and buffer zones of caves (U.S. Forest Service 2005, page 2-19). With these measures, the potential for pesticide use on MTNF to cause any impact to individual Indiana bats, their prey, or the population is so remote as to be considered insignificant and discountable.

No Effect

» ***Changes to microclimate of occupied hibernacula:***

Changes in airflow in occupied hibernacula can elevate ambient temperatures which will increase the bats' metabolic rates, and prematurely exhaust fat reserves (U.S. Fish and Wildlife Service 1999, page 17). Recent data suggest that when hibernacula temperatures are between 37 degrees F and 45 degrees F, populations increase, but when below 37 degrees F or above 45 degrees F, populations decline (U.S. Fish and Wildlife Service 1999, page 18).

Standards and guidelines in the Revised Forest Plan require that all structures placed at cave entrances must not alter airflow into or out of the cave (U.S. Forest Service 2005, page 2-10); that at least 20 acres of permanent old growth be designated at Indiana bat cave entrances (to include the area above known or suspected passages); and an additional 130 acres of mature forest/woodland be maintained around Indiana bat caves (U.S. Forest Service 2005, page 2-11). Other standards and guidelines restrict management activities from occurring within 100 feet of a cave entrance, or over known cave passages.

These measures would maintain the vegetative cover around cave entrances that, in turn, would maintain the cave microclimate and not alter airflow into or out of the cave. They would also essentially eliminate the possibility that unknown cave entrances would be affected by management activities.

» ***Wind turbines:***

Recent studies have found that wind turbines located on forested ridgetops are a potentially significant source of bat mortality, although no dead or injured Indiana bats were found during studies at two eastern wind facilities (Arnett et al 2004). There are currently no wind turbines or wind farms located on or near MTNF; nor are there any outstanding applications for such facilities. The revised Forest Plan states that special uses would be permitted:

"only when they comply with standards and guidelines for the management area prescription; do not result in environmental or resource degradation; do not preclude opportunities for ecosystem

management; and where locations on non-National Forest System lands are not reasonably available."

Any future application for wind energy structures would be evaluated individually and site-specifically to determine its possible impacts to National Forest resources, including Indiana bats.

Comparison of 3.5 Management Prescription with Revised Forest Plan

The 3.5 Management Prescription was developed in response to the June 23, 1999 Programmatic Biological Opinion. The purpose of the prescription is to provide management to protect Indiana bats and their habitat in and around hibernacula and known sites of reproductively active females. The emphasis is on habitat most likely to be used as foraging habitat by male Indiana bats in summer (U.S. Forest Service 2002). Management areas would be variable sizes and would provide a continuous supply of suitable roost trees and preferred foraging habitat for Indiana bats.

There are currently about 77,000 acres included in Management Prescription 3.5 on MTNF. This is about 5% of MTNF acres.

Because the Revised Forest Plan emphasizes the management and restoration of natural communities, the desired condition of about 29% of MTNF (Management Prescriptions 1.1 and 1.2) in the long term would be more similar to landscape conditions in which Indiana bats evolved in Missouri. The Forest Service believes that this change in management emphasis would, in the long term, provide the type, amount, and distribution of habitat components on about 1/3 of the Forest that Indiana bats lived in prior to the dramatic changes to caves, riparian landscapes and upland forest in the Ozarks and the start of decline of the species range wide. In the 2.1, 6.1 and 6.2 Management Prescriptions (63% of MTNF), management to provide a wide variety of goods and services will be done so that vegetation within these areas falls within the natural range of variability, and in turn, provides to a much greater degree than presently, the kind, amount, and distribution of habitat conditions in which Indiana bats evolved and survived prior to European settlement.

Indiana bats exhibit site fidelity to summer foraging and roosting areas (Menzel et al. 2001). However, in southern Missouri, it has been difficult to locate these areas, since summer surveys over the past 7 years have only resulted in capture of 5 Indiana bats and radio-tracking of 3. Two additional bats were radioed in April 2005 and some additional information on roost trees gained. In late May 2005, an additional 5 Indiana bats were captured and radioed, with four of those still being tracked as of June 1, 2005. Seven male roost trees and five maternity roost trees have been identified for these four bats.

Roost trees selected by Indiana bats are primarily dead trees, which only remain suitable roost trees for 1-8 years before all the bark sloughs off, or the tree falls down (U.S Fish and Wildlife Service 1999). Many times, roost trees are clustered in the environment, because living trees are subject to the same environmental stresses, such as storms, insect & disease, flooding, etc. This also means that clusters of roost trees may become unusable at approximately the same time, and Indiana bats using them must find other

roost trees (Kurta et al.2002). Therefore, management of individual roost trees alone will not ensure the maintenance of suitable habitat for this species (Gumbert et al. 2002; U.S. Fish and Wildlife Service 1999).

The management of MTNF to ensure suitable roost tree and foraging habitat availability across the Forest responds to new information gained through radio-tracking of Indiana bats on MTNF. Both the female and male bats captured on MTNF in 2003/2004 were foraging and roosting further than 5 miles from the nearest hibernacula (6 miles, 7.5 miles and 29 miles for males and 5.75 miles, 11 miles, and 36.5 miles for females). A female captured on private lands near Fredericktown, Missouri was about 18 miles from the nearest hibernacula. This information contradicts the information on male use of areas near hibernacula used to develop the RPM/TC of the June 23, 1999 Programmatic Biological Opinion, on which the 3.5 Management Prescription was based. Therefore, new information supports the direction of the Revised Forest Plan to manage ecological communities over the entire Forest, rather than concentrate management for a specific species in a few locations.

However, information gained from radio-tracking males and females in late May 2005 found one male roosting and foraging within about 1.3 miles of Cave Hollow Cave, and the other roosting about 4 miles from Cave Hollow Cave, consistent with other literature on male bats near hibernacula in summer. Female roost trees are located from about 2.2 to 3.8 miles from Cave Hollow Cave. This information, along with information gained in previous years, leads us to conclude that even though the area around hibernacula is undoubtably important for Indiana bats, the bats are also using areas outside the recognized literature distances, and those other areas also need to support adequate foraging and roosting habitat.

As early as 1980, LaVal and LaVal (1980) recognized that public land alone could not provide enough habitat to recover the Indiana bat. Later researchers also note that management cannot be limited to the few national forests and parks or other agency-owned lands occurring within the summer range of Indiana bat (Kurta et al., 2002). Most maternity colonies documented to date have been on private lands in highly agricultural areas (Gardner and Cook 2002). If management for the species must occur on areas greater than all public lands in the range, it does not make sense to limit the management of those public lands to a small area around known hibernacula (which is what the 3.5 Management Prescription was designed for). We can still protect known roost trees, foraging areas, and maternity colony areas, while ensuring that suitable habitat is available as appropriate to the landscape throughout the Forest. This will hopefully contribute to the survival and recovery of the species.

In the revised Forest Plan, Management Prescription 3.5 (AOI) acres will be allocated to other Management Prescriptions as follows:

Table IB-4: AOI acres by Management Prescription

District	AOI	Cave Priority*	Acres in 3.5 Current Plan	Acres by Management Prescription - Alternative 3 Revised Plan					
				1.1	1.2	2.1	6.1	6.2	8.1
ACW	Tumbling Creek Cave	N/A (3)	2,304	2,304					
EP	White's Creek Cave	NL (3)	4,353			4,353			
PF	Pilot Knob Mine	1	2,837				2,837		
PF	Cave Hollow Cave	NL (3)	20,356			18,870			1,486
Sal/PF	Bell-Bat-Saloon Caves	N/A	9,983		3,530	2,947		3,506	
HRCC	Great Spirit-Davis #2 Caves (includes Knife Cave)	2	10,825			10,825			
HRCC	Bruce-Onyx	N/A	7,707	655		7,052			
HRCC	Ryden	2	14,829		1,199	13,630			
HRCC	Dislocated Thumb	NL	5,625	5,625					
PB	Brown's Hollow Maternity		2,197			2,197			
Sal/PF	Cave Hollow Maternity		N/A	Included in Cave Hollow Cave hibernacula AOI					
	TOTALS		81,016	8,584	4,729	59,874	2,837	3,506	1,486
				13,313			6,343		
	Percent of original AOI		100%	16%		74%	8%		2%
	Percent of MTNF		5%	1%		4%	0%		0.10%

jae 1/24/05

*Priority One hibernacula = recorded population >30,000 bats since 1960
Priority Two hibernacula = recorded population >500 but <30,000 bats since 1960
Priority Three hibernacula = recorded population <500 bats
N/A - Not assigned in Recovery Plan
(3) – Appropriate priority given known populations
NL – Cave not listed in Recovery Plan

Approximately 74% of the acres currently in MP 3.5 will be in MP 2.1 in the revised Forest Plan. MP 2.1 emphasizes multiple use resource objectives.

Approximately 16% will be in MP 1.1 or 1.2; 8% will be in MP 6.1 or 6.2; and about 2% will be in PM 8.1. MP 1.1 and 1.2 emphasize restoration of natural communities; MP 6.1 and 6.2 emphasize opportunities for semi-primitive recreation with limited or no motorized access; and MP 8.1 emphasizes a variety of special areas.

In Table IB-6, standards and guidelines for the 3.5 management area compared with those for the Revised Forest Plan show that standards and guidelines for the Revised Plan, in most cases, provide the same or more protection of Indiana bat hibernacula, maternity colony areas, roosting and foraging habitat as does the 3.5 Management Prescription.

The following narrative explains the rationale for entries in the “Habitat Needs Provided” columns of the previous Table.

Vegetation –
The 3.5 Management Prescription allows vegetation management only to improve Indiana bat habitat, to maintain or enhance natural communities or for public safety.

The second part of this is exactly what the Revised Forest Plan requires in both the 1.1/1.2 and 2.1 Management Prescriptions. Even in the 2.1 MP, where the emphasis is on multiple resource objectives, one of the goals is to manage within the capability and resource potential appropriate to natural communities and the landscape (U.S. Forest Service 2005, page 3-10). What this means is that even within the 2.1 Management Prescription, management to provide a wide variety of goods and services will be done so that vegetation within these areas falls within the natural range of variability.

While the purposes for management in the new Management Prescriptions are not specifically to provide Indiana bat habitat, the results will be the same or better in MP 1.1/1.2 as natural communities are restored and the landscape provides a greater diversity of structural conditions and species distribution than currently exists. In the 2.1 MP, desired conditions for open and closed woodland would provide the moderate canopy closures considered "optimum" for Indiana bat foraging, and the desired condition for savanna and both upland and bottomland forest would provide lesser and greater canopy closures respectively that may also be used by foraging Indiana bats.

Rangeland –
There are no existing grazing allotments in any of the AOI's with the exception of Tumbling Creek Cave. The two allotments within that AOI include glade and woodland natural communities, and as such, under the Revised Plan, those areas must be closed when the current permit expires (expiration dates are 12/31/2005 and 03/30/2007). 150 acres of improved pasture in the Mark Twain Allotment would probably be continued as a grazing allotment after expiration of the current permit. Eliminating cattle grazing from the glades and woodlands within the cave recharge area would eliminate the potential for sedimentation or nutrient enrichment of the cave stream due to cattle presence on National Forest lands, and may improve water quality of the cave stream.

