2010

Missouri's Forest Resource Assessment and Strategy

Seeking a Sustainable Future for Missouri's Forest Resources

Assessment prepared by:

Missouri Department of Conservation,

U.S.D.A Forest Service

Northern Research Station

Forest Inventory and Analysis Program

Strategy prepared by:

Missouri Department of Conservation

Acknowledgements

The author gives special thanks to John Fleming, now retired from the Missouri Department of Conservation (MDC), for his guidance and unlimited support in developing this project; to Mike Morris, MDC, for patiently fulfilling my requests for maps, data and other support; to Keith Moser, U.S. Forest Service – Northern Research Station, for producing and supplying a large amount of Forest Inventory and Analysis Data, for his content contributions and his invaluable review; to Tom Treiman, MDC, for providing helpful insights and review; to Sherri Wormstead, U.S. Forest Service – Northeastern Area - State and Private Forestry, for her tireless work collaborating with NA/NAASF to compile and create terrific guidance to states for preparing State Forest Resource Assessments and Strategies; and to Lisa Allen, MDC State Forester, for believing in this project and dedicating the resources needed to pull it off.

Much thanks also goes to our MDC FRAS interdivisional team for offering their ideas and review: Paul Calvert (Fisheries Division), Dennis Figg (Wildlife Division), Tim Nigh (Resource Science Division) and Bill White (Private Lands Division); to MDC's Forestry Division Leadership, Program Staff and Regional Supervisors who endured countless questions and requests for information or review; and last, but certainly not least, to the countless stakeholder groups and individuals who participated in meetings and other feedback opportunities and who will ultimately make FRAS the success it is intended to be.

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Forward

Welcome to Missouri's first statewide Forest Resource Assessment and Strategy (FRAS). FRAS represents a new beginning in the way Missourians care for our trees and forests. Missouri's trees, woodlands and forests are a resource to behold – providing us with clean water, clean air, high-quality wildlife habitat, diverse outdoor recreational opportunities, and a forest products industry that contributes $5.7 billion to Missouri's economy annually. Ensuring that these benefits are sustained and enhanced for Missourians today and into the future is a priority for the Missouri Department of Conservation.

FRAS is a comprehensive Assessment of our current and future expectations for our trees, woodlands and forests, and an analysis of challenges and opportunities for achieving these expectations. The Assessment provides the foundation for our Strategy – which in turn serves as a blueprint for maintaining and enhancing the health and benefits of our forest resources.

FRAS reveals that Missouri's forest resources are at a unique crossroads. Missouri's forests are increasingly more threatened. Simultaneously, our forests offer tremendous potential to alleviate many of our most pressing social and environmental challenges. Properly addressing these threats and opportunities is far more than any one agency or organization can tackle on its own. This complex task will require unprecedented levels of collaboration and partnership between conservation agencies, non-government organizations and dedicated individuals. It will also necessitate greatly increased public awareness of the importance of our trees, woodlands and forests, and public engagement in activities which enhance their sustainability. FRAS serves as the vehicle that has the potential to fulfill all of these needed elements.

I trust this document will be informative and inspire you to join us in our pursuit to sustain Missouri's treasured trees and forests!

Lisa G. Allen
State Forester, Missouri Department of Conservation

Chapter One: Introduction

Missouri's landscape includes an impressive 15.4 million acres of forestland, comprising 35% of Missouri's total acreage[1], and an extensive urban forest network of street, yard and park trees. These forest resources come in a wide assortment of sizes, shapes and ownerships which collectively provide extensive benefits we all depend on – clean water and air, protection of soil, forest products, wildlife habitat, recreational opportunities, aesthetics, and much more.

Periodic assessment and strategic planning of forest resources allows Missourians to help ensure that these benefits are sustained and enhanced for present and future generations. Such planning is especially important now because: 1) Missouri's forest resources are under tremendous threat to stressors such as exotic species, fragmentation, and poor harvesting practices; 2) Missouri's forest resources offer tremendous untapped potential to address our most pressing social and environmental challenges; and 3) The current financial climate makes it especially critical that limited financial resources are invested into projects which will provide the greatest impact, and that collaborative partnerships and synergies are fully utilized.

The 2008 Farm Bill recognizes the need for forest planning by requiring states to complete a Statewide Forest Resource Assessment and Strategy in order to continue receiving federal funds through the Cooperative Forestry Assistance Act. In response, the Missouri Department of Conservation (MDC) has collaboratively developed Missouri's Forest Resource Assessment and Strategy (FRAS) with help from over forty partner organizations.

The Assessment identifies Desired Future Conditions (DFCs) for Missouri's forest resources, key threats and opportunities which impact our ability to achieve these DFCs, and priority geographies for focusing limited resources. Subsequently, the Strategy details how MDC and partners intend to use limited existing resources to address Assessment findings, and leverage additional resources to the extent possible.

The scope of FRAS includes all land ownerships, both public and private. FRAS uses the term "forest" in the broadest of senses including all forest and woodland natural communities, rural and urban settings, and everything from the largest patch of forest in the Ozarks to individual city street trees.

An important focus of FRAS is to ensure that Missouri's forest resources are managed sustainably. For the purposes of FRAS, sustainability is defined and guided by the "Seven Criteria of Forest Sustainability" established in the United Nations 1993 Montreal Process:

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[1] Source: U.S.D.A. Forest Service – Northern Research Station – Forest Inventory and Analysis Data.

The Seven Criteria of Forest Sustainability

1. Conservation of Biological Diversity
2. Maintenance of Productive Capacity of Forest Ecosystems
3. Maintenance of Forest Ecosystem Health and Vitality
4. Conservation and Maintenance of Soil and Water Resources
5. Maintenance of Forest Contribution to Global Carbon Cycles
6. Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies
7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

(NAASF 2008)

FRAS is further guided by:

The Mission of the Missouri Department of Conservation:

"To protect and manage the fish, forest, and wildlife resources of the state and enhance their values for future generations; to serve the public and facilitate their participation in resource management activities; and to provide opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources."
(MDC 2010)

U.S. Forest Service National Priorities and Objectives:

National Priority 1: Conserve Working Forest Landscapes
    1.1. Identify and conserve high priority forest ecosystems and landscapes
    1.2. Actively and sustainably manage forests
National Priority 2: Protect Forests from Harm
    2.1. Restore fire-adapted lands and reduce risk of wildfire impacts
    2.2. Identify, manage, and reduce threats to forest and ecosystem health
National Priority 3: Enhance Public Benefits from Trees and Forests
    3.1. Protect and enhance water quality and quantity
    3.2. Improve air quality and conserve energy
    3.3. Assist communities in planning for and reducing wildfire risks
    3.4. Maintain and enhance the economic benefits and values of trees and forests
    3.5. Protect, conserve, and enhance wildlife and fish habitat
    3.6. Connect people to trees and forests, and engage them in environmental stewardship activities
    3.7. Manage and restore trees and forests to mitigate and adapt to global climate change

(USDA FS-S&PF 2010)

Chapter Two: Executive Summary

The FRAS Process...

Assessment:

1. 11 key **Issue Themes** were identified to organize and describe the threats and opportunities facing Missouri's forest resources, guided largely by the Seven Criterion of Forest Sustainability, MDC's Next Generation of Conservation Goals, and the USFS National Themes and Objectives. The Issue Themes were initially developed by MDC's Forestry Division and then thoroughly vetted by stakeholders.
2. **Desired Future Conditions (DFC's)** were established for each Issue Theme to help describe the issues and provide direction for the Strategy. As with the Issue Themes, DFC's were developed by MDC's Forestry Division and then vetted by stakeholders.
3. **Conditions**, **Trends**, **Threats and Opportunities** which describe the challenges and opportunities for achieving DFC's were researched and summarized in 11 Issue Theme Write-ups, prepared by MDC's Forestry Division. Stakeholders contributed ideas to be included in the Write-ups, and were provided opportunity to review draft documents, although this review period was limited due to timing constraints.
4. **Forest Opportunity Areas** and **Multi-state Priority Areas** were established as the best geographic areas for strategically addressing Assessment findings. These priority areas were developed by MDC Forestry Staff using considerable data made available by stakeholders. Priority areas were vetted through stakeholders.

Strategy:

1. Assessment findings were used to develop a list of seventy-seven individual strategies which will be utilized to best achieve DFC's. This list was initially developed within MDC's Forestry Division and then vetted by stakeholders.
2. Once this list of strategies was developed, it was used to create a Strategy Matrix which provides the following information for individual strategies: 1) Example Action Items, 2) Target Geographies, 3) Issue Themes and DFC's Supported, 4) Criterion and Indicators Supported, 5) National Priorities, Objectives and Performance Measures Supported, 6) Key Potential Stakeholders, 7) Resources Needed, 8) Measures of Success. The Strategy Matrix was developed by MDC's Forestry Division in order to help guide Strategy implementation.

Key Assessment Findings...

Issue Themes and Desired Future Conditions:

Below is a brief synopsis of the 11 Issue Themes, plus a list of associated Desired Future Conditions (DFC's). Chapter 3 presents a more detailed description of conditions, trends, threats and opportunities that will support or obstruct achieving these DFC's. **Issue Themes are not listed in any particular order of importance.**

Issue Theme One - Private Forest Landowner Demographic Trends and Corresponding Land Use Changes: Missouri's family forest landowners are getting older. This trend, paired with other factors such as increasing land prices, real estate taxes and economic hardships are making Missouri's privately owned forestland increasingly vulnerable to threats such as forest conversion, fragmentation, parcelization and urban sprawl. Issue One explores the ties between these influencers, and how they can impact Missouri's forest resources.

> **Desired Future Conditions:**
> 1. As privately owned forestland changes ownership, it transitions smoothly to new owners who will continue or initiate sustainable forest management.
> 2. There is no net loss of Missouri's total forest acreage.
> 3. Forested acres in Forest Opportunity Areas and Priority Forest Landscapes (defined in Chapter 3) increase in total acreage of quality forestland.
> 4. Forests become less fragmented, and less vulnerable to fragmentation.
> 5. Privately owned forest tracts remain sufficiently large to maintain various management options, or such management can be achieved across multiple adjoining ownerships.
> 6. Future residential and commercial development is well planned in order to avoid destroying or negatively impacting important green infrastructure.

Issue Theme Two - Challenges and Opportunities for Private Forest Landowners: Private forest landowners face a number of challenges and opportunities which affects their ability to manage forestland sustainably. Professional forester, loggers and contractors exist, but are not always readily available. Furthermore, taxes, ordinances and forest investment costs can impact landowners' ability to make management decisions based on long term conservation objectives. Despite these challenges, new opportunities are developing such as ecosystem service markets, biofuels markets, and conservation easement programs. These and other developments could significantly change the face of private land ownership in the coming years.

> **Desired Future Conditions:**
> 1. Foresters, contractors and loggers are readily available who can help private forest landowners manage their forests sustainably.
> 2. Voluntary incentives and markets make it simple and cost effective for private forest landowners to practice sustainable forest management.

3. Disincentives to sustainable forest management are minimal.
4. Societal benefits of Missouri's privately owned forest land (i.e. water quality, forest products, etc.) are recognized by private landowners and the public.

Issue Theme Three - Climate Change: Without taking appropriate precautions, Missouri's trees and forests could be highly vulnerable to potential changes in climate. There is much we do not know about how climate change will take form in Missouri. However, forest management practices can make our forests more resilient and adaptable regardless of how our climate changes. These same practices pose many other benefits to our forests such as improved overall forest health, productivity and wildlife habitat. The threat of climate change simply underscores the importance of these practices. Issue Three also explores the important role Missouri's forest resources could play in mitigating climate change.

Desired Future Conditions:
1. Ecosystem services are sustained as forests successfully adapt to changing climate.
2. Forests are contributing to mitigation of global climate change.
3. New scientific information, tools, and technology increase understanding of climate change impacts, adaptation and mitigation options, and risks and uncertainties.

Issue Theme Four - Maintaining High Quality Soil and Water Resources: Trees and forests, when managed properly, are highly effective at conserving soil and water resources. Forested landscapes produce much of our cleanest and most cost effective drinking water. Riparian forests help hold stream-banks in place and filter out pesticides, nutrients and sediments before they can reach streams. Urban trees and forests minimize storm water runoff and associated issues. In order to maintain and enhance the soil and water benefits of trees and forests, existing forest resources must be carefully managed, and reforestation should be conducted in strategic locations. These same efforts will also help to ensure that soils will remain productive and abundant into the future.

Desired Future Conditions:
1. Forests provide high quality, cost effective drinking water.
2. Aquatic ecosystems, and the plants and animals they support, are maintained and enhanced by forests*.
3. Soil and water resources are protected through the widespread use of riparian forest buffers and best management practices*.
4. Soil productivity is maintained through sustainable forest management practices.
5. Urban storm-water runoff is minimized through the use of trees and forests.
6. Forests maintain and enhance water related recreation opportunities (canoeing/boating, fishing, hunting, wildlife viewing and aesthetics, etc.)

*These DFC's may not apply to some grassland dominated landscapes.

Issue Theme Five - The Role of Fire in Missouri's Forests – Past, Present and Future:
Historically, fire played a large role in shaping Missouri's forests and woodlands. Over the last century, Missouri has waged a highly successful campaign to keep wildfires to a minimum. These efforts have done tremendous good in protecting people and property. However, the exclusion of fire is significantly modifying the structure, diversity and function of many forest and woodland communities. Since wildfires can no longer be tolerated, proactive management practices (i.e. prescribed fire, TSI, harvesting) are often needed in order to restore and/or maintain Missouri's forest resources in a healthy, productive and wildlife friendly condition.

Desired Future Conditions:
1. Frequency and size of wildfires are kept to a minimum.
2. Homes, structures and communities are "Firewise".
3. Forest resources and ecosystem services are not adversely affected by wildfires.
4. Public and volunteer firefighters spend less time fighting wildfires, and therefore can direct time and financial resources to other priorities.
5. Fire adapted landscapes and natural communities are restored and/or maintained through the use of prescribed fire and/or other management tools.
6. Prescribed fire techniques are developed and practiced to maximize the benefits of prescribed fire while minimizing negative impacts.

Issue Theme Six - Missouri's Growth, Harvest and Consumption of Forest Products:
Missouri's forest products industry is an important contributor to Missouri's economy, and supports a number of economic, social and environmental values. Ensuring that these values are maintained into the future means carefully balancing harvest and consumption rates with available growth, and making sure that harvest practices account for long term productivity and sustainability of all forest benefits and services.

Desired Future Conditions:
1. Missouri's forests and forest industry provide forest products demanded by the public (i.e. certified wood), and contribute significantly to MO's economy.
2. Missouri's forests produce a volume of forest products equivalent to the amount Missourians consume.
3. The harvest of forest products, including potential new markets, is sustainable both statewide and regionally.
4. Harvesting maintains and enhances the health and productivity of forests, and does not compromise other forest services and benefits.
5. Forests are resilient to potential stressors (insects and disease, drought, climate change) to ensure sustained growth and yield over time.
6. Forest industry and communities which depend on it remain viable.
7. Trees are grown and utilized to their highest value.
8. Missourians are aware of how they use wood, how much they use, and where it comes from.

Issue Theme Seven – Forest Health Threats: Plants, Animals, Diseases and Weather:
Missouri's forest resources are vulnerable to a number of current and potential forest
health stressors. Exotic and invasive plants (i.e. honeysuckle, garlic mustard, ironwood),
insects and diseases (i.e. emerald ash borer, gypsy moth, thousand cankers disease), large
animals (i.e. feral hogs, livestock, overpopulated deer), and extreme weather events are
posing increasingly detrimental impacts to our forests. Proactive measures are needed in
order to avoid preventable forest health issues and minimize harm from health stressors
that arise.

> ### Desired Future Conditions:
> 1. Missouri's forests are able to sustainably provide important ecosystem services.
> 2. Missouri's forests remain well balanced in type, species composition, and age and
>   size distribution.
> 3. Missouri's forests continue to provide valuable habitat to the plants and animals
>   which depend on them.
> 4. Forest management options are not compromised by exotic/invasive plants,
>   animals and diseases.
> 5. The geographical extent and potential future threat of various exotic and invasive
>   plants, animals and diseases are well understood.
> 6. Methods for most effectively and efficiently preventing and dealing with
>   exotic/invasive plants, animals and diseases are well known and practiced.

**Issue Theme Eight - The Role of Trees in Improving Quality of Life and Sustainability
in Cities:** Urban/community trees and forests provide numerous social, economic and
environmental benefits. Urban/community trees and forests decrease storm water runoff,
improve air quality, reduce the heat island effect, provide wildlife habitat and aesthetics,
decrease energy demands, and much more. Maintaining and enhancing urban forest
resources will require better quantification of benefits, existing condition and maintenance
needs so that local decision makers can more easily plan and justify investments in urban
forest infrastructure.

> ### Desired Future Conditions:
> 1. Healthy and sustainable urban/community trees and forests support desirable and
>   environmentally healthy places of residence for Missouri citizens.
> 2. Urban and community trees and forests contribute significantly to minimizing
>   storm-water runoff, improving air quality, reducing heat islands, reducing energy
>   consumption, and more.
> 3. Trees and forests are recognized as an important component of city and community
>   infrastructure needing to be maintained and adequately funded.

Issue Theme Nine - Public Lands which are Managed for the Greatest Public Good:
Public lands and other protected lands are important assets which are highly valued by
society. Beyond the normal benefits and services provided by forests, public forest lands
are especially important because they are typically managed under agency mandates for
sustainability and conservation, and are generally protected from conversion to other uses
such as urban development. Furthermore, due to size, location and management
objectives, public forests offer many of Missouri's best opportunities to maintain
biodiversity and provide high-quality recreational opportunities. Sustaining the benefits of
public forest land will require maintaining sufficient funding for management, and carefully
balancing the demands of a diverse public and the needs of a healthy forest resource.

   Desired Future Conditions:
   1. Public lands are inviting, and provide numerous benefits and services.
   2. Public lands provide convenient and desirable opportunities to enjoy Missouri's
       forests.
   3. Citizens are aware of public lands and their availability, benefits and issues.
   4. Public lands provide sufficient infrastructure (parking lots, trails, etc.), which can be
       maintained efficiently and sustainably.
   5. Public lands are managed sustainably to provide multiple benefits (recreation,
       wildlife habitat, ecosystem services, timber, aesthetics, etc.).
   6. Public land management serves as a model for private landowners to view
       sustainable management practices and outcomes.
   7. Citizens understand the need to actively manage public forests (thinning, prescribed
       fire, harvest, etc.) in order to improve and maintain their health and benefits.

Issue Theme Ten - Maintaining Biodiversity (a.k.a. Wildlife Diversity): Missouri's
forests and woodlands support a great diversity of plants and animals. Missouri's
Comprehensive Wildlife Strategy (CWS) was created to maintain and enhance this
diversity. Threats and opportunities facing Missouri's forest and woodland biodiversity
are virtually identical to the forest sustainability issues described in great detail
throughout this Assessment. Therefore, CWS and FRAS will work together very closely
towards achieving overlapping visions. Issue Ten provides a brief overview of CWS, and
describes three additional tools and resources MDC and various stakeholders are using to
maintain and enhance diversity: Missouri's ecological classification systems, Forest Land
Action Guidelines, and the Missouri Natural Areas Program.

   Desired Future Conditions:
   1. Forest natural communities are restored and/or maintained through proper
       management.
   2. Forests are well balanced in type, age and size distribution.
   3. Populations of Species of Conservation Concern and Threatened and Endangered
       Species are stabilized.
   4. Populations of all Missouri flora and fauna are sustained by healthy and well-
       functioning natural communities and landscapes.

<u>Issue Theme Eleven</u> - **Logistical Framework for Sustainability:** Today's actions will largely determine the future health and sustainability of our forest resources, and the future benefits these resources will provide. Sustaining forest resources requires adequate funding, and a diversity of partnerships and people collaborating on the implementation of strategies which are as efficient, effective and synergistic as possible. Above all, sustainability of Missouri's forest resources requires that Missouri citizens understand and appreciate the value of forest resources, the issues facing them, the opportunities they present, and the role people play in determining the future of the forest.

> <u>Desired Future Conditions:</u>
> 1. Public agencies efficiently and effectively work towards sustainability of Missouri's forest resources and the services they provide.
> 2. Various public and private forest stakeholders collaborate effectively to generate new ideas and knowledge, feed off of each other's strengths, and increase dialogue.
> 3. Sufficient funding is available and widely supported by Missouri citizens to ensure the sustainability of Missouri's forests and the services they provide.
> 4. Missouri citizens understand and appreciate the value and diverse benefits of Missouri's forest resources, and the threats facing their sustainability.
> 5. Missouri citizens understand and support the need for proactive management to maintain the health and sustainability of Missouri's forest resources.
> 6. Missouri citizens understand the role they play in determining the future sustainability of Missouri's forest resources.

Forest Opportunity Areas:

FRAS designates Forest Opportunity Areas (FOA) as the best geographic areas for focusing limited forestry financial resources to achieve FRAS objectives. In Rural/Wildland Urban Interface areas, FOAs generally include areas that offer the greatest current or potential benefits from forests which are also vulnerable to stressors which we can positively influence. This is determined largely by a Forest Opportunity Model analysis which includes the following data sets: Biodiversity, Forest Productivity & Carbon Sequestration, Soil and Water Conservation, Recreation & Social Values, Forest Patch Size, Current Harvesting Pressure, Insect and Disease Vulnerability, and Housing Density Projections. Urban FOAs include areas with the greatest concentrations of people and impervious surface.

Our analysis results in the following map of Forest Opportunity Areas:

Combined Map of Forest Opportunity

- 🟩 ⋰ = Rural Forest Opportunity Area
- 🟧 ⋮ = WUI Forest Opportunity Area
- 🟪 ⋰ = Urban Forest Opportunity Area (shown by impervious surface)
- ⬜ = Priority Forest Landscape

St. Joseph

Kansas City

Columbia

St. Louis

Jefferson City

Lake of the Ozarks

Cape Girardeau

Springfield

Joplin

Branson

0 25 50 100 Miles

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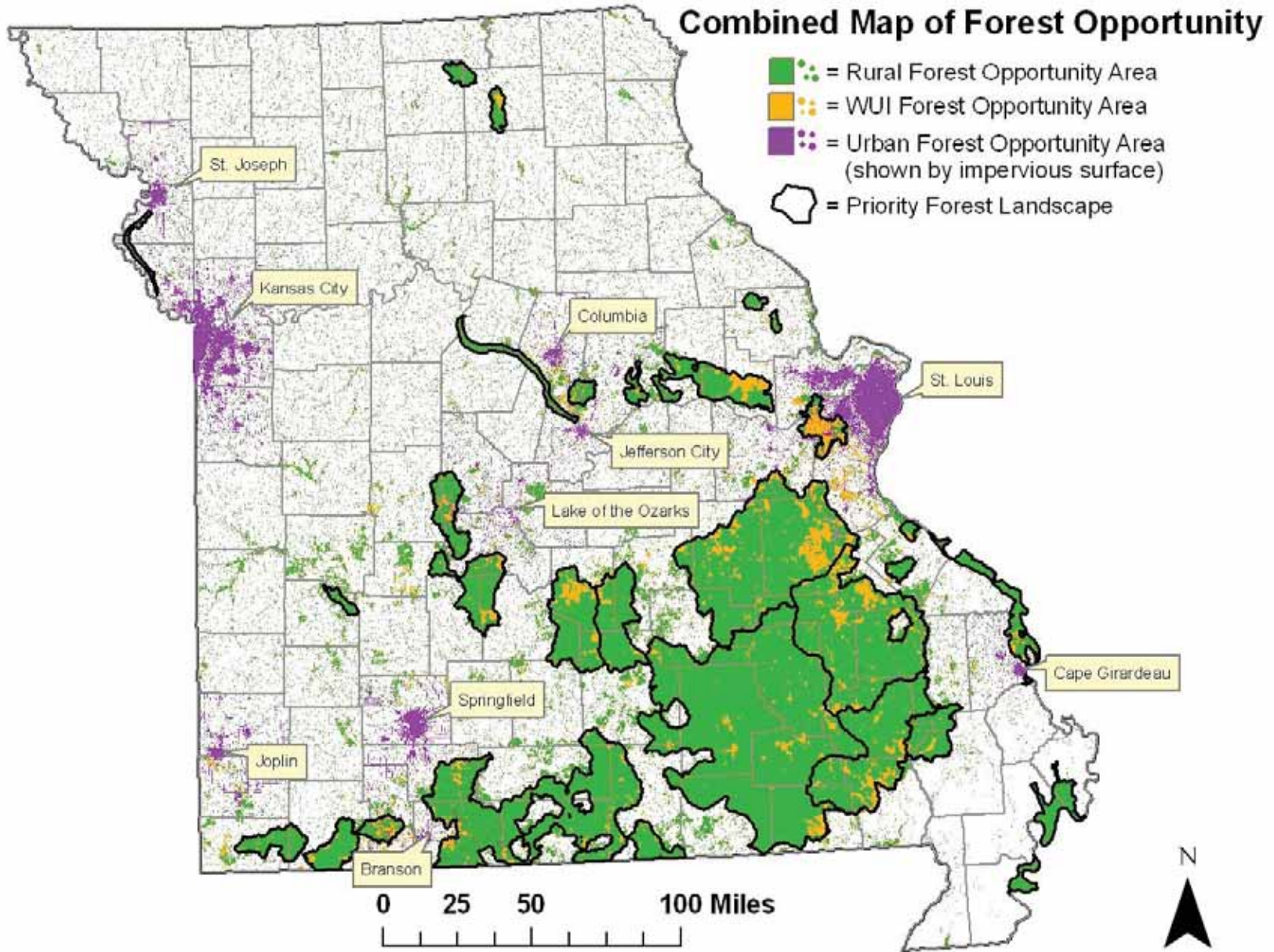
Missouri's Strategy...

Missouri's Strategy includes seventy-seven individual strategies - organized by the Eleven Issue Themes. In reality, each strategy addresses multiple Issue Themes. However, each strategy is listed only once under the most appropriate heading. Therefore, in order to properly achieve DFCs, it is necessary to consider strategies listed under all related Issue Themes.

In Chapter 4, individual strategies are presented in two different formats. The first format includes the "List of Strategies" found below. This format is intended to serve as a simple overview and reference. The second format is a more comprehensive "Strategy Matrix". The Strategy Matrix is a table which provides detailed information to help explain how strategies might be implemented, where efforts will be targeted, why the strategy is important, what people and resources are needed for implementation, and what are our benchmarks for success.

List of Strategies:

Issue Theme One - Private Forest Landowner Demographic Trends and Corresponding Land Use Changes.

Forest Land Conservation Strategies:
1.1.1. Provide successional planning information to landowners to help facilitate the smooth and sustainable transition of property to the next generation of landowners.
1.1.2. Focus development in less ecologically important areas utilizing smart growth principles.
1.1.3. Develop and implement a strategic forest land conservation program in order to protect tracts and forests of especially high public benefit.

Small Acreage Landowner Assistance Strategies:
1.2.1. Develop effective and efficient techniques for assisting small acreage landowners.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 2-6, 8, 9 & 11.

Issue Theme Two - Challenges and Opportunities for Private Forest Landowners.

Technical Assistance Strategies:
2.1.1. Increase the availability and credibility of quality foresters, loggers and contractors able to help landowners set and achieve personal objectives through sustainable forest management practices.
2.1.2. Provide technical information, assistance and financial help to private landowners which enables them to make and carry out informed management decisions towards healthy and sustainable forests.

Ecosystem Service Markets, Programs and Incentives Strategies:

2.2.1. Develop and promote markets for ecosystem services, such as carbon sequestration and clean drinking water, and incentives which make sustainable forest management a more affordable option for private landowners.

Private Landowner Awareness Strategies:

2.3.1. Increase private landowner awareness of important forestry threats and opportunities, and the important role their property contributes to particular watersheds, landscapes or initiatives.

Public Awareness Strategies:

2.4.1. Increase awareness of the general public and local decision makers regarding the existing and potential ecosystem services offered by privately owned forests (i.e. clean drinking water) to the extent that they are willing to support programs which enable landowners to cost effectively manage their forests sustainably for the greater public good.

Private Landowner Recognition Strategies:

2.5.1. Recognize landowners who contribute significantly to forest conservation and sustainability.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 5, 6, 7, 10 & 11.

Issue Theme Three - Climate Change.

Climate Change Adaptation Strategies:

3.1.1. Increase the adaptability of Missouri's forests to uncertain changes in climate.

Climate Change Mitigation Strategies:

3.2.1. Promote the role of forests and forest products in sequestering carbon and mitigating the potential effects of carbon emissions.

Climate Change Research Strategies:

3.3.1. Conduct research to increase our understanding of carbon sequestration, climate change, potential impacts and management implications.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, & 4-11.

Issue Theme Four - Maintaining High Quality Soil and Water Resources.

Best Management Practices (BMPs) Strategies:

4.1.1. Increase and improve the use of forestry Best Management Practices which protect soil and water resources.

Riparian Forests and Wetlands Strategies:
4.2.1. Maintain existing riparian forests and wetlands, and re-forest priority riparian areas and wetlands which have been converted from forest to non-forest use.

Coordination with Watershed Partnerships and Plans Strategies:
4.3.1. Utilize and promote watershed basin partnerships and plans which incorporate tree and forest strategies to benefit water quality and quantity.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-3, 5-7, & 9-11.

Issue Theme Five - The Role of Fire in Missouri's Forests – Past, Present and Future.

Wildfire Prevention Strategies:
5.1.1. Minimize the occurrence and impact of wildfire through the use of prevention efforts.

Wildfire Suppression Strategies:
5.2.1. Suppress wildfires in order to protect people, property and natural resources through effective collaboration between public agencies and fire departments.

Prescribed Fire Strategies:
5.3.1. Advance the science and understanding of Rx fire in order to better quantify its effects and improve its effectiveness.
5.3.2. Provide resources needed by private landowners to safely conduct Rx fires without the assistance of public agency personnel.

Multi-agency Collaboration and Preparedness Strategies:
5.4.1. Develop an active, multi-agency Fire Council to better foster communication and collaboration concerning wildfire and Rx fire.
5.4.2. Develop Community Wildfire Protection Plans (CWPP).
5.4.3. Monitor fire weather and fuel conditions to determine fire risk and the appropriateness of Rx fire, and communicate information to fire partners.
5.4.4. Monitor wildfires and Rx fires to determine the frequency, acreage & spatial distribution.
5.4.5. Maintain expertise in wildfire suppression and the use of prescribed fire in order to sustain proficiency and preparedness.

Public Awareness Strategies:
5.5.1. Increase public awareness of the benefits of carefully planned and executed Rx fire, the harm of wildfire, and the differentiation between the two.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-3, 6, 7 & 9-11.

Issue Theme Six - Missouri's Growth, Harvest and Consumption of Forest Products.

Forest Product Market Strategies:

6.1.1. Promote certified forests and certified forest products as a means of encouraging sustainable forest management on private lands and also to maintain Missouri's market share in the forest products industry.

6.1.2. Encourage better utilization of forest products in a way which provides better incentive to landowners for sustainable management.

6.1.3. Promote marketing and branding of Missouri grown forest products.

6.1.4. Steer potentially emerging woody biomass markets, and other potentially emerging markets, in a sustainable direction.

Timber Price Trends Monitoring Strategies:

6.2.1. Monitor and report timber price trends in order to maintain a pulse on demand and to improve trust levels between mills, loggers and landowners.

Forester, Logger and Mill Communications Strategies:

6.4.1. Improve communications between foresters, mills and loggers to provide better understanding of each other's needs, expectations and to increase awareness of long term impacts of management decisions.

Forest Health Strategies:

6.5.1. Develop partnership between governmental agencies and private industry towards minimizing forest health risk from plant, insect and disease threats.

Consumer Strategies:

6.6.1. Encourage the wise consumption of forest products.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-5, 7 &, 9-11.

Issue Theme Seven - Forest Health Threats: Plants, Animals, Diseases and Weather.

Insect and Disease Threat Strategies:

7.1.1. Monitor the current and potential range and extent of new and existing forest insect and disease threats. Strive for early detection of new forest health threats in order to minimize harm, and increase the affordability and effectiveness of control strategies.