Recreation –
In the seven existing hibernacula AOI key areas, there are non-system roads within three, county roads running through two, and no roads in two. The non-system roads should be closed under the existing Forest Plan AOI and in the Revised Plan, regardless of management prescription. The ROS objective would not affect on-the-ground conditions in any of the existing AOI key areas.

Visual –
There is no Indiana bat habitat need addressed through the visual management system.

Timber –
See discussion under vegetation.
In the Revised Forest Plan, rotation ages for all species within the 1.1/1.2 Management Prescriptions are higher than rotation ages under the current plan, which means that over the long term, there would be more large, old trees across the landscape that would provide suitable roost trees when they died, or when certain species (i.e. white oak) develop exfoliating bark as they age.

In the Revised Plan, all intermediate harvest should generally leave the largest, oldest trees to meet the basal area objectives. This measure should increase the number of larger, older trees present across the Forest, which may increase the number of suitable roost trees available in the long term.

Wildlife – Hibernacula and Key Area
All occupied hibernacula are closed to human entry during the fall swarming, hibernation, and spring staging seasons in both the current 3.5 Management Prescription and in the Revised Plan.

All structures placed on Indiana bat hibernacula must permit bats to pass safely and not alter airflow in both the current 3.5 Management Prescription and in the Revised Plan.

Key areas for caves are the same in the current 3.5 Management Prescription and in the Revised Forest Plan (although not named key areas). Key areas already designated will almost certainly stay the same (Bell/Bat/Saloon – 140 acres; Cave Hollow - 170 acres; HRCC – 390 acres for 2 caves; none for Pilot Knob Mine or Tumbling Creek Cave since neither has National Forest lands near the cave; none for White's Creek Cave since it is in Wilderness). There was no key area identified for the Brown's Hollow maternity AOI.

Wildlife – Foraging and Roosting Habitat
The current 3.5 Management Prescription requirements for 20% old growth and 50% mature oak-hickory/oak-pine forest within 5 miles of occupied hibernacula are intended to provide a sustained source of large trees that would eventually become suitable roost trees. This is based partly on studies that show most roost trees are dead, deciduous trees. However, the bats captured on MTNF in 2004 used both dead shortleaf pine snags and oak snags. Most of the male roost trees were shortleaf pine snags, and the one maternity roost tree on National Forest lands discovered in 2004 was also in a large shortleaf pine snag.

Currently, about 64% of MTNF is in oak-hickory/oak-pine 50 years old or more. About ½ of the shortleaf pine present on MTNF is 50 years or more (5% MTNF).

In the Revised Plan, old growth in the 1.1/1.2 Management Prescriptions would be provided as a result of restoration activities, would fit within the range of natural variability, and would not be specifically designated. Standards and guidelines require that the range of variability specifically includes areas exhibiting old growth characteristics and that the predominant age of those areas should be 25% or more above the rotation age (USDA Forest Service 2005, page 3-4). Rather than have specific areas in old growth, old growth characteristics (such as large living and dead trees) would be dispersed throughout the landscape. There may be many in some areas, and fewer in others. Suitable roost trees would be available on a sustained basis, and would be available in amounts and distribution more typical of natural disturbance regimes that created snags.

In the 2.1 Management Prescription 8-12% old growth would be specifically designated and would be considered "permanent"; that is it would be unavailable for timber harvest. This is about ½ of what is currently provided in the 3.5 Management Prescription. Potential roost trees are also provided throughout the Forest by leaving most standing dead trees where they do not compromise safety. Regardless of any designation of old growth, it is estimated that there will be about 130,000 acres of old growth on MTNF in 2015 (9%) and about 263,000 acres of old growth in 2025 (18%) simply due to the current age-class distribution and projected management intensity of the Revised Plan (Pers. comm. Charly Studyvin, Forest Silviculturist, Mark Twain National Forest).

While the old growth designation in the current 3.5 Management Prescription may in the long run provide a higher number of potential roost trees within 5 miles of a hibernacula, we have nothing to suggest that providing more roost trees would have any positive effect on the local or range-wide population of Indiana bats. Using FIA data, Missouri Department of Conservation (2003) estimated that in counties in which National Forest land is located, there would be over ½ million potential roost trees. Assuming that 20 roost trees are used by each maternity colony in a year, MTNF could support 25,000 maternity colonies, and with an average of 50 adult females per colony, there are enough potential roost trees to support a population of about 1.25 million bats on MTNF. Since there are only an estimated 64,800 Indiana bats hibernating in Missouri, and about ½ those are females, it is clear that there are many times more suitable roost trees existing on MTNF than there are Indiana bats to use them.

Brack et al. (2002) when considering potential climatic influences on Indiana bat distribution and abundance and as a potential causal factor in continued declines states "It seems implausible that managing for more trees (i.e. roosts) across the southern and southeastern United States will have a significant effect on recovery of the species."

The current 3.5 Management Prescription requires a minimum of 50% of the AOI be maintained in pole/saw with 50-70% canopy closure This is intended to provide what is considered "optimum" foraging habitat for Indiana bats and comes from a 1995 model developed by Romme et al (1995). When looking at the recent body of work on foraging habitat for both males and females, it appears that while moderate canopies may be optimum, there is a wide variety of habitat types in which foraging occurs. Most is forest cover of some type but canopy closures range from very little (20%) to full canopy (100%). The bats captured on MTNF in 2004 foraged in areas that had a variety of canopy conditions.

In the Revised Plan 1.1and 1.2 Management Prescriptions, desired canopy conditions for natural communities range from 10-30% for savannas (very small percent of MTNF) to 30-50% for open woodland, 50-80% for closed woodland, and 80-100% for upland and bottomland forest (U.S. Forest Service 2005, page A-2). These habitat components would be distributed across the landscape in a variety of age classes, with a variety of understory and ground cover conditions that would also provide a diversity of food sources for insects that Indiana bats eat. The distribution and abundance of these conditions would closely approximate the dynamic landscape in which Indiana bats evolved and survived in Missouri (Page 3-48 of the Revised Plan shows the historic vegetation for National Forest lands).

In the 2.1 Management Prescription, there would also be a variety of canopy closure conditions, although somewhat less diverse than found in the 1.1/1.2 MPs.

Currently, about 80% of MTNF is in pole/saw-sized trees. About 74% of MTNF is currently 50 years of age or older. Stocking classes, which measure the density of trees, have changed dramatically from 1989 to 2003 with about 60% of MTNF in fully to overstocked condition today, as opposed to about 32% fully to overstocked in 1993. This occurred during a time when MTNF harvested an average of 15,000 acres annually. Obviously, the amount of timber harvest conducted on MTNF has not resulted in a lack of forest greater than 50 years old, or created large areas of unacceptably low canopy closure for Indiana bat foraging. With the emphasis of all vegetation management on meeting desired conditions, it is possible that the Revised Forest Plan implementation

would result in more acres moving back to moderately stocked, which would fall within the 50-70% canopy closure considered optimum.

Because Indiana bats forage relatively high in the forest canopy (several authors cited in Romme et al 1995) and clearcuts remove the majority of canopy from the harvest area, the restriction of 7% in 0-9 age class at any one time in the 3.5 Management Prescription was developed to address the possible avoidance of clearcuts by foraging Indiana bats, while still providing a way to regenerate oak-hickory and oak-pine forests.

Currently, there is about 3% of MTNF in the 0-9 age class. The area of MTNF affected by even-aged regeneration under the Revised Forest Plan would be relatively small (0.7% MTNF each year or 7% over the 10 year plan period) (U.S. Forest Service 2005, page E-3) and would be dispersed across the Forest, so that each area would be surrounded by a large matrix of forest cover of different ages.

Even though the Revised Forest Plan allows more even-aged regeneration than what is allowed under the 3.5 Management Prescription, the total amount is still relatively small and the projected management activities for Decades 1 and 2 in the Revised Plan give the same amount of regeneration as is currently allowed in the 3.5 Management Prescription.

Wildlife – Maternity Colony Foraging and Roosting Habitat
The 3.5 Management Prescription for maternity areas is generally no more than ¾ mile in radius from known sites of reproductively active females, and shall be managed to provide a continuous supply of suitable roost trees and preferred foraging habitat for Indiana bat.

The Revised Forest Plan requires protection of roost trees until they fall to the ground, minimizing human disturbance during the time the bats would be using the area, and maintaining the character of the site by (1) maintaining snags, (2) maintaining large, live trees to provide future roosting opportunities, and (3) maintaining small canopy gaps to provide a continual supply of foraging habitat. The size of the area to be managed in this way would be determined on a site-specific basis after considering the existing conditions and any relevant information gained through radio-tracking or other forms of survey.

Although there would not be a change in management prescription if new maternity colonies are found in the Revised Forest Plan, all of the elements contained in the 3.5 Management Prescription are included in standards and guidelines in the Revised Forest Plan; i.e. known roost trees would be protected, a continuous supply of roost trees and foraging habitat would be provided, and human disturbance at the site would be minimized during the time the bats were in residence. The areas to be managed in this way would be mapped and tracked through a spatial layer available to all MTNF employees, so they would be evident during project planning.

Wildlife – Water and Openlands
The current 3.5 Management Prescription requires 1-4 water sources per square mile. The Revised Plan allows maintenance of existing waterholes, but only allows construction of new waterholes if a viability need is demonstrated. Currently MTNF has over 3000 constructed ponds and waterholes and about 92% of MTNF is within ¼ mile of a permanent water source (not including private ponds or large lakes such as Table

Rock or Wapapello). The availability of drinking water would not be affected under the Revised Forest Plan.

In the current 3.5 Management Prescription, up to 15% of an AOI can be in open or semi-open habitats. These areas presumably would not provide good foraging habitat, nor would there be much potential for roosting, although many openlands do contain small groups of trees. In the Revised Plan, only existing artificial openlands can be maintained – no new openlands can be developed. Natural openings (such as glades or warm season grasses on appropriate sites) may be maintained and enhanced. Currently, each of the AOIs has much less than 15% in artificial openland habitat. Since only exiting artificial openlands can be managed, each of the existing AOIs would have less than 15% in openlands under the Revised Forest Plan.

Table IB-5: Acres of Artificial Openland in AOIs

AOI	Acres	Acres Openland	% artificial openland in AOI
Tumbling Creek Cave	2329	105	5
White's Creek Cave	4350	53	1
Pilot Knob Mine	2790	0	0
Cave Hollow Cave	19563	210	1
Bell-Bat-Saloon Caves	8549	49	0.6
Great Spirit-Davis #2 Caves	39710	~2380	~6
Bruce-Onyx			
Ryden			
Dislocated Thumb			
Brown's Hollow Maternity	2197	25	1
Cave Hollow Maternity	Not yet established	See Cave Hollow Cave	

Minerals –
There is no drilling within the key area (150 acres surrounding hibernacula) in either the current 3.5 Management Prescription or in the Revised Plan (although not named "key area" in the Revised Plan).