7.1.2. Develop, maintain and implement strategic plans for known forest insect and disease pests which pose high current or potential threat.

7.1.3. Conduct and/or compile research on the most effective and efficient methods for addressing miscellaneous tree insect and disease pests.

Invasive Plant Threat Strategies:

7.2.1. Develop geographic information on the range, extent, and level of threat of invasive plants detrimental to forest health.

7.2.2. Develop and implement a strategic plan for protecting forests from exotic and invasive plants in the most effective and efficient manner possible.

7.2.3. Conduct and/or compile research on the most effective and efficient methods for addressing exotic plant species outbreaks.

Forest Health Communications Strategies:

7.3.1. Improve communications and awareness of forest health threats to the public to help citizens identify threats, avoid their establishment, and appropriately address detected outbreaks and occurrences.

Forest Resiliency Strategies:

7.4.1. Improve the overall health of trees and forests in order to make them as resilient as possible to miscellaneous forest health threats.

Feral Hog Strategies:

7.5.1. Reduce or eradicate feral hogs.

Livestock Exclusion Strategies:

7.6.1. Promote the benefits of excluding livestock from the woods, and provide financial resources to landowners to make this possible.

Deer Strategies:

7.7.1. Monitor deer browse impacts where this is a concern and recommend modifying hunting regulations as needed.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 5, 6, 8, 9, 10 & 11.

Issue Theme Eight - The Role of Trees and Forests in Improving Quality of Life and Sustainability in Cities.

Public Awareness Strategies:

8.1.1. Increase awareness of the general public and local decision makers regarding the public benefits of urban trees and forests - to the extent that they demand the maintenance and development of green infrastructure and are willing to pay for it.

8.1.2. Increase public awareness of the importance of proper tree selection, planting and maintenance practices, and provide training to municipalities, private arborists, utility workers and homeowners.

Technical Assistance Strategies:
8.2.1. Promote the use of International Society of Arborist certified arborists and Society of American Foresters certified foresters who are trained and qualified to manage urban forests.

8.2.2. Provide technical assistance to communities for developing comprehensive community forestry programs.

Data Strategies:
8.3.1. Gather data to accurately monitor and assess urban forests.

Development BMPs Strategies:
8.4.1. Demonstrate and showcase BMP's for green development with partners.

Recognition Strategies:
8.5.1. Recognize arborists, volunteers, etc. for quality work and contributions.

Urban Wood Waste Strategies:
8.6.1. Develop cost effective and resourceful methods of utilizing wood waste.

Urban Forest Diversity Strategies:
8.7.1. Diversify the urban forests by promoting the use of native species and cultivars which are not as well known, but desirable for urban landscape use.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 7 & 11.

Issue Theme Nine - Public Lands which are Managed for the Greatest Public Good.

Recreation Strategies:
9.1.1. Maintain recreational facilities to provide sufficient, yet efficient public recreational opportunities.

Forest Planning Strategies:
9.2.1. Develop Area/Forest Plans to formalize and guide management objectives and strategies on specific public ownerships.

Public Trust and Awareness Strategies:
9.3.1. Develop better public trust and awareness of public land management needs and activities through enhanced communication, transparency and stakeholder input.

Conflict Avoidance Strategies:
9.4.1. Manage and maintain public lands in a way which minimizes potential conflicts and impacts between different user groups and interest groups.

Forest Land Conservation Strategies:

9.5.1. Develop and implement a strategic forest land conservation program with goals of: 1) Acquiring or otherwise protecting tracts key to maintaining or enhancing the value of existing public lands; 2) Acquiring or otherwise protecting tracts key to providing other important public benefit; and 3) Disposing of tracts which offer minimal conservation or public value (replacing them with equal acreage of greater public value).

Partner Collaboration Strategies:

9.6.1. Foster better communication and collaboration between all public forest land management agencies.

Demonstration Strategies:

9.7.1. Manage public land in a way which demonstrates sustainable forest management practices – providing examples for others to follow.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 8, 10 & 11.

Issue Theme Ten - Maintaining Biological Diversity.

Natural Community Restoration and Maintenance Strategies:

10.1.1 Maintain and restore forests, woodlands, glades and savannas which are well suited to their growing sites, best suited to wildlife targets, and most resilient to forest threats.

Forest Land Action Guidelines Strategies:

10.2.1. Maintain and Utilize MDC's Forest Land Action Guidelines (FLAG) to help guide forest management decision-making on MDC forestland and other forests as land managers so choose.

Comprehensive Wildlife Strategy Strategies:

10.3.1. Work with and utilize the CWS process to maintain and enhance Missouri's biodiversity.

Natural Areas Program Strategies:

10.4.1. Recognize the best examples of healthy forest and woodland community types and manage them to maintain their integrity.

Wildlife Population Data and Target Strategies:

10.5.1. Establish baseline data and targets for forest wildlife habitat initiatives.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 9, 10 & 11.

Issue Theme Eleven - Logistical Framework for Sustainability.
Partner Collaboration Strategies:
11.1.1. Develop Priority Forest Landscape (PFL) and Urban Forest Opportunity Area (UFOA) stakeholder groups for the purpose of collaborating on the development and implementation of objectives and strategies specific to established priority geographies.
11.1.2. Utilize the Missouri Forest Resources Advisory Council (MOFRAC) as a means of collaboration and communication of prominent forestry issues between Missouri's forestry agencies and partner organizations.
11.1.3. Utilize the Missouri Community Forestry Council as a means of collaboration and communication of prominent urban and community forestry issues between forestry agencies and partner organizations.
11.1.4. Develop a Missouri Forest Landowner Association to improve communication of important forestry information to and from landowners, and to develop advocacy for sustainable forestry.

Data and Research Strategies:
11.2.1. Inventory and monitor forests and forest product trends to ensure harvest rates remain sustainable, to facilitate sustainable forest management decisions, and to help prioritize forestry efforts.
11.2.2. Develop and/or obtain better geographic information to enhance assessment capabilities, planning efforts, and management decision making.
11.2.3. Conduct research on important data gaps which will facilitate the advancement and improvement of forest resource planning, management and assistance.

Legislation Strategies:
11.3.1. Explore the feasibility and desirability of establishing forest-friendly legislation.

Volunteer Recruitment Strategies:
11.4.1. Recruit concerned citizens and volunteers to assist with miscellaneous activities towards sustainability of Missouri's forest resources.

Communications Strategies:
11.5.1. Develop and implement a comprehensive forestry communications and marketing strategy for building awareness of Missouri's forest resources and their associated benefits, threats and opportunities.

Engagement Strategies:
11.6.1. Increase the connection and engagement of the general public, especially kids, to the trees, forests and natural world that support their quality of life.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-10.

Chapter Three: The Assessment

Part A: Issue Themes - Conditions, Trends, Threats and Opportunities

Note: Issue Themes are not listed in any particular order of importance.

Issue One: Private Forest Landowner Demographic Trends, and Corresponding Land Use Changes

In a nutshell: Missouri's family forest landowners are getting older. This trend, paired with other factors such as increasing land prices, real estate taxes and economic hardships are making Missouri's privately-owned forestland increasingly vulnerable to threats such as forest conversion, fragmentation, parcelization and urban sprawl. Issue One explores the ties between these influencers and how they can impact Missouri's forest resources.

Desired Future Conditions:
1. As privately-owned forestland changes ownership, it transitions smoothly to new owners who will maintain or initiate sustainable forest management.
2. There is no net loss of Missouri's total forest acreage.
3. Forest Opportunity Areas & Priority Forest Landscapes (defined in Chapter 4) increase in total acreage of quality forestland.
4. Forests become less fragmented, and less vulnerable to fragmentation.
5. Privately-owned forest tracts remain sufficiently large to maintain various management options, or such management can be achieved across multiple adjoining ownerships.
6. Future residential and commercial development is well planned in order to avoid destroying or negatively impacting important forestland.

A. Private Forest Landowner Demographic Trends

82 percent of Missouri's forestland is in private ownership (Butler 2008). Therefore, the future sustainability of Missouri's forests rests largely in the hands of private landowners.

Missouri Forestland Ownership

State, 5%
Local, 0.40%
Federal, 12%
Private, 82%
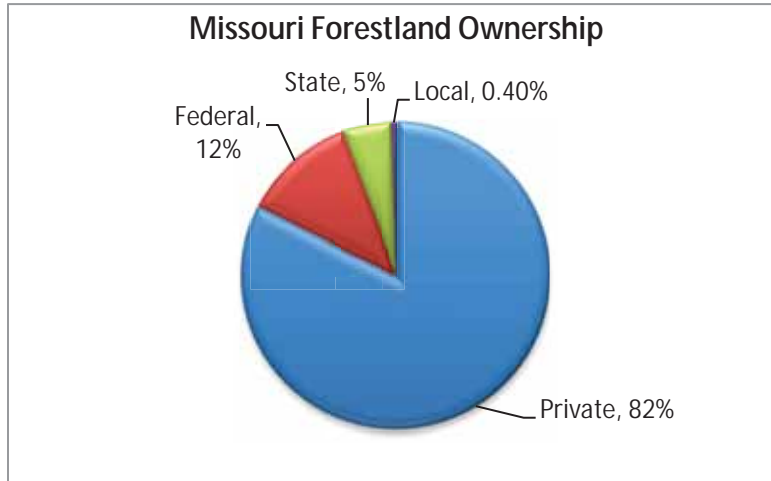
Figure 1.1 Missouri Forestland Ownership
(Source: Butler 2008)

Without a doubt, private landowners can be terrific stewards of Missouri's forests. However, we are currently in the early stages of a significant "changing of the guard" in terms of our family forest owners, and this adds much uncertainty to the future of these privately owned forests. According to a 2006 survey of Missouri family forest owners, **17 percent of Missouri's family forest land is owned by people 75 years of age or older**, **and nearly 70 percent is owned by people 55 years of age or older** (Butler 2008).

Family Forest Landowners and Acreage by Landowner Age

Percent

■ Private Forest Landowners
■ Private Forestland Acreage

Landowner Age: <35, 35-44, 45-54, 55-64, 65-74, 75+
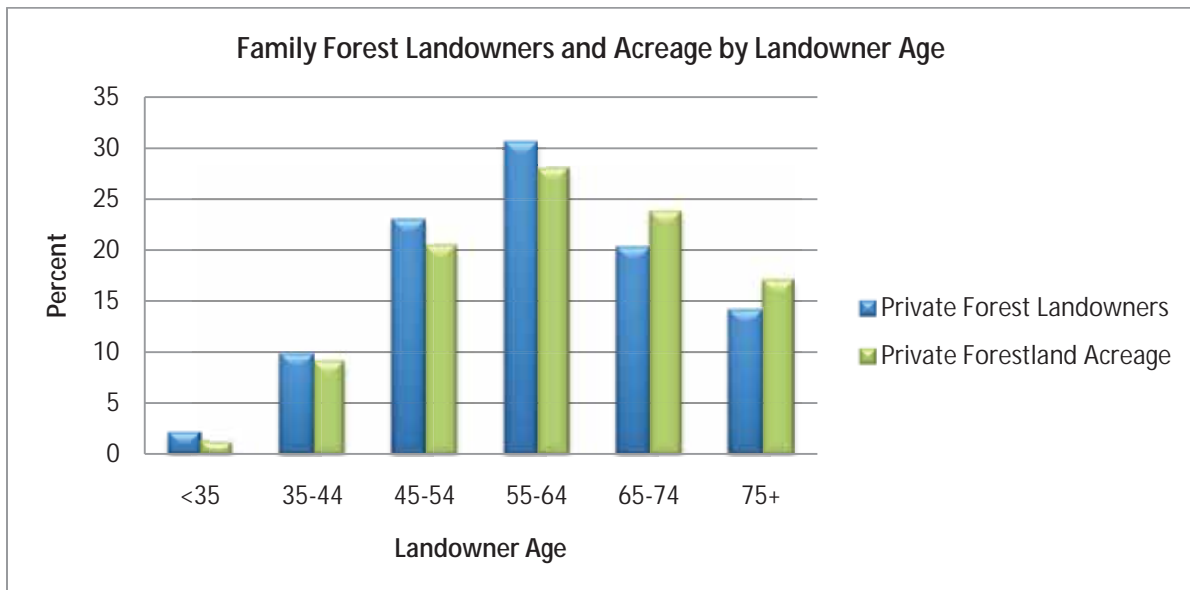
Figure 1.2 Family Forest Landowners and Acreage by Landowner Age
(Source: Butler 2008)

As these forests are passed on to heirs or sold to new owners, any changes in the way in which they are managed will affect us all. These management decisions will have profound implications for clean air and water, wildlife habitat, aesthetics, production of forest products, and numerous other services forests provide. While most family forest owners share a deep respect for their land and a desire to do "the right thing", many do not know just what this means or how to go about achieving their goals. One positive aspect of land ownership turnover is the great opportunity to form new partnerships between forestry organizations (such as MDC) and new family forest owners. New family forest owners are often eager to gain information and assistance to best manage their forested acres. It is important that these connections are made.

Unfortunately, even when these partnerships are formed, economic challenges can sometimes make it difficult for family forest owners to do what is best for conserving Missouri's forests. The combination of financial hardships, increasing land ownership turnover rates, and lack of information are making Missouri's forests especially vulnerable to conversion, fragmentation, parcelization, urban sprawl (USDA FS-NRS 2008), and unsustainable forest management practices such as timber liquidation. These threats are especially high in the wildland urban interface shown in Figure 1.5 on Page 30.

B. Land Use Changes: Forest Conversion

Forest conversion is deforestation of land for purposes such as development and agriculture. First the good news... While many acres of Missouri's forests are being lost or degraded each year, **Missouri's net forest acreage has actually increased substantially to 15.4 million acres since bottoming out in the 1980's at about 12.5 million acres[2].**
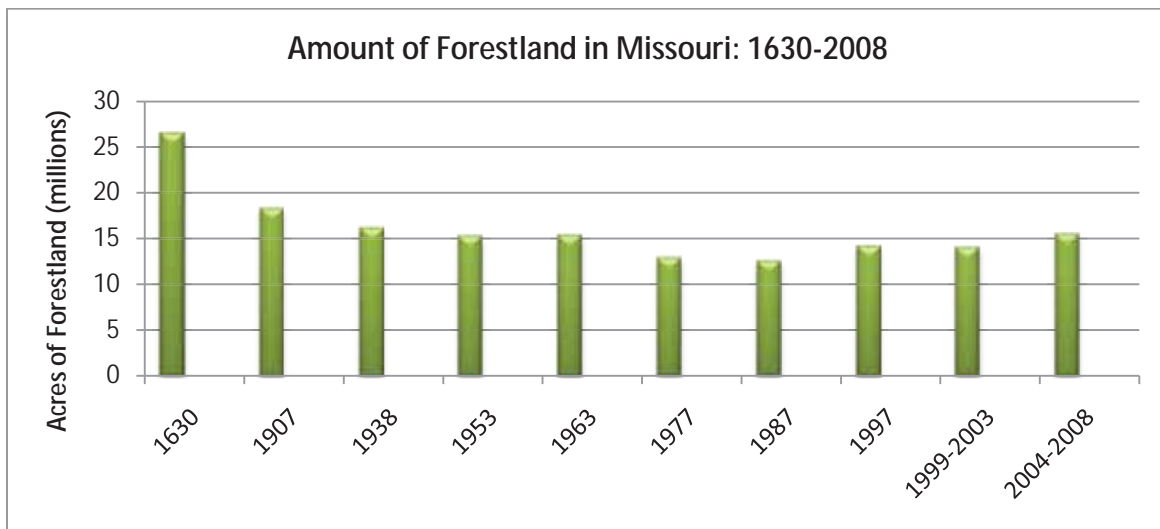
Figure 1.3 Amount of Forestland in Missouri: 1630-2008[3]
(Source: U.S.D.A. Forest Service - Northern Research Station. Forest Inventory and Analysis)

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[2] Source: U.S.D.A. Forest Service - Northern Research Station. Forest Inventory and Analysis
[3] Data for 1630 is an estimate for general reference purposes only to convey the relative extent of forest land at the time of European settlement.

Now the bad news… While Missouri's total acreage of forestland is increasing, this is somewhat misleading. Missouri is losing a considerable amount of high quality forestland each year. In the Midwest and Northeastern U.S., from 1992-1997, 59% of this loss was to development, 24% was converted to agriculture, and 17% was lost to other purposes (USDA NRCS NRI). While newly forested acres have somewhat offset these losses, many of these new forest acres are occurring on abandoned cropland, pastureland and glades. These new forests often consist of scrubby species (cedar, locust, boxelder, shingle oak, etc.) which are often of lower value for forest products or for promoting biodiversity compared to the forests being lost. In fact, some of these newly forested acres are actually decreasing biodiversity by replacing rare, but important, natural communities such as glades.
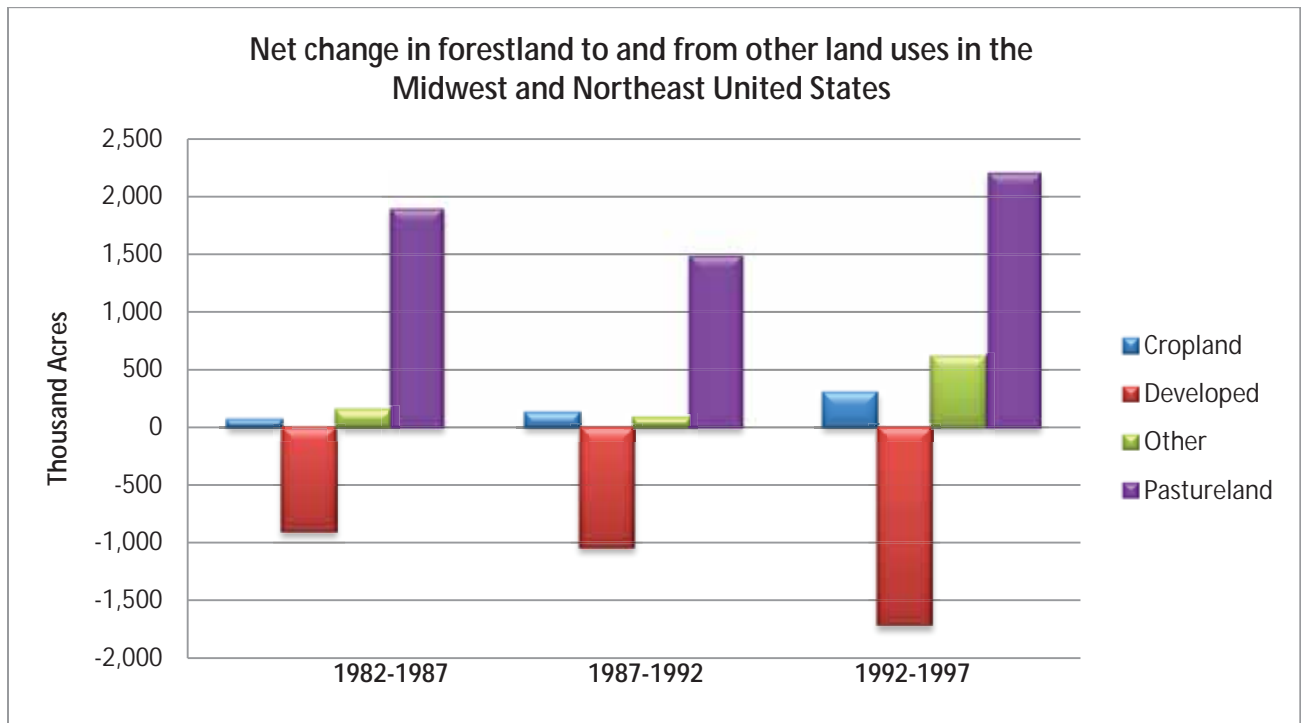
Figure 1.4 Net Change in Forest Land to and from Other Land Uses in the Midwest and Northeast United States[4]
(Source: U.S.D.A. Natural Resources Conservation Service – Natural Resources Inventory)

Forest conversion equates to loss of wildlife habitat and important natural communities, decreased capacity for ecosystem services such as water quality, carbon storage, and production of forest products, and exacerbated effects of forest fragmentation.

C. Land Use Changes: Forest Fragmentation

Forest conversion results in forest fragmentation. **Forest fragmentation** refers to the breaking up of larger forest blocks into smaller, disconnected patches, and also to the increase of forest edge created when sections of a forest are converted from within a larger

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[4] Includes 20 states and the District of Columbia ranging from Missouri to Minnesota to Maine to Maryland

forest block.   Most modern fragmentation is caused by residential and commercial development, and expansion of utility infrastructure and transportation networks.

Some of the negative impacts of forest fragmentation include the decline of forest dependent wildlife species requiring large continuous blocks of forest, increased forest vulnerability to insects and diseases (i.e. oak wilt), introduction of aggressive, opportunistic species like brown-headed cowbirds which thrive on forests edges, and exotic plant species such as bush honeysuckle. Fragmentation can also cut off migration corridors for flora and fauna - which could become increasingly important given projected changes in climate. Forest fragmentation also increases the frequency of negative encounters between people and wildlife such as vehicle collisions and wildlife damage to landscaping.

The following map paints a picture of forest fragmentation in Missouri. Areas in red are "urban", areas in light green are "non-forest", areas in dark green are "forest" and areas in orange and yellow are highly fragmented by housing development (the Wildland-urban interface, or WUI). Missouri's WUI has its own unique set of challenges that will need to be addressed in our Strategy.
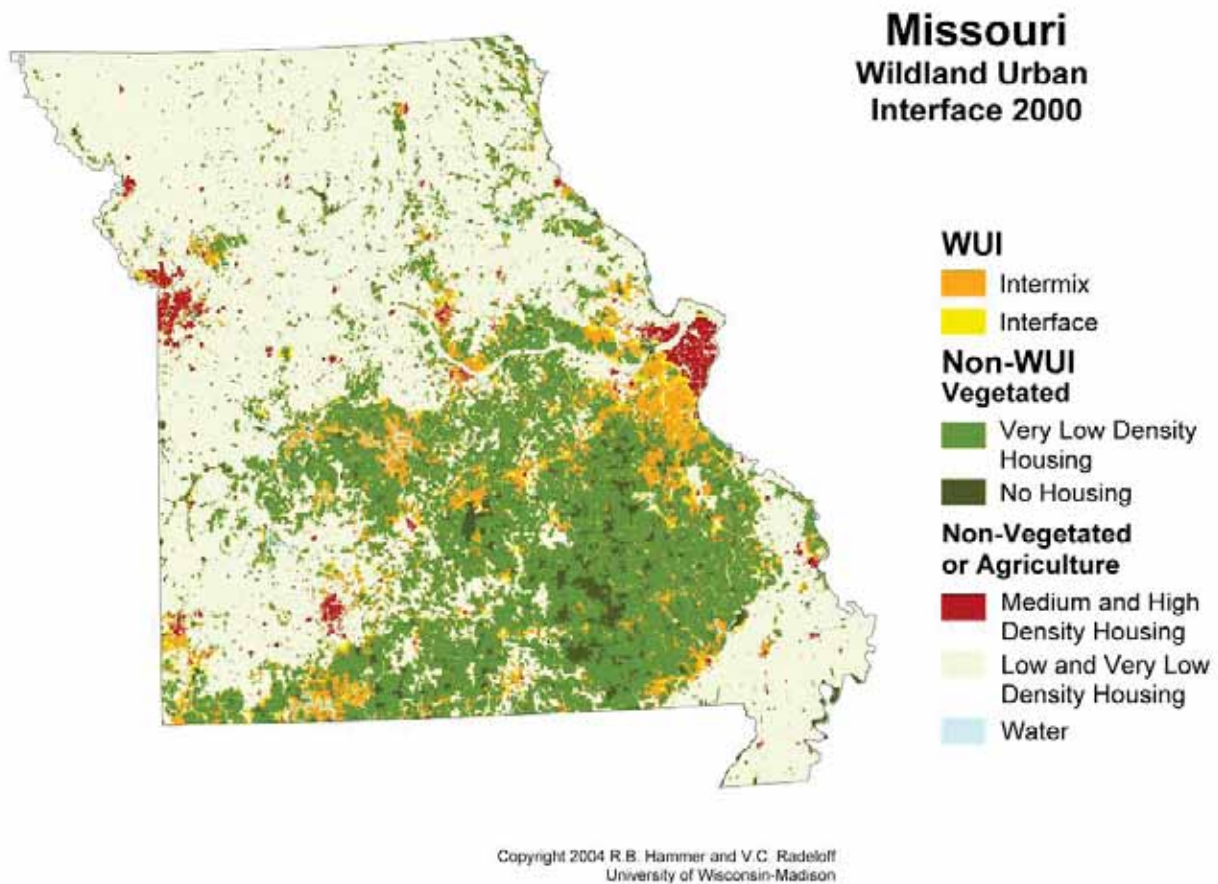
Figure 1.5 Delineation of Missouri's Wildland Urban Interface in Year 2000
(Source: Radeloff 2005)

Another way of looking at fragmentation is "Distance from Edge". The following map breaks down Missouri's forestland by it's proximity to "un-natural" edge. Wheras the WUI map focuses on fragmentation from residential development, this map also incorporates other agents of fragmentation (cropland, pasture, roads, commercial and residential development, etc.).

Forest Fragmentation (Distance to Edge)

N

☐ = Non-forest

☐ = Forest w/in 30 meters of edge

☐ = Forest w/in 90 meters of edge

■ = Interior forest

0   25   50   100 Miles
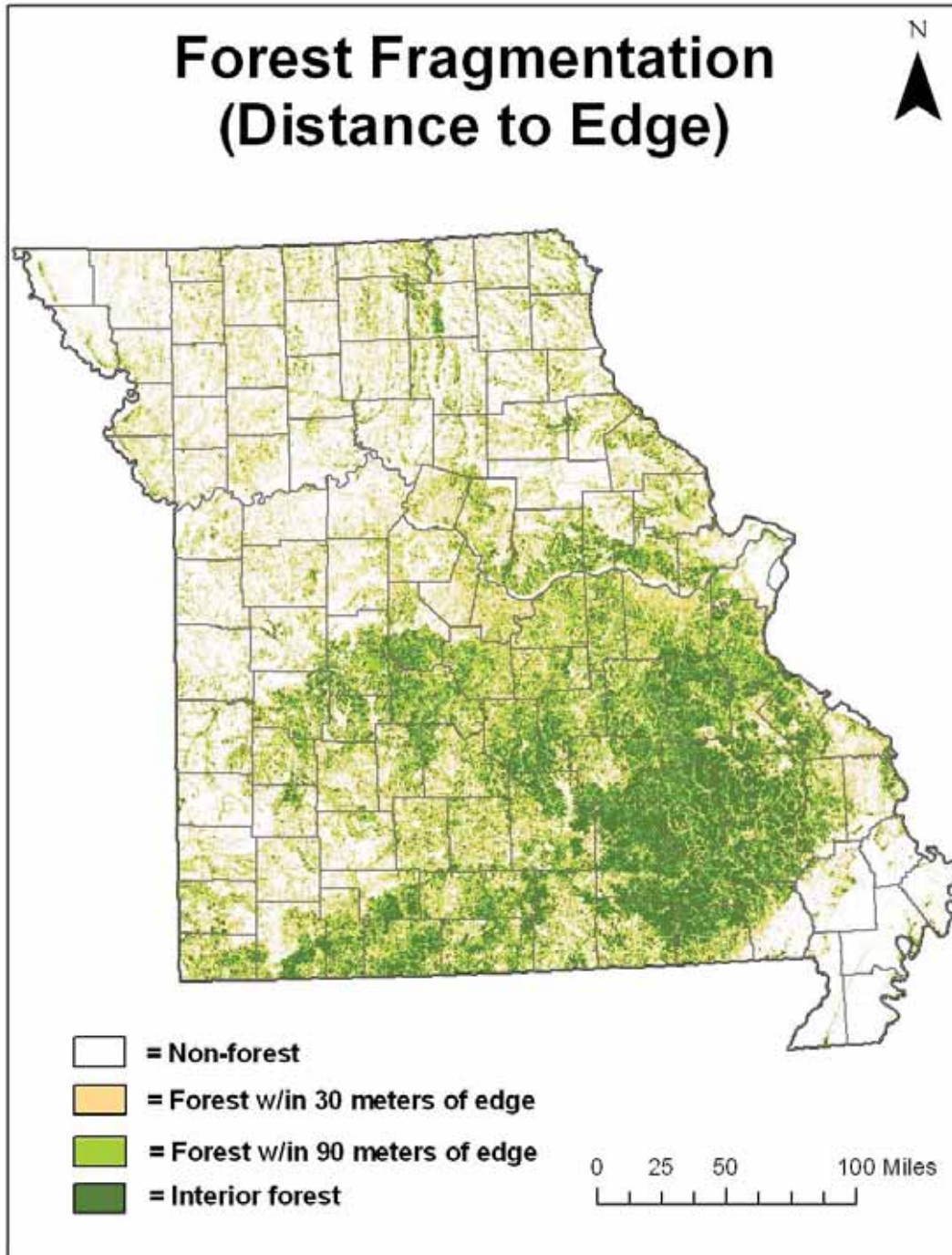
Figure 1.6 Forest Fragmentation (Distance to Edge)
(Source: Riemann 2009)

D. Land Use Changes: Forest Parcelization

Forest parcelization, also known as "subdividing", involves the division of a tract of forest into several smaller tracts. Forest parcelization can take many forms. A common example of parcelization is when a landowner divides his/her property into two or more tracts so that it can be passed down equitably to his/her heirs. Another common example involves splitting up a large block of forest into several 5 to 10 acres lots to maximize revenue (smaller lots often sell for a higher price per acre). Parcelization has profound effects on forests. Some of these effects are fairly obvious, and some are not.
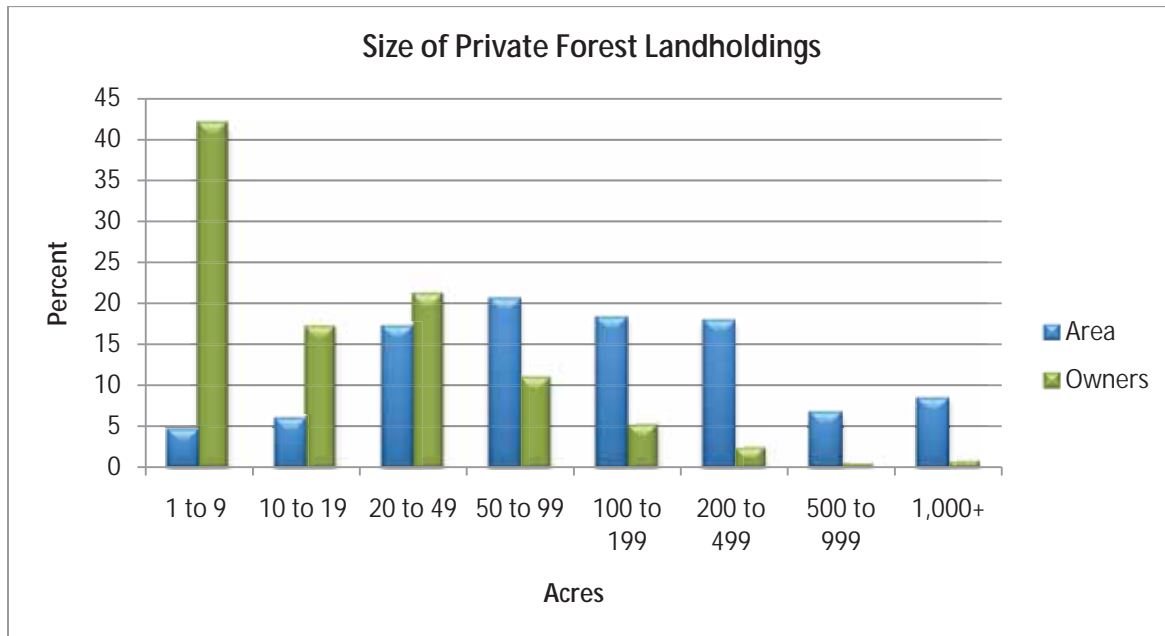
Figure 1.7 Size of Private Forest Landholdings
(Source: Butler 2008)

On smaller tracts of forest, management options are greatly reduced. For example, it is difficult for a logger to cost effectively harvest timber on a tract of 25 acres or less. It can also be challenging to manage and improve wildlife habitat on a smaller tract. Wildlife management practices such as forest thinning, prescribed fire and food-plots are often impractical on smaller acreages.