For maternity areas, human disturbance would be minimized during the time the colony was using the area. This would include activities associated with mineral exploration and development.

Fire -
All Indiana bat areas of influence are considered smoke sensitive areas in the current Forest Plan. While the Revised Forest Plan does not give a distance from the cave, all areas around occupied Indiana bat hibernacula are considered smoke sensitive. The specific area for each cave and each prescribed burn would be determined on a site specific basis after evaluating individual cave configurations, locations in relation to burn units, weather forecasts, etc. It is conceivable that prescribed burns further than 5 miles from a hibernacula would be modified to minimize potential smoke impacts under the Revised Plan.

In addition, prescribed burning in the 150 areas surrounding hibernacula would be avoided between September 1 and November 1 and March 15 and April 31 to minimize potential impacts during the swarming and staging periods respectively. Prescribed burning within the area of use of maternity colonies would be done only during hibernation season to minimize the potential for direct impacts to reproductively active bats.

The protection afforded hibernating and maternity bats is at least as good under the Revised Plan, and in some cases, may be better than the existing AOI provides.

Table IB-6: Comparison of Habitat Needs with Current and Revised Plan

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
Vegetation	Foraging habitat near hibernacula Roost trees near hibernacula Foraging & roost trees within maternity colony area	Vegetation management done only to improve or enhance Indiana bat habitat, to maintain or enhance natural vegetative communities on appropriate sites, or for public safety.	Restore, enhance, maintain the structure, composition & function of distinctive natural communities. Distribute activities across landscape to emulate historical vegetation patterns & quantities. Character of maternity colony areas maintained or enhanced by maintaining snags & roost trees & foraging habitat.	Same	Manage natural communities to enhance & retain their characteristic ecological elements. Distribute activities across landscape to emulate historical vegetation patterns & quantities. Character of maternity colony areas maintained or enhanced by maintaining snags & roost trees & foraging habitat.	Same
Rangeland	Foraging habitat across landscape over time Roost trees across landscape over time	Development of forage resource limited to existing allotments and allotment plans designed to protect or enhance Ibat habitat and water quality values	Grazing only on existing improved pastures. Close all areas that contain glades and natural woodlands when the current permit expires. Limitations on grazing w/in WRZ & RMZ to protect water quality. W/in allotments, retain all living shagbark & shellbark hickory,	Better in Revised Plan	Limitations on grazing w/in WRZ & RMZ to protect water quality. W/in allotments, retain all living shagbark & shellbark hickory, white oak, lightning struck & cavity trees >=12" dbh, unless pose safety hazard.	Same or better in Revised Plan

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
			white oak, lightning struck & cavity trees >=12" dbh, unless pose safety hazard.			
Recreation	Minimize physical disturbance near hibernacula entrance & maternity colony areas	Semi-primitive non-motorized in key area.	Avoid road construction above known cave passages w/in 100 feet of cave entrance. Relocate roads away from cave entrances when possible. Minimize human disturbance near maternity colonies during summer season.	Same	Avoid road construction above known cave passages w/in 100 feet of cave entrance. Relocate roads away from cave entrances when possible. Minimize human disturbance near maternity colonies during summer season.	Same
Recreation	None	Semi-primitive motorized in primary area	1.1 Roaded natural 1.2 Semi-primitive motorized	No habitat need addressed	Roaded natural	No habitat need addressed
Visual Quality	None	Visual quality objective = Modification	VQO determined based on site-specific conditions; range from Retention to Maximum Modification	No habitat need addressed	VQO determined based on site-specific conditions; range from Retention to Maximum Modification	No habitat need addressed
Recreation	Hibernation with no human disturbance	Caves closed to human visitation Sept 15 – April 30	Do not allow human entry during fall swarming, hibernation , & spring emergence	Same	Do not allow human entry during fall swarming, hibernation , & spring emergence	Same
Timber	Foraging	Timber management	Prohibit timber	Better in	Prohibit timber	Same

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
	habitat across landscape over time Roost trees across landscape over time	only to improve or enhance Ibat habitat, to maintain or enhance natural vegetative communities on appropriate sites or for public safety	harvest w/in 100 feet of cave entrance. Prohibit skid trails w/in 100 feet of cave entrance. Use silvicultural method appropriate to move toward desired conditions based on management objectives, natural community type, stand conditions, and silvical characteristics of tree species. Intermediate harvest normally leave largest &/or oldest trees to meet basal area objectives. All even-aged regeneration will leave 7-10% as reserve trees or groups. Rotation ages are: 100 SLP, 120 PO/WO; 80 RO/SO/BO	Revised Plan	harvest w/in 100 feet of cave entrance. Prohibit skid trails w/in 100 feet of cave entrance. Use silvicultural method appropriate to move toward desired conditions based on management objectives, natural community type, stand conditions, and silvical characteristics of tree species. Intermediate harvest normally leave largest &/or oldest trees to meet basal area objectives. All even-aged regeneration will leave 7-10% as reserve trees or groups. Rotation ages are: 70 SLP; 90 PO/WO; 70 RO/SO/BO	
Wildlife	Hibernation with no human disturbance	Protect hibernacula by restricting human entry Sept 15 – April 30	Do not allow human entry during fall swarming, hibernation, & spring emergence	Same	Do not allow human entry during fall swarming, hibernation, & spring emergence	Same

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
Wildlife	Cave microclimate maintained	Structures must permit bats to pass & must not alter airflow	Structures must permit bats to pass & must not alter airflow	Same	Structures must permit bats to pass & must not alter airflow	Same
Wildlife	Cave microclimate maintained Roost trees near hibernacula Foraging habitat near hibernacula Minimize physical disturbance near hibernacula entrance	AOI Key area 20 acres OG & additional 130 acres mature forest	At least 20 acres OG around cave & additional 130 acres mature forest or woodland	Same	At least 20 acres OG around cave & additional 130 acres mature forest or woodland	Same
Wildlife	Roost trees near hibernacula Foraging habitat near hibernacula	AOI Primary range – up to 5 miles- 20% OG and minimum 50% oak/oak-pine >50	Range of ages including old growth throughout management areas. Designate tree groups/stands >175 years old as OG.	More dispersed through landscape than current Plan	Designate 8-12% OG for each management area. Designate tree groups/stands >175 years old as OG.	Fewer OG acres, but roost trees don't appear limiting on MTNF
Wildlife	Foraging habitat across landscape over time	AOI Primary range - Maintain minimum 50% in pole/saw with 50-70% canopy closure	Open and closed woodland natural communities desired basal area is 30-50% and 50-90% respectively.	Better in Revised Plan	Open and closed woodland natural communities desired basal area is 40-70 and 70-90% respectively.	Foraging distributed across landscape on appropriate sites

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
			Maternity colony areas should maintain canopy gaps for foraging.		Maternity colony areas should maintain canopy gaps for foraging.	
Wildlife	Foraging habitat across landscape over time	AOI Primary range - Natural regeneration ok to perpetuate oak-hickory/oak-pine forest. No more than 7% in 0-9 age class at any time.	MP 1.1 & 1.2 - Desired canopy gaps in open woodland = 10 acres with 1-3 per 100 acres and in closed woodland = 3 acres with 1-5 per 100 acres. MP 1.2 - No more than 20% of each Management Area harvested during each decade	Better in Revised Plan	Regen 8-15% each management area w/1-5% in openings <=2 acres. Regen openings distributed proportionately to ELTs and natural communities present.	Same or better in Revised Plan
Wildlife	Drinking water	AOI Primary range 1-4 water sources per square mile	No new wildlife waterholes unless demonstrated viability need for TES, RFSS, species group; Construct temporary pools at end of outlet ditches when possible.	Same	Construct new waterholes only where existing water sources limited or lacking. Manage & rehabilitate existing waterholes as priority over constructing new ones. Construct temporary pools at end of outlet ditches when possible.	Same
Wildlife	Foraging habitat across landscape over time	AOI Primary range - Up to 15% can be in open or semi-open habitats	Maintain or improve artificial openlands only where they currently exist	Better in Revised Plan	Maintain or improve artificial openlands only where they currently exist	Better in Revised Plan

Resource	Habitat Needs Addressed	Current Plan 3.5 MP	Revised Plan 1.1/1.2 (16% current 3.5)	Habitat Needs Provided	Revised Plan 2.1 (74% current 3.5)	Habitat Needs Provided
Minerals	Cave microclimate maintained Minimize physical disturbance near hibernacula entrance Minimize disturbance near maternity colony areas	No drilling in key area.	Prohibit drilling or other surface disturbing mineral operations over known caves & within 150 acre hibernacula buffer. No surface disturbing mineral activity w/in 100 feet of cave entrance. Minimize human disturbance near maternity colonies during summer season.	Same	Prohibit drilling or other surface disturbing mineral operations over known caves & within 150 acre hibernacula buffer. No surface disturbing mineral activity w/in 100 feet of cave entrance. Minimize human disturbance near maternity colonies during summer season.	Same
Fire	Cave microclimate maintained Summer roosting bats Fall swarming	All Ibat AOI considered smoke sensitive areas	Area around Ibat cave is smoke sensitive area. Conduct prescribed burning within maternity colony areas only during hibernation season. Avoid prescribed burning within 150 acre buffer at Ibat hibernacula in swarming & staging periods. Prescribed burning in maternity colony areas only during hibernation season.	Same	Area around Ibat cave is smoke sensitive area. Conduct prescribed burning within maternity colony areas only during hibernation season. Avoid prescribed burning within 150 acre buffer at Ibat hibernacula in swarming & staging periods. Prescribed burning in maternity colony areas only during hibernation season.	Same

In summary, both summer and winter habitat needs are addressed and provided for in the Revised Forest Plan, in much the same way as is currently done in the 3.5 Management Prescription. While it appears that less protection is provided because the purpose of the areas are not specifically to provide habitat for Indiana bats, the results of management in either the 1.1/1.2 or 2.1 Management Prescriptions would be that a variety of forested canopy closures would be available for foraging and suitable roost trees would be available throughout the landscape. The hibernacula themselves have the same, if not better, levels of protection from human disturbance or physical alteration. Maternity colonies would be protected from disturbance and long-term management near them would be focused on maintaining the character of the area that makes it a suitable maternity site.