As larger forest tracts are subdivided, they become increasingly vulnerable to a variety of other degradations as well. Consider this fairly common scenario: An 80 acre tract of forest is sold off into eight 10 acre lots. New roads are put in to provide access. Half of the new owners build a house on their lot. Significant acreage is converted from forest to other uses in the process.   Two of the new owners plant bush honeysuckle in their yards because they love the red berries, resulting in exotic species spreading into the woods. During the road and housing construction, several red oaks were injured and have now acquired oak wilt which will kill these trees and continue to spread into the surrounding woods. Various wildlife species are faced with the need to adapt, succumb or migrate away from the new presence of people and their pets. The new increase in impervious surface increases storm

water flow and erosion and decreases water quality. In very short order, a high quality forest and its services are greatly diminished.

Parcelization also causes great headaches for agencies and professionals who work for and with private forest landowners. In addition to the great limitations on management options, smaller tracts are a huge drain on productivity. It takes about the same amount of time for a forester to assist a landowner who owns 10 acres as it does a landowner with 100 acres. Thus, as land continues to get subdivided, it becomes increasingly difficult for foresters to significantly impact privately-owned forest resources.

E. Land Use Changes: Urban Sprawl

Forest conversion, fragmentation and parcelization are often collectively referred to as **urban sprawl**. While residential and commercial development is necessary and desirable for many reasons, it is important that this growth is well planned. Some areas are well suited to development, and some are not. Many communities in the U.S. are beginning to incorporate green infrastructure planning into their decision making to ensure that urban development can continue in a manner which complements natural resource systems. Such planning will help to ensure the long term sustainability, desirability and economic viability of our communities and their growth. On the other hand, without this planning, communities are often stuck with large expenses dealing with increased storm water and erosion issues, decreased water quality (and increased treatment expenses), and costly road and utility maintenance and construction.

The map below shows Missouri's housing density in the year 2000. Areas in dark red are fully developed, and areas in the darker greens are mostly undeveloped. However, look at how much area lies somewhere in between the extremes. These are areas which currently stand to gain the most through green infrastructure planning and implementation.
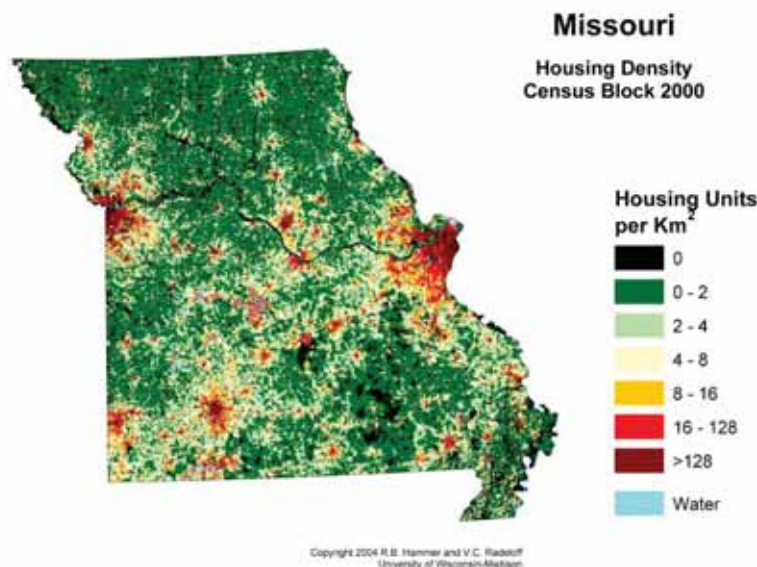
Figure 1.8 Missouri's Housing Density by Census Block in Year 2000
(Source: Radeloff 2005)

F. Forest Legacy Program

The Forest Legacy Program (FLP) is a partnership between States and the USDA Forest Service to identify and help conserve environmentally important forests from conversion to non-forest uses. The main tool used for protecting these important forests is conservation easements. Through FLP, the federal government funds up to 75% of program costs, with at least 25% coming from non-federal sources.

Missouri's participation in the Forest Legacy Program was approved in August, 2005, including approval of FLP planning requirements - collectively referred to as an Assessment of Need (AON). Through developing Missouri's Forest Resource Assessment and Strategy, MDC and Missouri's State Forest Stewardship Committee (a.k.a. Missouri Forest Resources Advisory Committee, or MOFRAC) has concluded that our current AON is up to date and will meet our FLP planning needs for the duration of this Forest Resource Assessment and Strategy. To meet federal eligibility requirements for Forest Legacy, Missouri's AON can be found within two documents (Missouri's Forest Legacy Program Assessment of Need – Part One and Part Two) available at the following link: http://mdc4.mdc.mo.gov/applications/MDCLibrary/MDCLibrary2.aspx?NodeID=2857.

Issue Two: Challenges and Opportunities for Private Forest Land Owners

In a nutshell: Private forest landowners face a number of challenges and opportunities. The future sustainability of Missouri's forests rests largely on maintaining and enhancing the benefits of forest ownership while minimizing the burdens and headaches. Issue Two focuses on describing these challenges and opportunities faced by private forest landowners and the foresters, contractors and loggers that work with them.

Desired Future Conditions:
1. Foresters, contractors and loggers are readily available who can help private forest landowners manage their forests sustainably.
2. Voluntary incentives and markets make it simple and cost effective for private forest landowners to practice sustainable forest management.
3. Disincentives to sustainable forest management are minimal.
4. Societal benefits of Missouri's privately owned forest land (water quality, biodiversity, forest products, etc.) are recognized by private landowners and the public.

A. Availability of Quality Forest Management Assistance

There are few private forest landowners in Missouri that have the time, equipment and information to sustainably manage their forestland completely on their own. Even if a landowner has no interest in ever harvesting a tree, they can likely benefit from professional advice on maintaining forest health, improving wildlife habitat, etc. Forestry assistance typically involves a professional forester, forestry contractor or logger.

Foresters

Professional foresters include foresters working for public agencies, private consultant foresters, industrial foresters (i.e. working for private industry), and urban foresters. All foresters have received formal education (Bachelor of Science degree at minimum) and training in managing forests. Whether a landowner's interests are more oriented towards wildlife habitat, producing revenue or aesthetics, a professional forester can help landowners reach their desired goals. Some of the many services that professional foresters offer include: 1) general advisory services, 2) forest inventorying and plan writing, 3) timber appraisals (private foresters only), 4) timber harvest marking and administration, 5) insect and disease diagnosis and prescription, and much more. Some private foresters also provide services offered by forestry contractors described later.

Although foresters are a terrific resource for private landowners, there are some significant capacity issues. **Approximately 10 percent of Missouri's family forest owners utilize assistance from a professional forester** (Butler 2008). Although much has been accomplished with this 10 percent of landowners, this leaves 90 percent of Missouri's family forest land being managed without any professional guidance. Public awareness of professional forestry services could certainly be increased through advertizing. However, there are currently not enough professional foresters in Missouri to handle significantly increased interest in private forest landowner assistance.   At this time, MDC has the equivalent of 14 full time foresters devoted to working with private forest landowners. Considering that there is 12.4 million acres of private forest land in Missouri, this equates to roughly 900,000 acres of private forestland per MDC forester! Private consulting foresters certainly add to the equation. However, Missouri does not have many consulting foresters either. A key component of our Strategy will be to explore ways to increase the number of foresters available to help private landowners, and to increase landowner utilization of forester assistance accordingly.

Another complicating factor that will need to be addressed in our Strategy is determining who will supply the next generation of foresters. Missouri only has one university that offers a B.S. in Forestry, and new enrollment into this program has dropped dramatically in recent years. This trend mirrors national enrollment figures for forestry programs. Some potential explanations include the popularity of "competing" job fields such as environmental science and misconception about the job market in forestry. Regardless, some changes will be needed to ensure that foresters will be available to meet Missouri's future forestry needs.

Contractors

Depending on the specific forest and landowner management objectives, sustainable forest management often involves some hands on labor. This could be in the form of exotic species control, non-commercial thinning, prescribed burning, tree planting, and more. Many landowners do not have the time or ability to do these jobs, or simply don't feel they know enough to do these tasks properly or safely. Fortunately, forestry contractors are often available to do these services, for a fee. Forestry contractors have the time and expertise to do quality work in a safe, timely and professional manner. They are also typically insured.   Although there are a limited number of forestry contractors in Missouri, there is significant potential for recruiting additional contractors. This is because contractors don't necessarily need to have a college degree in forestry (although it certainly helps). One of the biggest issues for forestry contractors is that landowners often cannot afford their services without the help of state, federal or private cost share funds. Therefore, the amount of work completed each year is based largely on the availability of cost share dollars rather than the amount of work needing to be done.

Loggers

Regardless of whether or not a landowner has utilized the services of a forester or contractor, if they want to sell timber, they are generally going to work with a logger. Very few landowners have the equipment or background needed to conduct a harvest on their own.   The logger chosen by a landowner will make a big difference as to the quality and satisfaction of the harvest operation. There are a few things that landowners can do to make sure they pick a good logger: 1) Utilize a forester to mark the trees for harvest, line out a contract, and administer the harvest; 2) Check references of loggers under consideration; 3) Choose a logger who has been through Missouri Forest Products Association's Logger Training Program; and 4) If possible, pick a Certified Master Logger.

B. Revenue drains

Taxes

One of the largest hardships faced by private forest landowners is taxes. These can take the form of real estate taxes, taxes from timber revenue, and inheritance/estate taxes.

Real estate taxes are assessed by the county in which a tract is located. Depending on the county and general parameters of the property, a private forest may be taxed at a relatively affordable "agricultural use" rate, a much higher "residential" rate, or something in between. When forest tracts are re-assessed at higher rates, which occurs somewhat frequently, landowners often inherit great financial stress. For some landowners, these higher tax rates force them to sell the property - often leading to forest parcelization and conversion, as discussed in Issue One.

Some counties have made provisions to keep tax rates down for landowners who sell timber, have a stewardship plan, or are a Certified Tree Farm. However, these policies are

often ineffective or lead to unintended consequences. For example, such policies can lead a lot of landowners to request stewardship plans or become a Certified Tree Farm who have no intention of implementing the plan or abiding by Tree Farm Program standards. They just want to keep their taxes down. Although these requests are understandable, they waste a lot of time and resources in the process.

When private landowners sell timber, the financial gain from the timber sold is subject to taxation as well. Proper planning can keep these taxes to a minimum. However, **timber taxes** can still impact the ability of landowners to manage forests sustainably.

As property values continue to skyrocket, many tracts have increased in value to the point that the tract is subject to **inheritance taxes** when a tract gets passed on to heirs. One of the unintended consequences of this tax is that it can make it difficult for heirs to be able to afford to keep tracts in their family. As a result, heirs are often indirectly forced to sell land - making it more vulnerable to the land use changes described under Issue One.

Forest Management Investment Costs

Although sustainable forest management can be profitable, it also requires some investment:
- During harvest time, "best management practices" are needed to protect soil and water resources and the future integrity of logging roads.
- In order to ensure that a harvest results in a quality future forest, site preparation is often needed to eliminate "cull" trees and to establish a desirable mix of tree species.
- In younger forests which are not yet suited for a harvest, "forest stand improvement" (non-commercial thinning) can do a great job of increasing forest health, tree quality, growth rate and wildlife habitat.

All of these practices require equipment, investment of time and/or money. Therefore, far too often these practices are neglected. Cost share programs can sometimes help offset the costs of these practices.

C. Revenue Sources:

Traditional Forest Products

One way that landowners can offset some of their costs, and possibly even generate some revenue, is by periodically harvesting trees. The potential for growing and harvesting trees for forest products varies widely from one site to the next. Factors such as site quality, past management practices, terrain/accessibility and proximity to sawmills play a big role in determining how much value a landowner could receive for their timber now and into the future. For example, in some parts of Missouri it is possible to sell 6 inch diameter trees for harvest because there is so much demand from sawmills. In other parts of Missouri it is difficult to sell 14 inch diameter trees because there is so much less demand. Timber

markets are further complicated by how well the economy is doing, how popular certain woods are at a given time, and how much wood is being sold from other nearby properties.

Fortunately, trees grown for forest products are a long-term crop. In most cases, harvests can be delayed until the market conditions are in the landowner's best interest. By harvesting trees sustainably, landowners can often expect to conduct harvests on a periodic basis for a semi-regular source of income. However, unsustainable harvesting, which happens all too often, could cause a 50-100 year delay before another harvest is possible.

To ensure that a harvest is being done in a sustainable manner which will best meet the landowner's long term goals, it is important to utilize the services of a professional forester. The forester can advise the landowner on whether his/her property is ready for a harvest and whether the market conditions are strong or weak. If a harvest is deemed to be appropriate, the forester can mark and administer the harvest.

Non-Traditional Forest Products

Some landowners enjoy gathering non-traditional forest products – either for personal consumption or to sell in niche markets. Such markets include medicinal products and herbs, mushrooms, nuts and fruits, decorative products and more. Gathering is hard work and rarely generates more than supplemental income. However, it is considered by many to be an important and enjoyable tradition passed on through generations.

Potential Ecosystem Service Markets

Privately-owned forests do not just benefit landowners, they benefit everyone. These forests provide clean water, carbon sequestration, wildlife habitat, aesthetics and much more. There is growing acknowledgement that if the public wants to continue to enjoy these benefits, they need to provide some form of compensation to the landowners who provide them. Ecosystem service markets provide payment to landowners who agree to maintain or enhance certain services provided by their woods (e.g. clean water or sequestered carbon). These markets create a new incentive for landowners to protect their woods from being converted to other uses such as pasture or housing, and ensure that they will be managed sustainably. Ecosystem service markets are a relatively new concept in Missouri. However, there is growing interest in their development - in Missouri and nationwide.

Lease Hunting

Many landowners enjoy hunting on their property, or extending the opportunity to family and friends. However, for those landowners that don't wish to hunt but are interested in controlling herbivores and/or gaining some income, one potential source of revenue is lease hunting. Many hunters who do not have their own land are willing to pay for the opportunity to hunt on someone else's.

Cost-share programs

As discussed previously, many of the management practices needed to maintain the health and functionality of a forest tract require either considerable time on the landowners part, or money to hire a contractor. In many situations, landowners don't have the equipment, time or money to do these practices all on their own. Cost share programs help make these management practices more realistic for landowners to complete by covering a portion of the cost (typically 50-75%). A combination of state, federal and private cost share dollars are sometimes available. Common cost share programs used in forestry include the federal EQIP, WHIP, CRP and WRP programs, MDC's Landowner Assistance Program, and miscellaneous opportunities from Not-for-Profit organizations.   In many cases, cost share is the only way to get sustainable forest management practices implemented.

D. Legal Issues

Planning and zoning ordinances

Many Missouri counties have planning and zoning ordinances in place to manage urban development growth, to help maintain open space or other environmental benefits, or to ensure that infrastructure, such as water supply or sewage capacity, is not overburdened. Depending on how such ordinances are written and enforced, they can be great tools for promoting forest sustainability. However, they can also have unintended consequences which could put them in direct conflict with sustaining forests.

For example, a common county ordinance provision is to require a minimum lot size of 3 acres for constructing new residences – intended to slow growth and maintain rural integrity. While well intentioned, this requirement strongly encourages urban sprawl and fragmentation. Consider this scenario: A new subdivision constructed with one hundred ¼ acre housing lots only consumes approximately 25 acres, whereas a new subdivision with one hundred 3 acre housing lots consumes approximately 300 acres!

FRAS strategies will include working with counties to create or strengthen county planning and zoning ordinances to make them more conservation friendly.

Conservation easements

One way that landowners can ensure that their property will be managed in a conservation friendly manner into the future is to place it into a conservation easement. Conservation easements are legal documents tied to a tract's deed which include provisions for development, subdividing, and sustainable management, often in perpetuity. Conservation easements are held by a land trust that is responsible for administering the easement. Such an entity monitors the property (typically annually) to make sure that the terms of the easement are being upheld. If violations are discovered, the land trust is responsible for enforcing the easement and ensuring that corrective actions are taken.

Conservation easements are a relatively new concept in Missouri. About 60,000 acres of forest in Missouri are under conservation easement held by private land trusts or under the Wetland Reserve Program. However, conservation easements are commonplace in many other parts of the U.S.

Besides the peace of mind that comes with donating a conservation easement, landowners can also gain potential tax benefits from such donations. Furthermore, a conservation easement may result in a reduction in property value which might make it easier for heirs to inherit property by reducing or eliminating estate taxes. In rare instances, conservation easements can also be purchased from landowners by public agencies. However, Missouri currently has little or no funds available for this purpose.

Issue Three: Climate Change

In a nutshell: The term "climate change" most often conjures up images of polar bears floating off to sea or sea levels rising and submerging coastal cities and resources. However, climate change has significant potential to affect Missouri's natural resources too, including forests. According to the U.S. Forest Service's <u>Strategic Framework for Responding to Climate Change</u>, "*Climate Change is one of the greatest challenges to sustainable management of forests and grasslands and to human well-being that we have ever faced, because rates of change will likely exceed many ecosystems' capabilities to naturally adapt. Without fully integrating consideration of climate change impacts into planning and actions, [we] can no longer fulfill [our] mission*".

Desired Future Conditions:
1. Ecosystem services are sustained as forests successfully adapt to changing climate.
2. Forests are contributing to mitigation of global climate change.
3. New scientific information, tools, and technology increase understanding of climate change impacts, adaptation and mitigation options, and risks and uncertainties.

A. Our Changing Climate

We do not know exactly what climate change will look like and mean in Missouri. However, prudence dictates that we need to take action immediately to manage our forests to be as adaptable and resilient to any potential climate change as possible. The potential consequences of inaction are much too great. Here is some of what we know:

Besides the anecdotal evidence of climate change (melting glaciers, increased extreme weather events, etc.), there are data that support the notion that our climate is changing. Figure 3.1 shows how the average global surface temperature, sea level, and Northern Hemisphere snow cover has changed from 1850 to 2000.
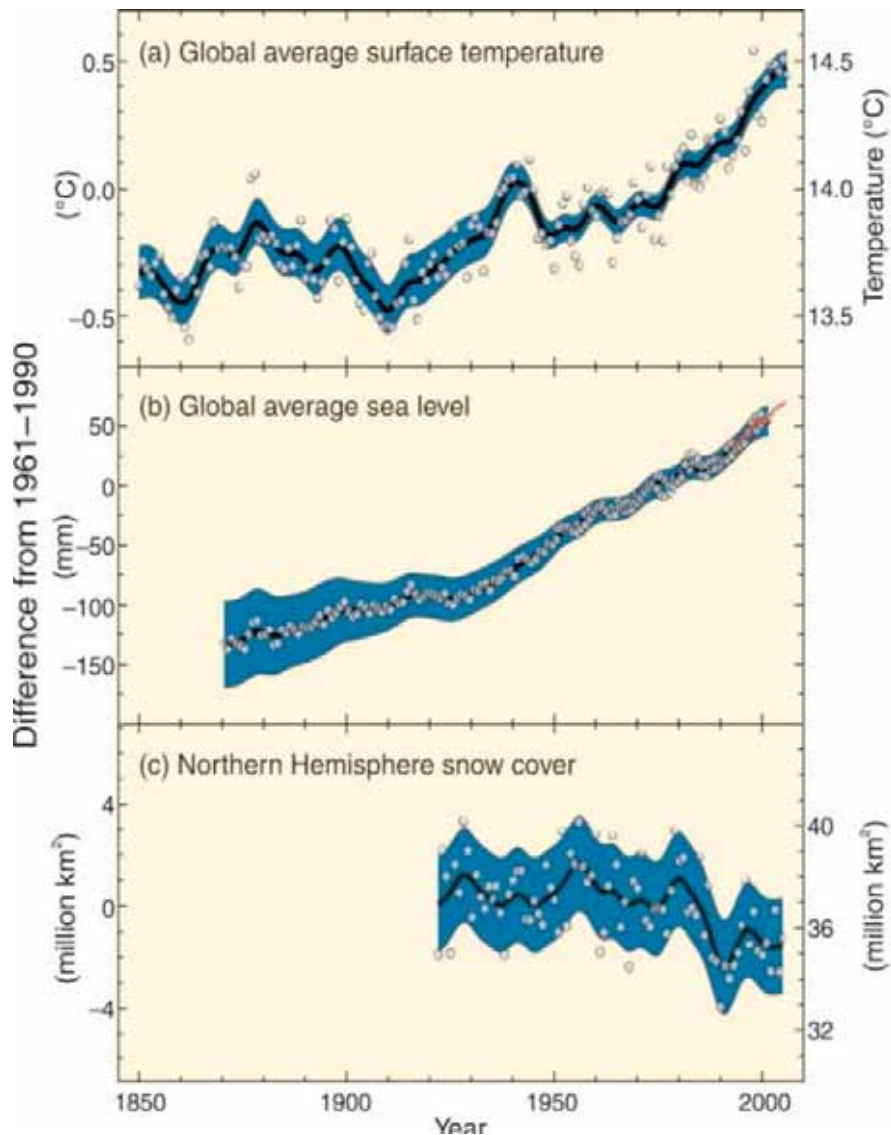
Figure 3.1 Global Changes in Temperature, Sea Level and Snow Cover: 1850-Present
(Source: IPCC 2007)

Missouri's climate could change considerably more in the foreseeable future. Figure 3.2 shows changes in temperature, carbon dioxide concentration and emissions over the last 1,000 years. Although these levels have fluctuated over time, these graphs shows the dramatic increase in atmospheric carbon dioxide concentration since the beginning of the "industrial age" powered by fossil fuels and land use changes, and the strong correlation between CO_2 levels and measurements of global temperature change. With atmospheric carbon dioxide levels expected to continue to increase, global circulation models suggest that global temperature will continue to increase as well.
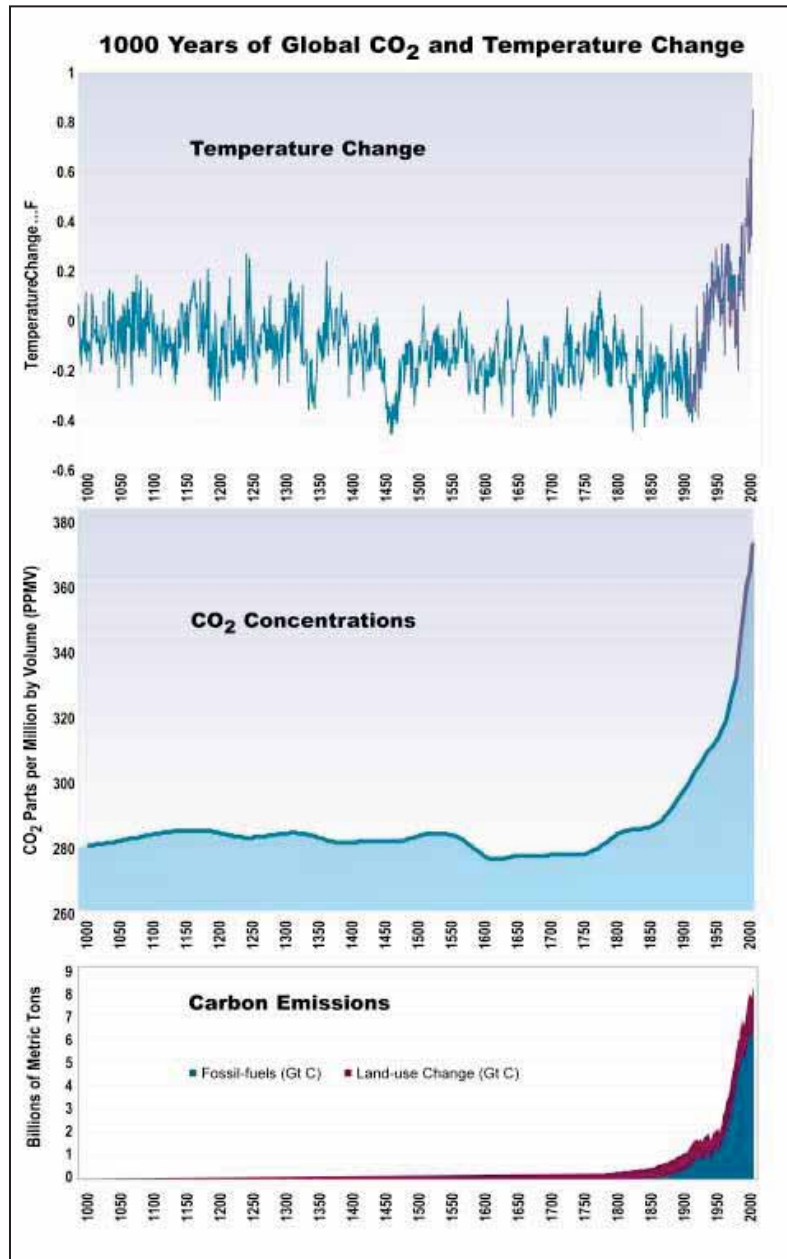
Figure 3.2 1000 Years of Global CO_2 and Temperature Change
(Source: US Global Change Research Program 2000)

There is considerable uncertainty as to how this change might take shape at local scales. Figures 3.3 and 3.4 show two prominent climate change models for precipitation and temperature in the continental U.S. First, note the variability between the models. The point is not to show just how climate will change, but rather to show the potential for change. Also, note that climate change does not always mean that a given area will become warmer. Although the overall climatic temperature is expected to rise, some areas of the world might get much warmer, and some areas might actually get cooler. There is also considerable uncertainty as to precipitation changes. The bottom line is that although we don't know how Missouri's climate will change, there is high likelihood that it will change.
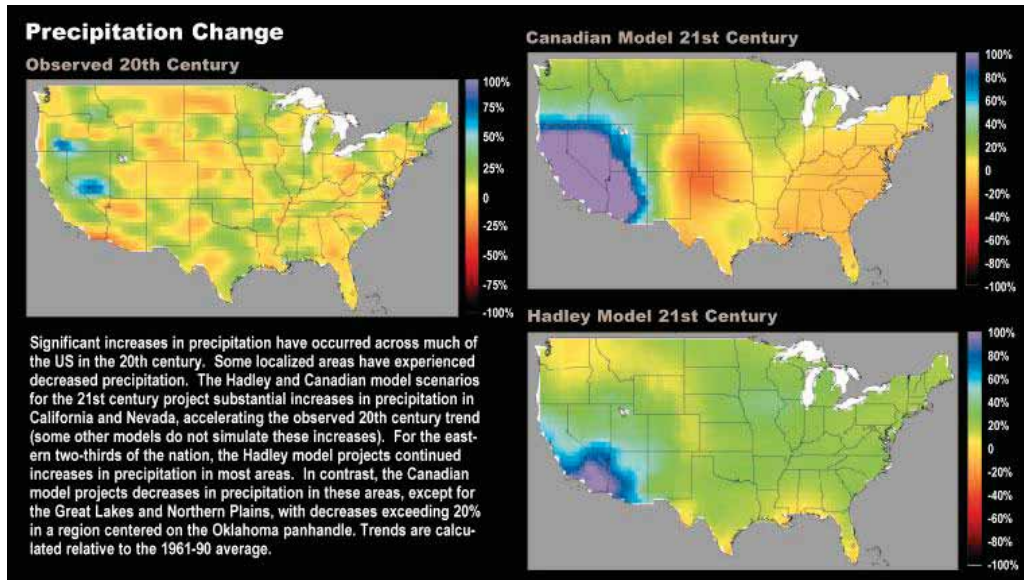
Figure 3.3 Precipitation Change
(Source: US GCRP 2001)
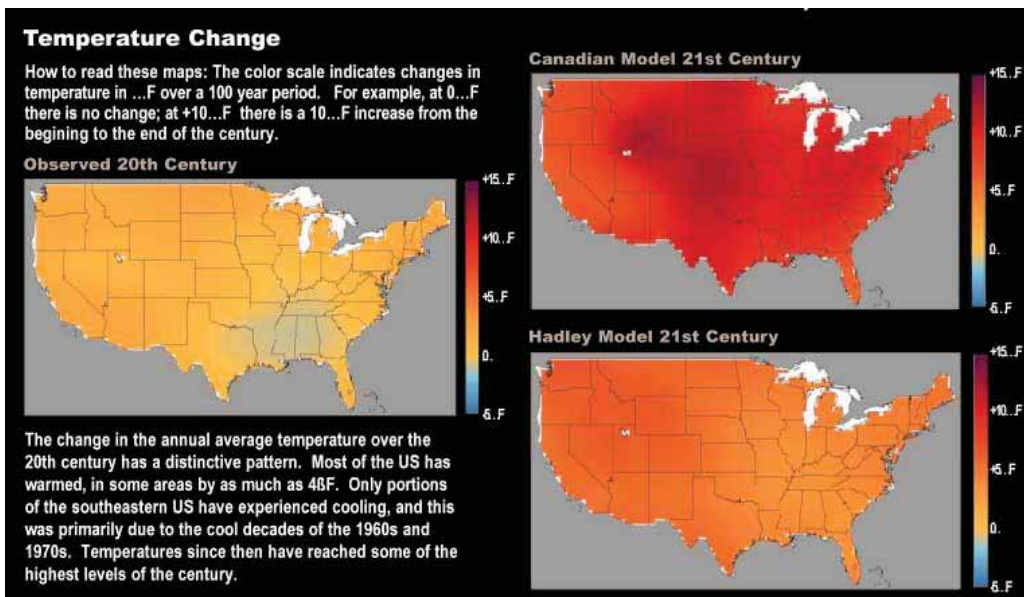
Figure 3.4 Temperature Change
(Source: US GCRP 2001)

There's more to it than averages. Even if Missouri's average annual temperature and precipitation stays the same, seasonal patterns could change considerably. This possibility is well demonstrated in Figure 3.5 which shows expected increases in July heat index. Seasonal pattern changes such as this could actually have a much more pronounced effect on forest communities than average annual temperature changes.
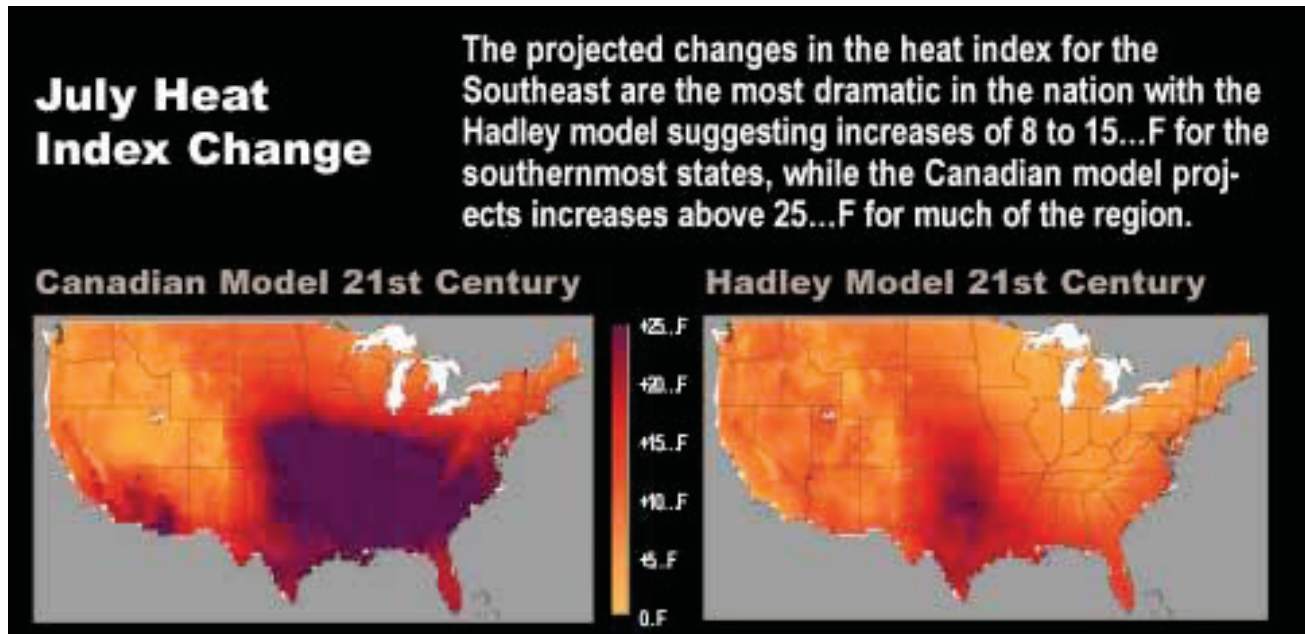
Figure 3.5 July Heat Index Change
(Source: US GCRP 2001)

B. Potential Implications of a Changing Climate

There is significant potential for climate change to alter the future health, sustainability and composition of Missouri's forests and the services they provide. The following pages show some of these potential implications. While many of these concepts are speculative, it is important that they be considered when planning for long-term forest sustainability.