Summary of Direct and Indirect Effects to Indiana bat

Table IB-7: Summary of Effects on Indiana bat

Effect	Actions potentially causing effects	Habitat potentially affected	Potential # Ibats affected	Potential for effect to occur
Human disturbance to occupied hibernacula (swarming, hibernating, staging)	Illegal entry; population monitoring	4 known hibernacula	<400	Very Low
Arousal due to human-created noise	Use of chainsaws, heavy equipment, boat motors, hunting	4 known hibernacula	<400	Low
Known occupied roost trees removed	Hazard tree removal	15 known roost trees as of 5/05	1-100	Very Low
Inadvertent removal of occupied roost trees (unknown to Forest Service)	Timber harvest, prescribed burning, hazard tree removal, road maintenance	Unknown	1-100	Very Low
Removal of potential roost trees (summer, migration)	Timber harvest, prescribed burning, hazard tree removal, road maintenance	Dead trees; large, live trees with exfoliating bark	1 - <35,000 (summer) 1-64,800 (migration)	High
Occupied foraging habitat altered (summer)	Timber harvest, prescribed burning, hazard tree removal, road maintenance, recreation area development	1 known maternity colony; 3 male areas known	1 to ~50	Moderate
Potential foraging habitat altered (summer, migration)	Timber harvest, prescribed burning, hazard tree removal, road maintenance, recreation area development	Potential foraging habitat across MTNF	1 - <35,000 (summer) 1-64,800 (migration)	High
Smoke enters occupied hibernacula (swarming, hibernation, staging)	Prescribed burning	4 known hibernacula	<400	Low-Moderate
		10 hibernacula on other ownerships near MTNF	~52,000	Low-Moderate
Smoke around occupied roost trees (summer, migration)	Prescribed burning	15 known trees	1 to ~50	Low-Moderate
		Unknown # others	Unknown	

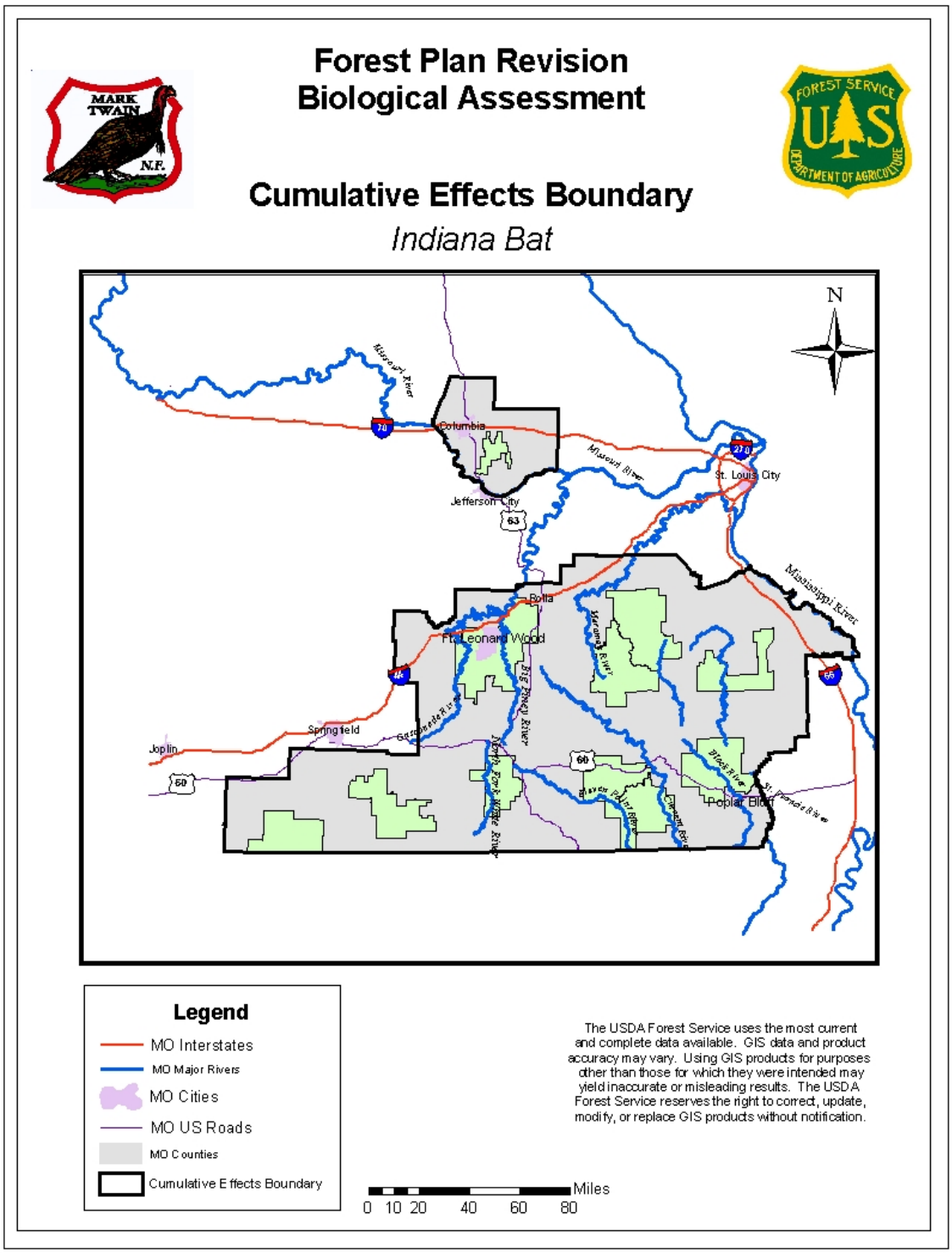
Potential night roost structures removed	Removal of concrete bridges	None on NF	1-50	None
No action	Deliberate no action (Wilderness, etc) or lack of action due to budget, etc.	Dispersed foraging habitat scattered throughout MTNF	1 - <35,000 (summer) 1-64,800 (migration)	High
Changes to water quality that affect number, distribution, type of aquatic insects available as prey	Timber harvest, prescribed burning, road maintenance & reconstruction	Aquatic insect populations in streams & rivers	1 - <35,000 (summer) 1-64,800 (migration)	Very Low
Physical protection of occupied hibernacula (swarming, hibernation, staging)	Construction of gates or other structures: Maintance of existing structures	4 known hibernacula	<400	Very High
Roost trees & foraging habitat provided around occupied hibernacula (summer, swarming, staging, migration)	Buffers around cave entrances; snag retention; timber harvest & prescribed burning creating variety of age classes, structural stages	Area around & near 4 known hibernacula	<400	Very High
		10 hibernacula on other ownerships near MTNF	~52,000	Low-Moderate
Potential roost trees provided across MTNF (summer, swarming, staging, migration)	Snag retention; large tree emphasis in 1.1/1.2; Old growth designations;	Roost trees distributed across MTNF	1 - <35,000	Very High
Potential night roost structures provided	Design new bridges to be bat-friendly	Unknown	Unknown	Low (no new bridges anticipated in forseeable future)
Foraging habitat provided across MTNF (summer, swarming, staging, migration)	Selective timber harvest, prescribed burning, no action, road reconstruction & maintenance, old growth designation,	Foraging habitat throughout MTNF	1 - <35,000 (summer) 1-64,800 (migration)	Very High
Drinking water sources provided across MTNF	Maintain existing waterholes; Construct temporary pools at end of outlet ditches	>3000 waterholes; unknown # temp pools	1 - <35,000 (summer) 1-64,800 (migration)	Very High
Restoration of natural communities	Primarily prescribed burning & timber harvest	Foraging and Roosting habitat primarily 1.1/1.2 Management Areas, but also other parts of MTNF	1 - <35,000 (summer) 1-64,800 (migration)	Very High
Sedimentation minimized & water quality protected	WPZ & RMZ buffers; wetland buffers; soil & water standards & guidelines	Aquatic insect populations in streams & rivers	1 - <35,000 (summer) 1-64,800 (migration)	High
Landscape effects of forest management	Timber harvest, prescribed burning, road maintenance & construction, recreation management,	1.5 million acres of foraging & roosting habitat	1-64,800	Unknown
Bioaccumulation of pesticides in Ibat fat	Pesticide use for control of non-native invasive plants; Control bees/wasps at rec sites; Convert fescue to native vegetation	Edges of openings; riparian areas where rec sites occur	1-64,800	Extremely Low
Bats killed at wind turbines	Construction of wind turbines	None-No permit applications for MTNF as of 5/05	Unknown	None at this time

Cumulative Effects

Boundaries:

The spatial boundary for cumulative effects analysis for Indiana bat is the 29 county area in which all National Forest lands are located.

Figure IB-5: Cumulative Effects Boundary for Indiana Bat



Potential effects from activities on National Forest lands would be human disturbance at occupied caves; removal of occupied or potential roost trees, smoke entering occupied caves or affecting summer roosting bats, alteration of cave entrances or roosting or foraging habitat, and sedimentation of area waterways impacting aquatic insects. Protection of caves and roost trees, providing foraging habitat, drinking water and a continual supply of roost trees, maintenance of natural communities, and minimizing soil movement would also be potential impacts of Forest management.

Smoke from prescribed fires is unlikely to travel further than the 29 county area. In the rare instances where that may occur, the density, height, and area of smoke would be so dispersed as to be practically unmeasurable, particularly as regards Indiana bat caves or summer roosting areas.

The temporal boundary for cumulative effects analysis for Indiana bat is for 15 years after the Revised Forest Plan is approved. The Forest Plan is intended to be effective for 10 years, but effects of implementation of the Plan may be noticeable for several years after that. Five years was selected since that is the amount of time that effects from alteration of habitat or human disturbance to Indiana bats could reasonably be expected to be evident.

Past and Present Actions

Past and present actions on National Forest lands are those that implement the 1986 Forest Plan, including:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

Pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan describe how past and present actions have created current Forest conditions. Specifically, for Indiana bats, known occupied caves on MTNF have been evaluated for physical protection and bat-friendly structures have been placed where determined to be necessary and appropriate. MTNF is primarily forested with a variety of canopy closures, understory structures, and ground covers. The Indiana bat population in MTNF caves is about 4-6% of Missouri's estimated population.

Past and present actions on private ownerships are also described in part on pages 3-7 through 3-10 and 3-19 through 3-25 of the Draft Environmental Impact Statement for the Revised Forest Plan. Of Missouri's nearly 45 million acres, about 86% had been paved or built upon, plowed, grazed, permanently flooded or mined by 1980 (Hawker 1992). In short, past and present actions on MTNF and other ownerships have resulted in nearly half of the most important Indiana bat caves in Missouri being acquired and protected from disturbance, and over 1/3 of the Priority One and Two hibernacula gated or fenced, but the Indiana bat population in Missouri still declining with no firm consensus as to the primary cause(s).

Reasonably Forseeable Actions

On National Forest lands, reasonably foreseeable actions are those which would implement the Revised Forest Plan. These include:

- treatment of non-native invasive species;
- protection of soil and water quality;
- stabilizing stream reaches
- planting trees, grasses, and/or other native species;
- protecting specialized habitats for species of concern;
- prescribed burning to meet a variety of objectives;
- suppression of wildfires;
- developing and maintaining roads and both motorized and non-motorized trails;
- a variety of types of timber harvest,
- minerals prospecting and development;
- acquiring and disposing of lands;
- issuance and administration of special use permits;
- grazing livestock and managing range forage;
- providing a variety of recreational experiences;

All these activities are subject to Section 7 consultation and thus would not be included in the discussion of cumulative effects as defined by ESA.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are so many owners within the 29 county area. Other state and federal landowners or managers include Missouri Departments of Conservation and Natural Resources (MDC and MDNR), the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Park Service, and state and federal Highway Departments. Each of these agencies has a different purpose and objectives for management of their lands. Land management on these other agency lands can be reasonably predicted based on past practices and planning documents.