Implication One: Biological Diversity

Climate change has the potential to drastically shrink, expand, or shift the suitable habitat ranges of flora and fauna in Missouri. Some of these changes could actually be desirable. For instance, the suitable habitat range for the exotic species bush honeysuckle could shift northward and cease to be a problem in Missouri. Other potential changes are much more troubling. For instance, the habitat suitability for white oak could greatly diminish causing large scale die-offs and forest species composition changes. It appears that some biological changes are already appearing. A recent analysis by the National Audubon Society concluded that in the last 40 years, land-bird species have shifted their habitat range centers by 48 miles on average (National Audubon Society 2009). A similar study by the U.S. Forest Service shows some tree species migrating north at a rate of approximately 62 miles per century (Woodall 2009).

The following figure shows an index of climate stress as a function of projected climate change, habitat quality, and habitat area (USDA FS RMRS 2009). The darkest areas are those in which ecosystems are expected to be under the most climate change-induced stress. According to this map, Missouri is projected to be one of the two most vulnerable states in the continental U.S. This is in large part due to the fact that Missouri is at the boundary of several ecological zones and thus at the edge of the habitat ranges of many plant and animal species.
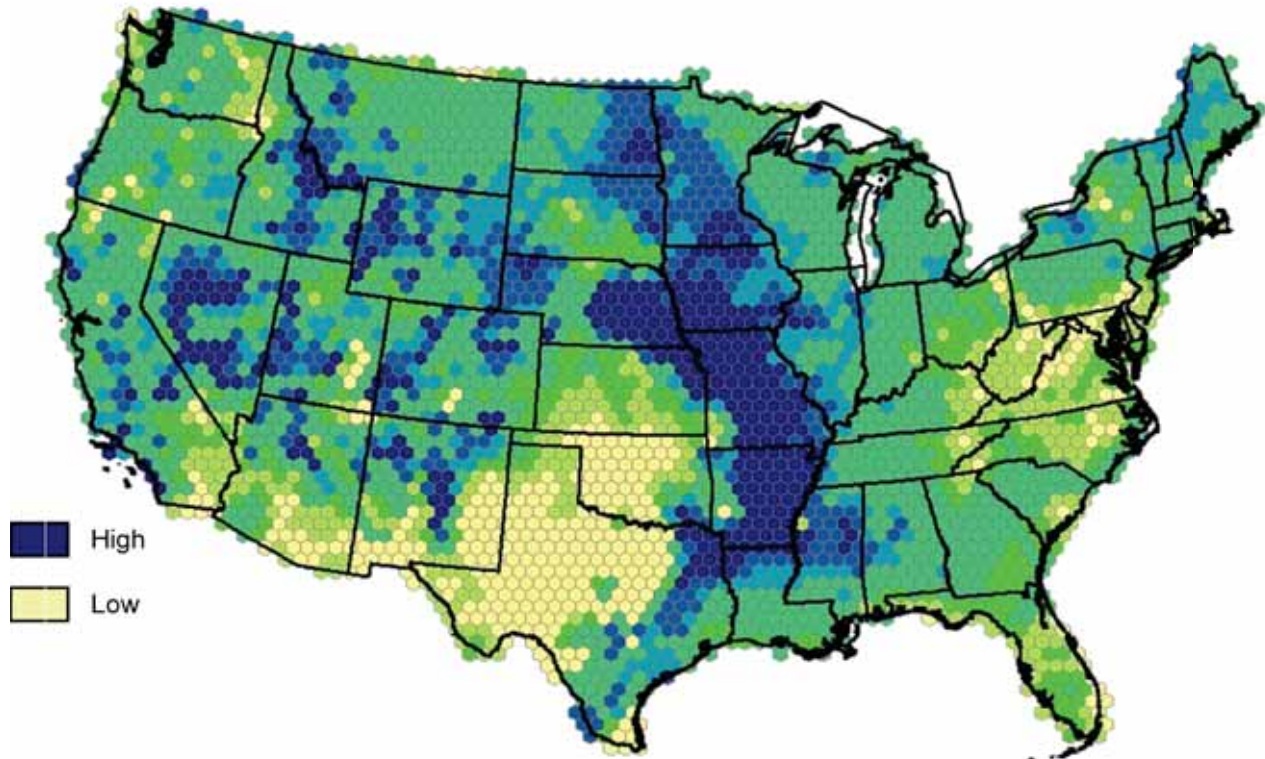
Figure 3.6 Climate Stress Index
(Source: U.S.D.A. Forest Service, Rocky Mountain Research Station, Wildlife Habitat Policy Research Program 2009)

While this model looks at climate change vulnerabilities to landscapes and communities as a whole, the USFS Northern Research Station has also put together a "Climate Change Tree Atlas" model which shows how the suitable habitat ranges of 135 different tree species could change due to climate change (Prasad 2009). Below are a couple of examples which are highly pertinent to Missouri. Note the dramatic increase in suitable habitat for shortleaf pine and the large decrease in suitable habitat for white oak. Obviously, one cannot predict with certainty what will happen to tree species distributions into the future. However, these maps show some potential outcomes that should be considered as we shape our forestry program into the future.

Figure 3.7 USFS Climate Change Tree Atlas:
Current and Predicted Future Distribution of Two Select Tree Species
(Source: Prasad 2009)

White Oak
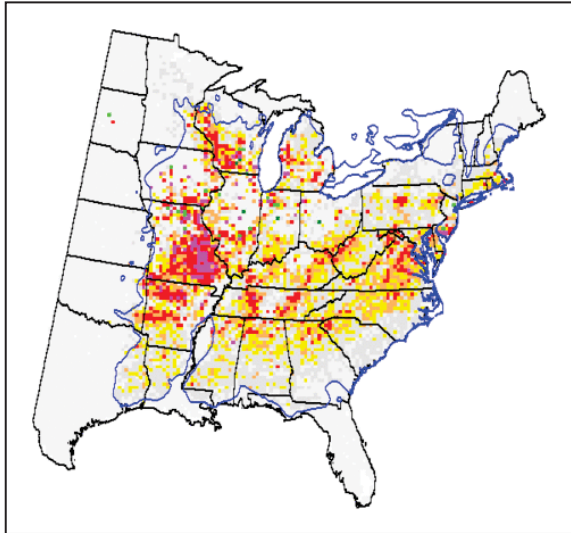
Current Modeled Distribution	Predicted Future Habitat Suitability with Improved Fossil Fuel Conservation
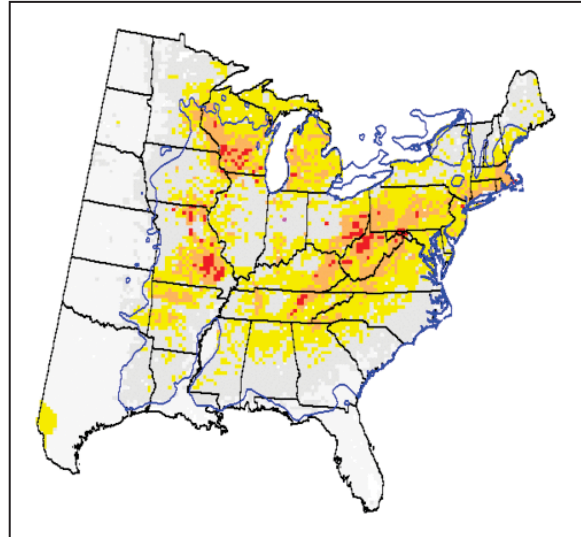
Shortleaf Pine

Current Modeled Distribution	Predicted Future Habitat Suitability with Improved Fossil Fuel Conservation
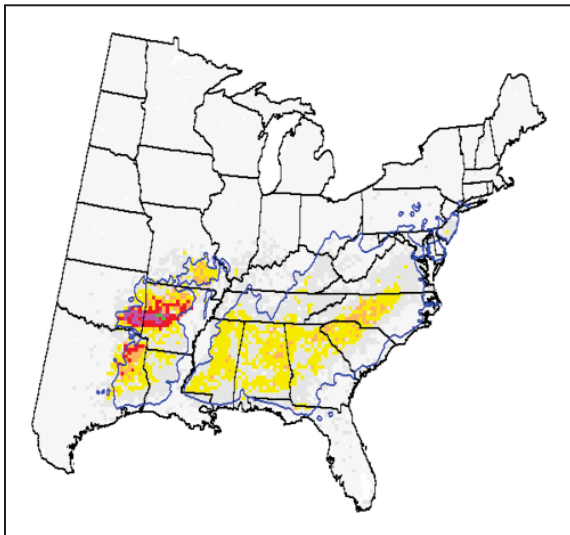
Least   **Habitat Suitability**   Greatest
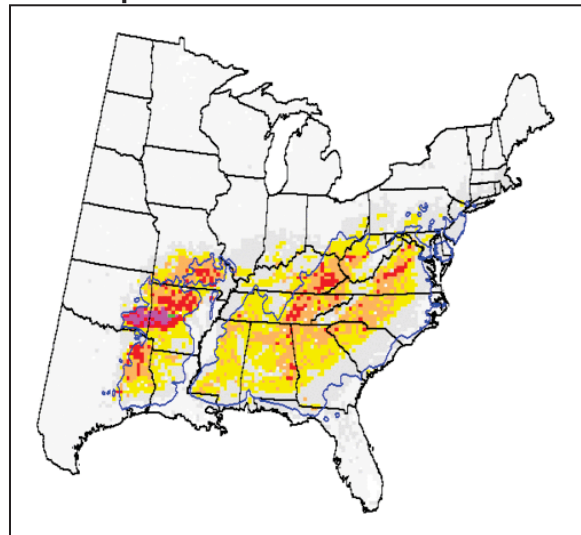
As you can see in these figures, some trees species stand to gain significant ground through climate change, and some could really decline. There is the potential for widespread mortality of trees from climate stress. Although different tree species will migrate and eventually fill in the gaps, such mortality could cause significant changes in forest age and size structure, and tree species composition. While these altered conditions could actually benefit some wildlife species, many others could be adversely affected or possibly eliminated. Therefore, it is important that forest management efforts focus on making our forests as resilient and adaptable as possible. Even if we can't avoid tree species shifts or mortality, we should be able to smooth the transition and help provide a bridge for flora and fauna to adapt to future conditions.

Implication Two: Productive Capacity of Forest Ecosystems

Forest products are a huge part of Missouri's economy - $5.7 billion annually (MDC 2008). The continued viability of the forest products industry and the benefits it provides to society is dependent on a healthy, sustainable forest resource. Sustainability might be significantly compromised if climate change causes much of our tree volume to die prematurely. Even if we do not experience such mortality, climate change could increase the vulnerability of trees to borers and other insects which degrade the quality of trees for most forest products. Also, Missouri's forest products industry is accustomed to working with certain tree species and products. If we were to experience a major shift in forest composition, our industry would need to make adjustments accordingly. Such a phenomenon could have global impact. For example, Missouri produces a high percentage of the world's barrel staves. Only white oak is suited to making barrel staves. If Missouri were to lose much of its white oak, it is uncertain where barrel staves would come from in the immediate future.

Implication Three: Forest Ecosystem Health and Vitality

As discussed above, climate change has significant potential to cause tree mortality or to increase trees' vulnerability to insects, diseases and major weather events (flooding, freezing rain, etc.). However, forest health could be affected in other ways as well:

Exotic/invasive species: Some exotic and invasive species which typically thrive south of Missouri, such as kudzu and Chinese privet, could become major problems in Missouri as well. Where these species proliferate, they choke out native vegetation and diminish wildlife habitat value for many species. On the other hand, some exotic species which are better adapted to colder climates, such as bush honeysuckle and garlic mustard, could decline or disappear entirely. Similar phenomena are equally possible with insect and diseases affecting forests. Since we don't have nearly enough resources to wipe out all exotic species in our forests, strategies will need to be crafted to best prioritize what outbreaks receive the most attention. These strategies could be based in part on climate change projections. Invasive species issues are not necessarily limited to foreign species. There will likely be species which are currently found in Missouri in small numbers which will begin to proliferate in a modified Missouri climate.

Wildfire: Depending on new temperature and precipitation patterns, there is also the potential for our forests to become much more vulnerable to wildfire. Seasonal periods of very warm and dry weather could lead to extreme wildfire conditions. Such conditions could be hazardous to people, personal property and natural communities.

Implication Four: Soil and Water Resources

Regardless of how Missouri's climate changes, there is the potential for significant future soil and water issues relating to forests. If our climate gets significantly wetter, riparian forests could become more important than ever for protecting stream banks and providing filtering functions. If our climate gets significantly drier, there could be real competition for drinking water supplies. Crowded forests consume a lot of water, and future forest management could include implications for providing adequate drinking water supplies. There is currently much debate in the western United States concerning how forests should be managed to minimize competition for drinking water supplies. Such a debate might occur in Missouri in the future as a potential reduction in available water supply conflicts with increasing population.

Implication Five: Forest Contribution to Global Carbon Cycles

According to the Society of American Foresters' Climate Change and Carbon Sequestration Task Force , "Unique among all possible remedies [to climate change], forests can both prevent and reduce greenhouse gas (GHG) emissions while simultaneously providing essential environmental and social benefits…" (Malmsheimer 2008). Missouri's forests are important to the maintenance of global carbon cycles in two respects:

1) **The amount of carbon currently stored in Missouri's forests**. Missouri's forests currently store a great deal of carbon – 844 million tons in fact[5] (Fig. 3.8). However, certain forest threats such as deforestation and mortality have significant potential to actually release carbon and exacerbate climate change. Forest management strategies should at minimum strive to maintain current levels of carbon storage.

2) **Additional climate change mitigation potential**. Beyond simply maintaining current levels of carbon storage, Missouri's forests have significant potential to help mitigate climate change:

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[5] Source: U.S.D.A. Forest Service – Northern Research Station – Forest Inventory and Analysis Data.
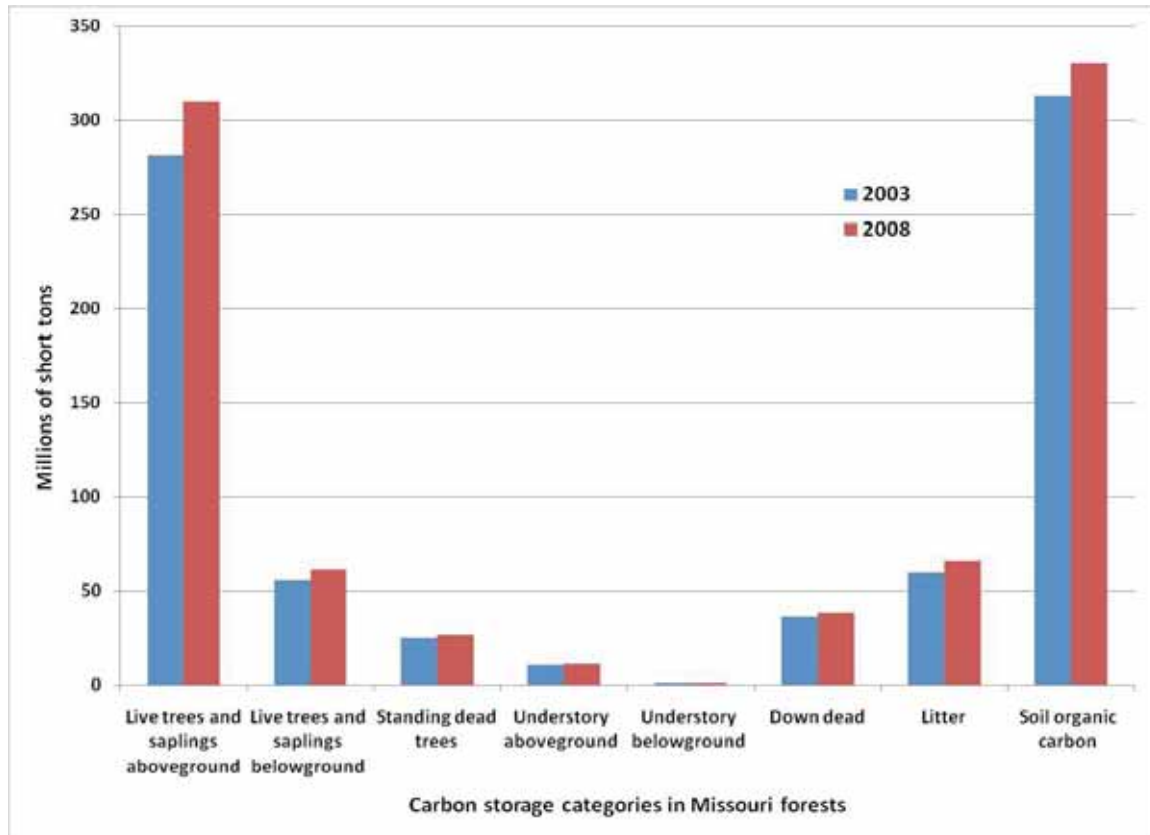
Figure 3.8 Tons of carbon stored in Missouri's forestland: 1999-2003 & 2004-2008
(Source: U.S.D.A. Forest Service - Northern Research Station. Forest Inventory and Analysis)

The Society of American Foresters' Climate Change and Carbon Sequestration Task Force identifies five key methods pertaining to forests for preventing and reducing GHG emissions - wood substitution, biomass substitution, wildfire behavior modification, avoiding land use change, and carbon sequestration (Malmsheimer 2008). These methods are briefly summarized and localized below.