While all have differing management objectives, the state and federal land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide use, providing recreational experiences, and for the Army Corps of Engineers, adjusting lake levels for flood control, hydropower production, and recreational use. Activities on other federal ownerships are also subject to Section

7 consultations and thus would not be included in the discussion of cumulative effects as defined by ESA.

The state and federal Highway Departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. Several highway projects are proposed within the 29 county area for the foreseeable future. The Missouri Department of Transportation website shows projects planned over the next decade (http://www.modot.state.mo.us/plansandprojects/construction_program/stip5year.htm). Federal Highway projects, and state projects which use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by ESA.

There are literally thousands of private landowners who own property within the 29 counties that contain National Forest lands. However, past trends on private properties within these counties are some indication of reasonably foreseeable trends for the future.

Those activities on private ownerships which may be reasonably expected to occur and which might have some impact on Indiana bats or their habitat include:

- Continued commercial use of some Indiana bat caves;
- Non-commercial, recreational use of occupied Indiana bat caves resulting in disturbance to the bats;
- Land clearing, road construction, and other uses that may result in permanent loss of forest cover and large, dead trees, and potential sedimentation of streams;
- Agricultural use of insecticides.

In addition, private landowners also conduct burns (usually small) on their land and wildfires occur on both National Forest and private ownerships within the proclamation boundary.

Effects Analysis:

» ***Protection of Caves from Human Disturbance***

Entry into occupied caves (either authorized or unauthorized, commercial or recreational) and the subsequent human disturbance of roosting Indiana bats is one of the primary threats that may occur both on private and public lands. This is also a primary threat identified in the Recovery Plan and other management plans for Indiana bats. This type of disturbance may affect only a few bats or tens of thousands of bats, depending on timing, which cave is entered, what activities are conducted in the cave, how many people enter, and how many bats are roosting at that time.

Two of the four known MTNF Indiana bat hibernacula have been gated and are closed during the time the bats are there. The other two caves are relatively safe from human disturbance, and one is being proposed for gating in the near future. On private ownerships, some Indiana bat caves are protected with physical structures while others are not. The Missouri Department of Conservation and U.S. Fish and Wildlife Service

work with willing private landowners to provide physical protection to Indiana bat caves currently vulnerable to human entry.

In Missouri, there are 67 known hibernacula (Clawson 2002), with 17 of these being classed as Priority One or Two (Currie 2002). Of these 17, seven are gated and 10 are not. In the 17 Priority One and Two hibernacula in Missouri, 6 of the 7 sites with gates have experienced population decline and all 10 of the ungated hibernacula have experienced population decline (Currie 2002). When looking at other gated and ungated caves throughout the range, it is evident that while some gates have been successful in increasing hibernating populations, other gates have not been effective in reversing declines (Currie 2002). This indicates that there are other factors involved in cave population dynamics than merely eliminating human disturbance.

Continuing protection efforts on MTNF caves, added to the continued protection of caves on other federal or state agency lands, and efforts to increase protection of caves on private lands means that the potential for human disturbance at occupied Indiana bat caves will continue to decrease over time. The additive impact of implementing the Revised Forest Plan on MTNF lands is that the potential for negative impacts to Indiana bat populations as a result of human disturbance is relatively low. However, this does not appear, in Missouri, to be a current cause of continued decline as evidenced by population decreases in both gated and ungated hibernacula.

- ***Protection of Caves from or Physical Alteration***

Changes in cave microclimate, resulting in temperatures and/or humidities that are apparently not conducive to Indiana bat survival, are thought by some to be one of the primary (if not the primary) causes of continued declines of Indiana bat (Tuttle and Kennedy 2002). MTNF caves are not subject to physical alterations of cave entrances unless they are done to reduce the potential for human disturbance inside the cave. Two of the four Indiana bat hibernacula on MTNF have gates with appropriate bat-friendly designs that maintain air-flow. Any future structures at hibernacula would also be designed to maintain air-flow, as well as permit bats to pass safely (U.S. Forest Service 2005, page 2-10).

Gates and other structures on other publicly owned caves are also designed to allow air-flow and safe passage by bats. Structures on privately owned caves may or may not be designed to maintain air-flow inside the caves. Those private landowners who work with MDC and/or USFWS in the future would have structures that do not affect air-flow. However, it is likely that there will be some hibernacula with inappropriate structures remaining on private ownerships into the foreseeable future.

Since MTNF does not alter entrances, and maintains a forest/woodland buffer around the entrance to all known Indiana bat hibernacula, there would be no additive impact from physical alteration of caves and no cumulative impact.

- ***Loss of foraging and roosting habitat and potential sedimentation of streams through land clearing, road construction, and other uses that may result in permanent loss of forest cover and large, dead trees***

Of the 29 counties which have some land within MTNF proclamation boundary, all have experienced population growth ranging from 7% to 38% from the 1990 to 2000 census, with the exception of two counties that lost less than 1% of their population growth over that 10 year period (U.S. Forest Service 2005b, page 3-277). The fastest growing

counties are near Branson (Table Rock Lake area) and Columbia, Missouri (Lake of the Ozarks/Truman Lake area). Average population growth for the 29 counties over the 10 year period was about 19%. These trends are likely to continue into the reasonably foreseeable future.

It is reasonably certain that some land development as a result of population growth will destroy, damage, or alter possible foraging habitat, including riparian corridors and upland forest/woodland, to some degree, possibly affecting individual Indiana bats or small groups. It is also possible that these activities would remove potential roost trees, suitable roost trees, or maybe even occupied roost trees. The probability of removing an occupied roost tree is much less than the probability of removing potential or suitable trees. Land development and certain land uses, may also cause erosion and sedimentation of nearby streams. The amount, duration, and extent of such sedimentation would determine whether or not there was any impact to aquatic insects on which Indiana bats may feed. The location of such impacts would determine whether or not Indiana bats would even be in the area to be affected. The extent to which these activities would result in decreased reproductive success or fitness of individual bats or local populations of bats is unknown. Miller et al. (2002) suggest that summer habitat limitations are not directly responsible for observed decreases in population because "Indiana bats seem quite flexible with respect to the proportion of various land-cover types that exist near maternity roosts, and colonies probably tolerate considerable alteration of the landscape" and that "the timing of major changes in land cover within Missouri does not correspond with the period of greatest decline in populations of Indiana bats.". There appeared to be little change in habitat conditions at northern Missouri maternity from the 1980s through the 1990s. "If changes have occurred, they do not appear to have taken place on a scale commensurate with the 80% decline in Indiana bats observed at hibernacula in Missouri" (Miller et al. 2002).

On MTNF, known roost trees would be protected from disturbance. Potential and suitable roost trees would be provided across the Forest, but some potential and suitable roost trees would be removed during management activities. Analysis of direct and indirect impacts indicates that removal of these types of trees in the manner and extent proposed would be unlikely to have any impact on the reproductive success, behavior or fitness of individual bats, or local populations because of the huge amount of potential and suitable roost trees available across the landscape. Therefore, there would be no impacts to add to those occurring on other ownerships.

Foraging habitat would be provided on MTNF by the creation and maintenance of a variety of structural, age, and species conditions across the Forest, through timber harvest, prescribed burning, and other activities. Restoration of natural communities in the 1.1 and 1.2 Management Prescriptions would also provide a range of habitat conditions that emulate the range of natural variability present before European settlement of the Ozarks. Canopy closures in forest/woodlands would range from about 40% to 100% providing a variety of foraging substrates and insect availability. Regeneration harvest on about 7% of MTNF in the plan decade would create areas that may not be used by Indiana bats as foraging areas. Even so, about 88% of MTNF would be continuously available as foraging habitat.

The alteration of foraging habitat would not eliminate foraging habitat (except temporarily in even-age harvest units) anywhere on MTNF. Alterations of habitat through timber harvest, prescribed burning, road reconstruction or maintenance, or other forest

management activities might change canopy closures, understory density, or ground cover abundance, but all these conditions have been documented as foraging habitat for Indiana bats. Even-age regeneration harvest would be unlikely to be used as foraging habitat for about 15-20 years, until the area grew into the pole stage. These areas are distributed throughout the forest in a matrix of otherwise dense forest cover, are generally less than 40 acres in size, and have areas of reserve trees retained within the harvest unit. With the documented size of male foraging areas, it is highly unlikely that the presence of regeneration harvest on the scale and size practiced on MTNF would cause any individual bat to have to completely change its foraging area, or cause adverse effects to fitness or reproductive success.

With the large amount of area providing foraging habitat, the different types of forest habitat used by Indiana bats for foraging, the type and extent of vegetation alteration, and the low capture rates for Indiana bats on MTNF, the alteration of foraging habitat would not be likely to result in any permanent changes in behavior, fitness or reproductive success of bats using MTNF. Therefore, there should be no adverse impacts from alteration of foraging habitat on MTNF and no cumulative impact.

MTNF has ownership in 65 different 5th level watersheds in Missouri. National Forest ownership is less than 10% in about ½ of these, and National Forest management would have very little impact on any streams or rivers in those watersheds. About 17% of these watersheds have National Forest ownership ranging from 15%-25%, and in these there would be only moderate influences on water from National Forest management activities. Only 11% of these watersheds have more than 40% MTNF ownership. In these 7 watersheds, MTNF management may a significant impact on rivers and streams (U.S. Forest Service 2005(c), page 3-185). However, even in these watersheds, National Forest ownership of riparian corridors adjacent to streams is low.

Monitoring of timber sales on MTNF showed soil loss from 0 tons/acre/year to 0.8 tons/acre/year with an average of about 0.2 tons/acre/year (U.S. Forest Service 1998). The estimated amount of commercial timber harvest under the Revised Forest Plan would be about 225,025 acres per year (U.S. Forest Service 2005, page E-3). The implementation of standards and guidelines to minimize soil movement and protect water quality and functioning of the RMZ would reduce the potential for any negative impacts to water quality, aquatic insect populations, or Indiana bats from these activities.

Standards and guidelines in the Revised Forest Plan would help insure that streambanks, substrates, and channels are within their natural range of variability and are functioning in a way that provides for the needs of all aquatic and terrestrial flora and fauna that depend upon them. Specifically there would be no stream channelization, no impoundments within the RMZ, in-stream equipment use would be minimized, hydrologic or habitat improvement structures would be designed to be natural appearing and functioning, aquatic organism passage would not be blocked or prevented, canopy closures would be maintained on all permanent streams less than 25 feet wide, and in-stream work would be minimized during spawning periods (U.S. Forest Service 2005, pages 2-5, 2-9 and 2-10). Therefore, there would be no added impact to aquatic insect populations or Indiana bats from instable banks, substrates or channels caused by National Forest management activities.

» ***Pesticide Use***

Over the past 15 years, the only insecticides used on MTNF have been commercially available sprays ("bee-boppers"). These are purchased as needed and used in small amounts to kill wasps and bees causing problems in developed recreation areas. To our knowledge, this is the also only type of insecticide used on other federal and state agency lands. There is no source of information on what types or amounts of insecticides are used on private lands within the 29 county area.

The Revised Forest Plan contains standards and guidelines limiting the use of pesticides within RMZs, WPZs, and within 100 feet of sinkholes, sprigs, wetlands, and cave openings (U.S. Forest Service 2005, page 2-19). These measures would help insure that any insecticides used on MTNF in the future do not enter waterways or groundwater. The small amount of insecticide used by the Forest Service to control wasps and bees in developed recreation areas is not likely to have any effects on aquatic insects.

Gypsy moths have not yet been a serious problem in Missouri, although it is anticipated that they will occupy the state by about 2025 unless control efforts are successful in slowing the spread (http://www.fs.fed.us/ne/morgantown/4557/gmoth/spread/). No widespread control measures have yet been instituted in Missouri. The Forest Service does not anticipate needing to use any form of chemical gypsy moth control in the foreseeable future. West Nile virus caused concern in Missouri for several years, but the Forest Service does not propose to use mosquito control measures in the Revised Forest Plan. .

» ***Smoke impacts from prescribed or wildfires***

In Missouri, about 58,600 are prescribed burned annually, which does not include private ownerships where burn acres are not reported to an agency. The MTNF contributes about 17% of this total. Average annual state-wide wildfire acres for the agencies which suppress fires in Missouri are about 59,200 (U.S. Forest Service 2005(a), pages 3-167 and 3-172). About 9% of these are on MTNF lands. The actual amount burned in any given year is a function of weather and fuel conditions. Cool, wet years have fewer acres burned, and warm, dry years have more acres burned.

Emission of fine particulate matter (PM 2.5) is expected to increase about 80% over current levels from prescribed fire on MTNF under the Revised Forest plan (U.S. Forest Service 2005(a), page 3-175). PM 2.5 is the greatest danger to human health and presumably also to bats, and fine particulates make up more than 70% of the matter produced by both prescribed and wildfires (U.S. Forest Service 2005(a), page 3-175).

Assuming all other agencies do not change their annual average prescribed burn acres, the MTNF increase in PM 2.5 (from about 450 tons to about 2325 tons annually) would increase the MTNF's share of total PM 2.5 emissions from about 21% annually to about 59% annually. However, each prescribed burn done on MTNF must have a smoke management plan prepared prior to ignition, where site-specific mitigations are developed to minimize the potential impact of smoke on sensitive receptors (U.S. Forest Service 2005(a), pages 3-176 and 3-177). Occupied Indiana bat caves are considered smoke-sensitive areas and prescribed burn plans must avoid or minimize smoke influences at or near these caves (U.S. Forest Service 2005, page 2-11). It is estimated that potential PM 2.5 emissions can be reduced by at least 31%-83% depending on the

type of mitigations used (U.S. Forest Service 2005(a), page 3-177). This would reduce the potential for negative impacts from smoke.

As stated in the indirect effects above, the possibility of smoke from MTNF prescribed burns affecting bats is considered so remote as to be insignificant and discountable. Even considering an increase in the acres of prescribed burning on MTNF under the Revised Forest Plan, the incremental effects would be that a few additional Indiana bats may be temporarily affected by minor amounts of smoke. These additional impacts would not be expected to adversely impact either individual bat survival or reproductive success or that of the population of Indiana bats in southern Missouri.

Conclusions:

Of the 45 documented Indiana bat hibernacula in Missouri, only 4 (9%) are on National Forest lands, and about 4-6% of Missouri's Indiana bat population is in caves on MTNF. MTNF caves harbor about 0.07-0.1% of the range wide population.

The number of Indiana bats that use MTNF lands in summer or in migration is unknown, but is expected to be much less than 35,000 (about ½ of those that winter in Missouri and making some allowance for bats potentially coming to Missouri from Illinois, Arkansas, or Oklahoma hibernacula). This is about 9% of the total range wide population of Indiana bats.

Since MTNF would continue to provide suitable habitat in known caves, provide foraging and roosting habitat, and protect occupied caves from disturbance, the effects of implementing Alternative 3 of the Revised Forest Plan, added to effects occurring from activities on other ownerships would be insignificant in terms of possible changes in behavior, fitness, or reproductive success of individual bats or local populations and would not individually or cumulatively result in a decrease in the potential for recovery of Indiana bats in Missouri or range wide. The probability of human disturbance in MTNF hibernacula is extremely low for the two gated caves, and very low for a third due to the size and location of the entrance. The fourth cave is being proposed for gating, which would make the probability for human disturbance there extremely low. The probability of being able to detect negative impacts from possible roost tree removal, foraging habitat alteration, or smoke impacts are so low as to be unmeasurable. This meets the definition of both insignificant and discountable effects.

» **Additional measures needed for species conservation and recovery**

Indiana bat populations are still decreasing in Missouri and across the range, although populations in northern states have increased.

» *Construct a bat-friendly, airflow gate at Knife Cave to prevent human entry during the hibernation period.*

» **Effects of additional measures**

Construction of a gate on this cave would protect about 70 Indiana bats from human entry and possible disturbance during hibernation.

» Determination – May Affect, Likely to Adversely Affect

Rationale: In order to make a determination of not likely to adversely affect, any potential effect must be entirely beneficial, or if adverse, must be insignificant or discountable. In addition, if incidental take is anticipated to occur as a result of the proposed action, the determination must be likely to adversely affect.

- Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- Insignificant effects relate to the size of the impact and should never reach the scale where take occurs.

Incidental take is defined as take of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by a Federal agency or its applicant [50 CFR 402.2].

Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. [ESA 3(19)]. **Harm** is further defined by FWS to include significant habitat modification or degradation that **results in death or injury** to listed species by **significantly impairing** behavioral patterns such as breeding, feeding, or sheltering (emphasis added). **Harass** is further defined by FWS as actions that create the likelihood of injury to listed species to such an extent as to **significantly disrupt normal behavior patterns** which include, but are not limited to, breeding, feeding or sheltering [50 CFR 17.3]." (emphasis added).

There are some potential effects of implementing the Revised Forest Plan that are entirely beneficial. These effects are consistent with a determination of Not Likely to Adversely Affect. These include:

- ✓ Physical protection of occupied hibernacula
- ✓ Providing roost trees and foraging habitat around hibernacula entrances
- ✓ Providing potential roost trees across the Forest
- ✓ Providing drinking water sources across the Forest
- ✓ Minimization of sediment and protection of water quality

There are some actions which may have both beneficial and potentially negative impacts on Indiana bats. Because these are not wholly beneficial, the potential adverse impacts must be extremely unlikely to occur or never reach the scale where incidental take occurs. These include:

- ✓ Alteration of foraging habitat (beneficial providing variety forest habitats; adverse potential removal foraging with even-age regeneration harvest)
- ✓ Prescribed burning (beneficial increase ground flora & insect abundance; adverse smoke in hibernacula or around roost trees)
- ✓ Restoration of natural communities (beneficial providing variety forest habitats; adverse removal of potential roost trees & smoke in hibernacula or around roost trees)

There are potential adverse impacts of implementing the Revised Forest Plan and these must be extremely unlikely to occur or never reach the scale where incidental take occurs in order for a Not Likely to Adversely Affect determination to be made. Potential adverse impacts include:

- ✓ Human disturbance to occupied hibernacula
- ✓ Removal of known roost trees
- ✓ Inadvertent removal of occupied roost trees (unknown to FS)
- ✓ Removal of potential roost trees
- ✓ No action
- ✓ Changes to water quality
- ✓ Bioaccumulation of pesticides in Indiana bats

Two of the four known hibernacula on MTNF are gated to exclude human entry during the hibernation season. A third is proposed for gating in the foreseeable future, which would nearly eliminate the potential for human disturbance to occur at that cave. The fourth MTNF hibernaculum has a very small and inconspicuous entrance which effectively minimizes the potential for entry, even without a physical barrier. For the three caves in which population surveys have been conducted, the population trend has fluctuated in about the same way in all three, indicating that human disturbance is probably not a factor in any of the three. Based on this, we do not expect that Indiana bats in MTNF hibernacula would be disturbed by human entry during the hibernation season. This meets the criteria for a discountable effect and is consistent with a Not Likely to Adversely Affect determination.

The probability of removing an occupied roost tree (defined as dead trees over 9" dbh and live white oak, shagbark or shellbark hickory over 9" dbh) through timber harvest or prescribed burning on MTNF (the two most extensive actions in the Revised Plan that would affect Indiana bat habitat) was calculated to be about 1 in 363,779 for timber harvest and 1 in 3,167,219 for prescribed fire.

If it is true that male Indiana bats which stay around hibernacula in summer are concentrated within 3-5 miles of the hibernacula entrance, the odds of removing an occupied male roost tree would increase somewhat as activities are conducted in that area. However, summer survey work on MTNF has found male Indiana bats roosting and foraging from about 1 to 29 miles from the closest known hibernacula entrance. Even if the odds of removing a male roost tree doubled as activities are conducted within 5 miles of a hibernacula (and it is doubtful the increase would be anywhere close to double), there would still be merely a 1 in 182,000 chance of cutting an occupied roost tree, or a 1 in 1,583,610 chance of affecting an occupied roost tree through prescribed burning.

These odds are only of removal of an occupied tree, and do not account for the adaptation of Indiana bats to roosting in a naturally ephemeral habitat. It is likely that even if an occupied roost tree was removed in some manner, the bat(s) (both male and female) would exhibit normal behavior when a roost tree becomes naturally unavailable (as in a windstorm or flood), and would fly to a previously selected alternate roost. Even though this would require some energy expenditure on the part of the affected bat(s), it falls within their normal range of behaviors, and would not be a significant impairment or disruption of normal behavior patterns. Therefore, although events may occur that affect Indiana bat habitat, incidental take, as defined, (significantly impairing behavioral patterns; significantly disrupting normal behavior patterns) would not occur.

A reasonable person would conclude from these odds that removal of an occupied roost tree resulting in incidental take through harm or harassment is extremely unlikely to occur (discountable), cannot be meaningfully measured, detected, or evaluated (discountable), and would not be expected to occur (discountable). This is consistent with a Not Likely to Adversely Affect determination.

None of the literature suggests that maternity colonies are concentrated near hibernacula entrances, so the potential for removal of maternity roost trees would not increase with closer proximity to hibernacula entrances.

However, maternity colonies generally occupy a relatively small area, with roost trees being encompassed in a 0.5-0.9 mile radius circle in northern Missouri (Callahan et al, 1997) and up to 5 miles apart in Michigan (Kurta et al 2002). At the two maternity colonies discovered on MTNF lands, roost trees were from 0.6-2.7 miles apart (Salem/Potosi) and from 0.2-1.3 miles apart (Brown's Hollow). As forest management activities are conducted closer to maternity colony areas, the odds of removing an occupied roost tree would increase to some degree. While female and volant young would exhibit the same natural behavior as described above (i.e. leaving the downed tree to occupy an already identified alternate roost), there is a very slight possibility that a bat or bats (particularly non-volant young) would be injured or crushed if a tree fell to the ground as a result of MTNF management or natural occurrences. Of the thousands of documented roost trees (both male and female), known throughout the range, only 4 were discovered as a result of the tree being cut or bulldozed (Belwood 2002, Gardner et al. 1991).

There is one documented instance of an adult female and three prevolant juvenile Indiana bats being killed when a dead tree was cut down in a subdivision (Belwood 2002). However, apparently all of the other adult females survived and after dark, removed their pups from the downed tree and a bat house in which some young had been placed by the author. During this situation, 6 of at least 38 Indiana bats (16%) died as a direct or indirect result of the tree being cut down. This colony apparently moved to another roost about 20 meters from the cut tree, and Indiana bats were netted about 100 meters from the original tree 4 years later.

While individual death or injury is possible if an occupied roost tree is removed, the odds of roost tree removal are extremely low as described above; and it is likely that most bats would survive and use normal behaviors to move to an alternate roost tree. While the potential for any Indiana bats to be injured or killed as a result of removal of an occupied roost tree is extremely low, the possibility cannot be removed, particularly for a

programmatic analysis which covers 1.5 million acres and 10-15 years of activity. Since some level of incidental take may occur during the implementation of the Revised Forest Plan, this does not meet the definition of discountable or insignificant and therefore is not consistent with a Not Likely to Adversely Affect determination.

The analysis of direct and indirect impacts shows that MTNF has limited ownership in many watersheds, and would not be able to significantly affect water quality in many. In those where MTNF does have a significant portion of the watershed, the analysis shows that sediment yields are extremely low and would not be expected to affect any waterway to the extent that aquatic insect populations were altered in any way. Due to the watershed ownership patterns and low yields from NF lands, there would be no way to meaningfully measure or detect potential impacts to Indiana bats from activities on National Forest lands. Therefore, this effect meets the criteria for discountable and is consistent with a Not Likely to Adversely Affect determination.

MTNF uses only a minute amount of insecticides and none of the pesticides that are known to bioaccumulate in bats. Therefore, this effect is not expected to occur and therefore meets the definition of discountable and insignificant, and is consistent with a Not Likely to Adversely Affect determination.

In the 5 years since issuance of the 1999 Programmatic Biological Opinion, there has been no documented adverse impact to individual Indiana bats or hibernating populations. In 7 years of summer mist-netting and acoustic surveying on MTNF, only 10 Indiana bats have been captured, and only a handful of others have been captured on other ownerships adjacent to MTNF or within MTNF proclamation boundary. The extremely low capture rate as compared to other National Forests in the Indiana bat range, indicate that summer use of MTNF is very low, giving further support to the contention that effects to Indiana bats are unlikely to occur and cannot be meaningfully measured (discountable).

Most of the potentially adverse impacts are extremely unlikely to occur and there is no reasonable way to meaningfully measure, detect, or evaluate these effects. Therefore, they meet the criteria for discountable, and for a Not Likely to Adversely Affect determination.

However, in this programmatic analysis, the spatial scale is about 1.5 million acres of National Forest lands, and the temporal scale is over the next 10-15 years. In that area and over that time period, there is no way to completely eliminate the potential for wounding, injuring, or killing an Indiana bat, particularly non-volant young, through removal of an occupied roost tree in a programmatic sense. This is particularly the case since the Mark Twain National Forest has been affected with oak decline for over 20 years, and has about 400,000 acres of National Forest lands susceptible to further decline. While this creates an abundant supply of suitable roost trees, it also creates a forest health and fuel problem that MTNF will manage to address threats to public safety and effective, sustained use of the public's natural resources. The removal of dead trees through salvage harvest is an action anticipated to occur throughout the next decade or two.

Individual site-specific consultations would occur for all projects, including salvage of dead and dying trees. Incidental take may or may not be anticipated to occur at the project level. However, at the programmatic level, as long as recently dead trees are

being removed through commercial harvest and other forest management activities, the potential for incidental take is impossible to remove, leading to the conclusion that, programmatically, implementation of the Revised Forest Plan may result in a very small amount of incidental take at some point in the next 10-15 years.

Therefore, while confident that implementation of the Revised Forest Plan will, in fact, provide increased quality and quantity of habitat for Indiana bats across the Forest, and that the potential for adverse effects or incidental take through harming or harassing to occur is so remote as to meet the definition of insignificant and discountable; the possibility of incidental take by injuring or killing through removal of an occupied roost cannot be removed, making our determination for Indiana bat "**May Affect, Likely to Adversely Affect".**

When a revised Recovery Plan is approved, and/or as new science becomes available, this analysis and determination will be reviewed and modified if considered appropriate at that time.

Additional Considerations for MTNF Revised Forest Plan Implementation

Management of Indiana bat is particularly frustrating because there is no clear consensus on why this species continues to decline, in spite of protection of major hibernacula. While many potential causes are identified in the Agency Draft Recovery Plan and other literature, there are three factors that I believe the body of knowledge points to as the primary causes in the lack of recovery. These three factors are being addressed on MTNF by protection of known hibernacula, providing a variety of structural stages of forest/woodland cover, and limited use of pesticides; but actions on MTNF may affect only a tiny portion of the total Indiana bat population and are not likely to significantly affect the potential for recovery of this species.

The three factors are:

(A) The combination of hibernacula disturbance & microclimate change
It has been well-established that human disturbance of hibernating populations has been a cause of decline in specific caves across the range. However, recent evaluation of gated caves has shown that the lack of human disturbance does not always result in an increase in population (Currie 2002). Tuttle and Kennedy (2002) present evidence that cave microclimates may play a more important role than previously realized in whether or not hibernating populations increase or decrease over time. Clawson (2002) demonstrated that hibernating populations in the northern part of the range have been increasing in the past several years, while populations in southern hibernacula continue to decline, sometimes precipitously. These studies in combination clearly indicate that hibernacula microclimates are a key factor in the continued survival of the species.

(B) Simplification of summer habitat
Most Indiana bat maternity colonies (although not all) have been located in highly fragmented agricultural landscapes that were previously a matrix of mixed prairie, forested riparian stream corridors, and savannas or open woodlands (Gardner & Cook 2002). This landscape is now extremely simplified compared to the historic diversity of plant species and distributions. In the past several decades, the non-native cool-season

fescue has become the dominant plant in most pastures and hayfields in Missouri. This plant forms heavy clumps with thick mats of roots, crowding out other plants, including native species. It also contains allelopathic substances, which prevent other plants from growing near it. These factors result in a decrease in plant species diversity where fescue exists (Missouri Department of Conservation 1993). The size of the average crop or hayfield in Missouri has also increased, and in order to accommodate larger equipment, thousands of acres of the small, "odd" acres such as fencerows, brushy draws, and woodlots have been cleared and converted to agriculture (Dailey and Hutton 1993).

Floodplain habitats on the Mississippi and Missouri Rivers, as well as other major rivers in the Indiana bat range, have been channelized, floodplains cut, drained and converted to agriculture or industrial uses (Hawker 1998). The dynamic floodplain systems that created large, dead trees through time that probably served as Indiana bat maternity roosts no longer function over the length of the rivers. Only very small segments of these rivers retain the natural disturbance cycles (Mlot 2004).

Forests of the Ozarks are much more homogenous today than they were historically. Much of the forest on MTNF is of similar age and species composition, and has much less ground vegetation than historically. On MTNF, historic vegetation is estimated to consist of about 8% savanna (shrub/barren), 36% open woodland (20-50% canopy cover), 41% closed woodland (50-80% canopy cover) and 15% forest (>80% cover) (U.S. Forest Service 2005(c), page 3-48). Today, MTNF is primarily closed canopy and overstocked forest with much less white oak, post oak, and shortleaf pine than historic levels. Conversely, the amount of black and scarlet oak (short-lived species) is much higher (U.S. Forest Service 2005(c), page 3-50). The number of large trees scattered across the landscape is also much less than it would have been historically.

Probably the most important results of this simplification of the landscape for Indiana bats are the change in insect distribution, abundance, and variety within their summer ranges, and the reduction in the sustained supply of large, dead trees near streams and rivers.

(C) Pesticide impacts on prey species and accumulation in bats
While only a few studies are available on the impacts of pesticides on Indiana bats, the results show that insect-eating bats do bioaccumulate some types of pesticides and mortality has resulted (O'Shea and Clark 2002; Schmidt et al.2002; McFarland et al.1998). The pesticides implicated are those used for pest control in agricultural settings. O'Shea and Clark (2002) state that studies "suggested chronic mortality from OC (organochlorine) pesticides prior to their discontinuance." With the amount of core maternity area in agriculture, and the sustained use of pesticides to control crop pests which may be Indiana bat prey, "many scientists believe that population declines occurring today might be due to pesticide use, possibly through eating contaminated insects, drinking contaminated water, or absorbing the chemicals while feeding in areas that have been recently treated." (U.S. Fish and Wildlife Service 2005)

Management of MTNF lands has little influence on these three primary causes of decline, as described below.

(A) Hibernacula Changes
The MTNF Revised Forest Plan protects known Indiana bat hibernacula on MTNF from human disturbance and physical alteration of entrances and the area around entrances. Therefore, implementation of the Revised Plan would not contribute to this factor in the decline of the species.

(B) Simplification of Summer Habitat
The majority of known maternity habitat is outside of the MTNF boundaries and (with the exception of Cedar Creek unit) outside of the ecological Subsections which encompass MTNF (U.S. Forest Service 2005, page A-1). MTNF has not contributed to simplification of summer habitat in the core maternity range.

None of MTNF is within the Missouri or Mississippi River floodplains. Management of floodplains within MTNF under the Revised Forest Plan is modified to protect water quality and to maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the riparian corridor (U.S. Forest Service 2005, page 1-3). The manner in which floodplain habitats are managed on MTNF would not contribute to this factor in the decline of the species.

Restoring the structural and species diversity of all of the varied upland and riparian natural communities is the major goal of vegetation management under the Revised Forest Plan (U.S. Forest Service 2005, page 1-1). Tables A-1 and A-2 summarize the range of desired conditions for the different types of natural communities. Management under the Revised Forest Plan would, over time, increase the relative amounts of longer-lived tree species (such as white oak and shortleaf pine) and decrease the relative amounts of shorter-lived tree species (such as black and scarlet oak). There would also be an increase in the amount, species, and distribution of ground vegetation in many areas across the Forest; thereby increasing the variety of food substrates for terrestrial insects that Indiana bats eat. Forest management on MTNF under the Revised Forest Plan would not contribute to simplification of summer habitat; and would, in fact do the opposite.

(C) Pesticides
MTNF uses a very minor amount of insecticides, primarily in recreation areas or areas of concentrated human use where wasps, bees, and hornets are an identified problem. MTNF uses some herbicides for rangeland management, control of non-native invasive species, and conversion of non-native vegetation (such as fescue) to native species. These are all pesticides approved for use by EPA and all state and federal laws are followed in their application. None are organochlorine pesticides. Pesticide use under the Revised Forest Plan is likely to be similar to current use, and would therefore not contribute to this factor in the decline of the species.

In support of my conclusions, I have assembled the following quotes and exerpts from literature:

- **Hibernation microclimates are key**

Tuttle and Kennedy (2002) "All populations of which we are aware, which are not jeopardized by inappropriate temperatures, disturbance, or flooding, are stable or growing, indicating that problems during hibernation likely are a key factor in the species' overall decline."

Tuttle and Kennedy (2002) "comparison of other populations of Indiana bats that remained stable or increased with those that declined over the past 20 years (Table 5) strongly implies that inappropriate temperatures at hibernating sites are a primary cause of decline as suggested by Humphrey (1978)."

Johnson et al (2002) "Disturbance, vandalism, and altered microclimates inside hibernacula are primary factors in decline of winter populations."

Kath (2002) "Colonization of the Magazine Mine by more than 14,000 Indiana bats in only 20 years indicates that these bats have the behavioral plasticity to adopt new sites for hibernation, as long as environmental conditions are appropriate and disturbance is limited."

Currie (2002) "Results of this study and that of Johnson et al. (2002) indicate that recovery of hibernating populations of Indiana bats will not necessarily occur simply because human disturbance is reduced or eliminated.'

Brack et al. (2002) "More roost trees in southern forests will not produce more Indiana bats if appropriate hibernacula are lacking."

- **Simplification of summer habitat – Prairies (maternity habitat)**

Hawker (1992) In the 1970's and 1980's, "managers of large holdings were forced to plow prairies that had never been plowed before"

Hawker (1992) "virtually all of northern Missouri had been planted in domesticated grasses and crops bythe turn of the 20th century. The tills and loess of the glaciated prairie were just too productive not to plow. If all the remaining native prairies north of the Missouri River could be gathered into one place, they would not fill a single section of land." (*Note: 1 section of land = 640 acres*).

Hawker (1992) "Today, a sense of grassland, a prairie image, cannot easily be conjured in Missouri. Especially in the glaciated region, the biome has been completely obliterated and replaced by brushy farmland."

- **Simplification of summer habitat – Floodplain forests (maternity habitat)**

Hawker (1992) "It would be nearly a century, after the great swamps were drained, cut, and burned at the beginning of the 20th century that the bulk of Bootheel lands would be converted to agriculture." "Today, the few patches of forest and swamp that managed to somehow survive the original drainage continue to wither at a depressing rate as bulldozer and fire open increasingly marginal flood plain to periodic crop production possible only in dry years."

Hawker (1992) "The Bank Stabilization and Navigation Project, completed in 1980 at a cost of $427 million, virtually eliminated all of the river's islands, bars, meanders, braided sections, backwaters, and sloughs, destroying habitats that supported the abundant wildlife reported by Lewis and Clark." "Most wildlife changes are due to physical changes in the river itself. Indeed, the Missouri is actually 8 percent shorter today because of straightening and has lost about half of its total water surface area due to constriction of the channel. Over 60,000 acres of prime wildlife habitat, including 24,000 acres of islands along 550 miles of the river's course were lost in Missouri alone during the construction phase. An unrecognizably docile version of its former self today…."

Hawker (1992) "mile after mile of contorted prairie streambed has been drag-lined into oblivion." "Channelization projects have altered reaches of all major northern Missouri streams…and hundreds of their tributaries. Very few miles of unaltered streambed exist in a pre-settlement condition in northern Missouri."

» **Simplification of summer habitat – Ozark forests (male summer habitat)**

Hawker (1992) "As a result of these many demands and wasteful practices, nearly all marketable timber originally in the state was removed by 1910."

Hawker (1992) When settlers first began entering the primitive Ozarks, about three-fourths of the upland was covered by trees: dense forests on the moist, sheltered north slopes and cove-like valleys; parklike savannas along ridges and most southern slopes; and prairies and glades on the broadest plateaus and most exposed south-facing slopes. It is clear that Indian fires were instrumental in the creation and maintenance of these …extensive savannas …and other relatively open areas in the Ozarks."

Hawker (1992) "For 40 years the large, insatiable timber companies stripped virtually every marketable tree from the Ozarks. Their endowment to Missouri was a greatly depleted natural resource, a drastically altered environment…."

» **Summer habitat not limiting in Missouri (roost trees & foraging habitat)**

Using FIA data, and calculating mortality rates for the 5 most preferred species of roost trees in Missouri, it is estimated that there are at least 1.5 million potential roost trees in Missouri (Missouri Department of Conservation 2003). In counties in which National Forest land is located, there would be over ½ million potential roost trees. Assuming that 20 roost trees are used by each maternity colony in a year, Missouri forests could support about 75,000 maternity colonies (MTNF could support 25,000), and with an average of 50 adult females per colony, there are enough potential roost trees in Missouri to support a population of about 3.7 million reproductively active Indiana bats (Missouri Department of Conservation 2003) (1.25 million bats on MTNF). Since there are only an estimated 64,800 Indiana bats hibernating in Missouri, and about ½ those are females, it is clear that there are many times more suitable roost trees existing in Missouri than there are Indiana bats to use them.

Brack et al. (2002) when considering potential climatic influences on Indiana bat distribution and abundance and as a potential causal factor in continued declines states "It seems implausible that managing for more trees (i.e. roosts) across the southern and southeastern United States will have a significant effect on recovery of the species." "More roost trees in southern forests will not produce more Indiana bats if appropriate hibernacula are lacking."

Miller et al. (2002) “”two lines of evidence suggest that a deficiency in summer habitat in areas used by maternity colonies is not directly responsible for observed decreases in population. First, Indiana bats seem quite flexible with respect to the proportion of various land-cover types that exist near maternity roosts, and colonies probably tolerate considerable alteration of the landscape. Second, the timing of major changes in land cover within Missouri does not correspond with the period of greatest decline in populations of Indiana bats.” “visual assessment of habitats near sites used by maternity colonies in Missouri suggests that they changed little from the 1980s through the 1990s. If changes have occurred, they do not appear to have taken place on a scale commensurate with the 80% decline in Indiana bats observed at hibernacula in Missouri”

Miller et al. (2002) “our data suggest that Indiana bats are tolerant of a high degree of habitat variability and that they are able to sustain maternity colonies in spite of considerable anthropogenic or naturally induced change in their environment. In the case of forest-cover, it seems that the critical element is not amount of land covered by forest, but rather specific characteristics of the stand, that makes an area habitable.”

Gumbert et al. (2002) “Managing for roost trees may involve implementing cutting regimes (e.g. shelterwood and highgrade cuts – Vonhof 1996) that maintain multi-aged stands and retain a component of mature tres following harvest, leaving dead and damaged trees standing, and leaving all trees previously used by Indiana bats. Silvicultural managers should work to create numerous areas of mixed-forest types, ages, and stand conditions near hibernacula, while maintaining a continuing supply of suitable roost trees.”

Carter et al. (2002) “With increases in urbanization and habitat fragmentation and continued degradation of bottomland habitat, populations of this species will continue to decline, if changes in land-use policy are not made.”

» **Pesticide use continues to affect insect-eating bats**

Schmidt et al. (2002) “Based on our preliminary results, we believe that bats in the wild, with dietary and habitat preferences similar to those in our study (FLW), are bioaccumulating PAHs and pesticides. Various species of bat, including the Indiana bat and gray bat, may be affected adversely by such environmental contaminants.” “Effects may be sublethal and difficult to detect.” “Bioaccumulation of environmental contaminants, such as PAHs and pesticides, could be a contributor to the decline of populations of Indiana bats….”

O’Shea and Clark (2002) “These data provide the first evidence for mortality of Indiana bats due to insecticides of the organochlorine pesticide era….” “suggested chronic mortality from OC pesticides prior to their discontinuance. Nevertheless, the extent of OC poisoning of Indiana bats during the 1970s possibly was even greater than indicated by our samples.”

Conclusions:

While summer roosting and foraging habitat may be important to the few Indiana bats which stay in southern Missouri in the summer, and to Indiana bats migrating to and

from hibernacula on and near MTNF, the totality of evidence points to factors other than forest management as primary contributing factors to the continued decline of this species. There is abundant summer habitat on MTNF and throughout southern Missouri – enough to support many times the current range-wide estimated population.

- MTNF has not contributed to the alteration of hibernacula microclimates or entrances (other than constructing gates to minimize human entrance during the swarming, hibernation, and staging periods).

- MTNF can contribute to protection of hibernacula by ensuring that hibernacula on MTNF are not physically altered and that entrances are surrounded by mature forest or woodland.

- MTNF is a minor part of simplification of summer habitat as a result of historic land uses that reduced the number of large trees, decreased the proportion of longer-lived tree species such as shortleaf pine and white oak, increased the proportion of shorter-lived tree species such as black and scarlet oak, and reduced the diversity and abundance of ground flora. In addition, more recent forest management practices have resulted in the majority of the Forest being in a much more dense condition than historic natural communities.

- MTNF can contribute to diversification of summer habitat by reducing tree densities throughout the Forest; increasing the proportion of longer-lived tree species and decreasing the proportion of shorter-lived tree species to amounts more closely approximating historic levels; increasing the number and distribution of large trees throughout the landscape; and increasing the amount and diversity of ground flora. All of these conditions can be created and maintained through restoration, enhancement, and maintenance of natural communities, as is described in the Revised Forest Plan.

- MTNF has not contributed to pesticide loads in bats because there has been no use of the organochlorine products implicated in bat mortality or bioaccumulation; insecticides are used in small amounts to treat specific problems, and herbicide use is relatively low.

- MTNF can contribute to ensuring pesticide-free food sources for Indiana bats by using herbicides and insecticides according to label directions and only where clearly demonstrated to be the most effective means to meet the overall management objectives.

While MTNF will continue to provide quality spring, summer and fall habitat and protect winter habitat, the potential impact (positive or negative) of all forest management on MTNF lands to the survival and/or recovery of Indiana bats in Missouri and range-wide is likely to be minimal.

REQUEST FOR FORMAL CONSULTATION

Mark Twain National Forest requests initiation of formal consultation on Indiana bat and Mead's milkweed. The Forest also requests concurrence from US Fish and Wildlife Service on determinations of No Effect and May Affect – Not Likely to Adversely Affect for gray bat, bald eagle, Hine's emerald dragonfly, scaleshell, pink mucket, Tumbling Creek cavesnail, Topeka shiner, running buffalo clover, and Virginia sneezeweed.

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