Wood products and wood substitution: Wood substitution involves using wood products instead of fossil-fuel intensive products. Examples could include installing a hardwood floor in your home instead of a vinyl floor or using lumber for construction framework rather than aluminum framing. Wood products and wood substitution help mitigate greenhouse carbon emissions in a couple of ways. First, the wood product itself stores considerable carbon for the life of the product. Second, wood products typically use much less fossil fuels to extract compared to other products such as steel, concrete, brick or vinyl.

Biomass substitution: For the purposes of this assessment, biomass substitution involves the use of wood and wood residues to produce heat and/or energy. Biomass substitution includes utilizing mill residue and harvesting woody biomass (trees in this case) for purposes such as heating, electric generation, and transportation fuels. By using biomass for such purposes, the equivalent amount of coal or oil needed to create such energy can be left underground. Although utilizing biomass for energy also emits carbon, this carbon is

fairly quickly sequestered as harvested trees are replaced by the growth of new and remaining trees.

Although not readily obvious, Missouri already makes substantial use of woody biofuels for heat and energy production. Missouri is one of the biggest charcoal producers in the nation. Many homeowners, especially in rural areas, use wood to heat their water and homes. Many sawmills utilize their mill residue (sawdust, bark, slabs) to heat their mills or fuel their dry kilns.

There may be opportunities to expand the use of woody biofuels for heat/energy production in Missouri. However, it is essential that any such markets are established in a way which will ensure that our forests are managed and harvested in a sustainable manner. It would be very easy for a large biofuels producer to over-extract woody biomass. If this would happen, it could be at the expense of other forest product industries that require larger trees, wildlife that need a good balance of forest structure, and soil productivity which relies on logging residue to return minerals and organic matter back into the soil.

Wildfire behavior modification: Although wildfire behavior modification is listed as a key means of preventing greenhouse gas emissions nationally, this is not considered a significant factor in Missouri, at least in the long term. In 2006 for example, only 0.15% of the nation's wildfires occurred in Missouri. Furthermore, the average wildfire in Missouri produces a fraction of the greenhouse gas emissions compared to wildfires in the western U.S. Fuels in Missouri are comparatively less combustible and volatile.

Historically, wildfires played a large role in shaping and maintaining our wooded natural communities in Missouri. As the presence of fire has been significantly reduced from our landscape, many of our natural communities have been altered – often to the detriment of plant and animal populations. Consequently, there is increasing interest in incorporating prescribed fire into forest and woodland management. Prescribed fires are burns conducted under carefully planned and controlled conditions. While it does not appear that prescribed fires significantly contribute to GHG emissions, there is increasing evidence that they help restore fire dependent natural communities.

Avoided land use changes: Since forests have a tremendous ability to store and sequester carbon, converting forests to other uses such as agriculture or residential development has the opposite effect of releasing a large amount of carbon back into the atmosphere and significantly reducing the capability of those acres to sequester carbon in the future. Voluntary incentives should be developed to avoid the conversion of forestland into other uses.

Carbon sequestration: As a forest grows over time, it has increasing ability to sequester carbon from the atmosphere. This carbon up-take continues until the forest "matures" and reaches its maximum potential storage. Depending on how the forest is managed, this maximum state may never occur. Harvesting, insect and disease outbreaks, weather events, and fire can change the amount of carbon stored in a given forest. Many of these

influencers will release carbon back into the atmosphere, at least temporarily. Although harvesting releases some carbon back into the atmosphere, much of this harvested carbon will continue to be stored in the form of wood products. Regardless, over the long term, forests absorb and hold a tremendous amount of carbon and play a critical role in climate change mitigation and the reduction of net GHG emissions.

Implication Six: Socioeconomic Benefits of Trees and Forests

Missouri's trees and forests provide a wide variety of socioeconomic benefits to people. Any threats and stressors to trees and forests place these benefits in jeopardy. Although these effects would be felt state wide, they could be especially apparent in urban areas for two reasons: 1) These trees and forests are viewed and enjoyed by many people and provide a connection to nature; and 2) Urban environments are already stressful for trees. Therefore, additional stress caused by climate change could be even more devastating to trees and forests in urban areas compared to rural forests.

Despite the potential negatives of climate change, efforts to mitigate climate change could actually provide a unique opportunity for forest landowners. Land ownership includes a number of expenses such as real estate taxes, maintenance costs, management inputs and more. These costs can make it difficult for landowners to hold on to their land. As tracts are sold off, they become increasingly vulnerable to subdividing, conversion, fragmentation, etc. Opportunities to help offset some of the costs of land ownership can help to minimize these negative forest influencers. One such opportunity could present itself in the form of carbon sequestration credit markets.

Carbon markets: Markets are currently evolving for the trade of forestry "carbon credits". Carbon credits are essentially units of carbon being sequestered on a given forest which can be traded to a company that needs or wants to offset the amount of carbon they release. Although forest carbon markets are in the early stages of development in the U.S., there is speculation that these markets could flourish if a national carbon "cap and trade" system is enacted. In addition to the benefits of sequestering carbon, carbon markets could potentially make it more affordable for private landowners to keep their forests intact rather than sell forestland off for development or convert it other uses, and could also provide a financial incentive for sustainable forest management.

Implication Seven: Logistical Framework for Sustainability

Global climate change has just recently entered the radar screen in terms of long term forest planning. However, it is becoming increasingly apparent that forest managers need to incorporate climate change considerations into forest planning and implementation efforts immediately. At first glance, it may seem awkward to plan for climate change given the significant uncertainty of what form climate change will take in Missouri. However, in reality, most of the steps needed to address the implications of climate change on Missouri's forests are the same regardless of whether Missouri gets wetter or drier, or warmer or cooler. Furthermore, most of these measures are things which we should be doing anyway for other reasons. For example, thinning an overstocked forest will make it

more resilient to climate change. However, it can also improve wildlife habitat, increase the growth rate of remaining trees, and reduce vulnerability to insects and diseases.

In the U.S. Forest Service's "Strategic Framework for Responding to Climate Change", seven goals are established for sustaining forests for present and future generations under a changing climate. These seven goals are modified slightly below to make them more relevant to Missouri's Forest Resource Assessment:

1. **Advance understanding** of the environmental, economic, and social implications of climate change and related adaptation and mitigation activities.
2. **Enhance the capacity of forests to adapt** to the environmental stresses of climate change and services of these ecosystems.
3. **Promote the ability of forests to help mitigate climate change**, while sustaining the multiple benefits and services of these ecosystems.
4. **Integrate climate change**, as appropriate, **into MDC internal policies and program guidance**.
5. **Reduce the environmental footprint** of MDC operations and be a leading example of "wise use".
6. **Advance awareness** of principles and methods for sustaining forests and their services in a changing climate.
7. **Establish**, **enhance and retain strong alliances and partnerships** to provide sustainable forests for present and future generations.

Issue Four: Maintaining High Quality Soil and Water Resources

In a nutshell: Trees and forests, when managed properly, are highly effective at conserving soil and water resources. Forest vegetation and leaf litter help protect soil from forces that cause erosion. Riparian forests help hold stream-banks in place and filter out pesticides, nutrients and sediments before they can reach streams. Through filtration, interception and evapo-transpiration, trees and forests reduce storm water runoff problems and moderate stream-flow rates and volumes. In these and other ways, forested landscapes produce much of our cleanest and most cost effective and reliable drinking water. In order to enhance soil and water resources for today and ensure that they will be available into the future, existing trees and forests need to be carefully managed and strategic areas should be re-forested.

Desired Future Conditions:
1. Forests provide high quality, cost effective drinking water.
2. Aquatic ecosystems, and the plants and animals they support, are maintained and enhanced by forests[6].
3. Soil and water resources are protected through the widespread use of riparian forest buffers and best management practices[2].
4. Soil productivity is maintained through sustainable forest management practices.
5. Urban storm-water runoff is minimized through the use of trees and forests.
6. Forests maintain and enhance water related recreation opportunities (canoeing/boating, fishing, hunting, wildlife viewing and aesthetics, etc.)

[6] These DFC's may not apply to some grassland dominated landscapes.

A.   The Role of Trees and Forests in Maintaining Soil and Water Resources

All forested areas help maintain soil and water resources. Leaf litter and forest vegetation protects soil from forces that cause erosion so well that erosion from forests is virtually non-existent compared to erosion from crop fields.   Figure 4.1 shows estimated soil loss rates for three land-use types on the same soil type and percent slope. While actual soil loss rates can vary considerably by soil type, percent slope and management practices, this example helps illustrate the effectiveness of forests in protecting soil resources and the waters in which eroded soils are ultimately deposited.
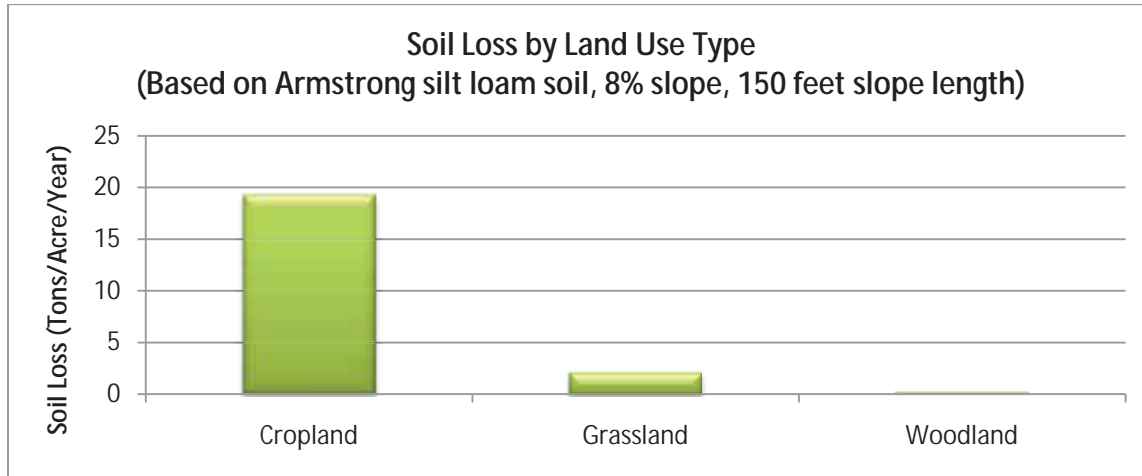
Figure 4.1 Soil Loss by Land Use Type[7]
(Source: USDA Natural Resources Conservation Service[3])

All forested areas in Missouri also provide hydrologic benefits. Compared to cropland, pasture, turf and urban developed areas, trees and forests are highly effective at intercepting precipitation and releasing it slowly into the atmosphere, groundwater and streams. In this way, trees and forests help reduce storm water runoff, and therefore reduce the threat of flooding and the amount of stormwater needing to be handled by local governments. By releasing precipitation slowly into groundwater and streams, trees and forests also help moderate stream flow and volume - providing a more consistent and reliable source of water for public drinking purposes as well as for aquatic habitat. Although non-forested areas often produce a larger volume of water, this volume often comes in rapid pulses which typically does more harm than good.

Riparian Forests and Forested Wetlands:
Although all wooded areas provide significant soil and water benefits, riparian forests and forested wetlands are especially important.

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[7] These figures were generated by Doug Wallace, former State Forester of Missouri Natural Resource Conservation Service, using the Universal Soil Loss Equation. All figures were based on an Armstrong silt loam soil, 8% slope, 150 feet slope length. Cropland = minimum tillage (30% cover after planting), corn-soybean (drilled) rotation, up and down tillage; Grassland = 80% ground cover, grass with some weeds and brush, continuously grazed; Woodland = no grazing, low management, 90% duff cover; 90% canopy cover.

Riparian forests are forests found adjacent to streams. Riparian forests help armor stream-banks to keep them from eroding into streams.   They filter out pesticides, nutrients and sediments before they can reach the stream. They provide shade which is important for maintaining water temperatures conducive to healthy aquatic ecosystem functioning. Vegetation from riparian forests helps provide the food base and habitat needed by many aquatic organisms. Riparian forests also provide important wildlife travel corridors and can be highly productive for forest products. **Of Missouri's 3,238,536 acres of potential riparian forest buffer, approximately 1,782,368 acres or 55% are currently forested[8]**.   Reforesting much of these currently unforested riparian areas would significantly benefit soil and water resources.   (Note: Although some Missouri streams were historically prairie streams and are best suited for prairie cover, a significant majority of stream riparian zones are best suited for forest cover.)

Similar to riparian forests, forested wetlands filter out sediments, nutrients, fertilizers and pesticides from adjacent fields before they reach streams. They also help moderate stream flow and minimize flooding potential.   Forested wetlands have terrific wildlife value and can be highly productive for forest products. Throughout the 19th and 20th century, most of Missouri's historically forested wetlands have been drained and converted to agriculture. A prime example is Missouri's Bootheel which was historically dominated by forested wetlands and is now dominated by agriculture. Although most of Missouri's forested wetlands have been lost, Missouri does still have some quality forested wetlands as well as many areas that have good restoration potential.

B. Forests and Drinking Water: The USFS Forests, Water and People Assessment

For reasons mentioned above, forested landscapes produce our cleanest and most cost effective drinking water. In order to determine the most important forested watersheds for protecting and enhancing public drinking water supplies, public health and aquatic ecosystems, the US Forest Service recently completed a "Forest, Water and People Assessment" (Barnes 2009). This assessment was based on the following four factors:

1) The ability of watersheds to produce clean water
     (Greater ability = higher priority)
2) Total water consumers served by surface water supplies in each watershed
     (Greater number of consumers = higher priority)
3) The percentage of unprotected private forest land in each watershed
     (Greater percentage of unprotected private forest land = higher priority)
4) Areas of greatest development pressure
     (Greater development pressure = higher priority)

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[8] These figures were generated by Mike Morris of the Missouri Department of Conservation using National Land Cover Data – 2001 and the following two parameters for riparian areas: 200 feet wide on either side of permanent streams, and 100 feet wide on either side of intermittent streams.

In this assessment, Missouri had the two highest scoring watersheds in the seven state Midwest Region (Fig. 1). The Meramec watershed, which provides surface drinking water to 586,750 people, received the highest score; and the Lower Missouri watershed, which provides surface drinking water to 588,819 people, received the second highest score. In addition to these two watersheds, Missouri's Big River, Cahokia-Joachim River, and North Fork-White River Watersheds also scored in the top 20. Composite results of the Forests, Water and People Assessment in the Midwest are shown below. This analysis is incorporated into our Forest Opportunity Model described in Chapter 4.
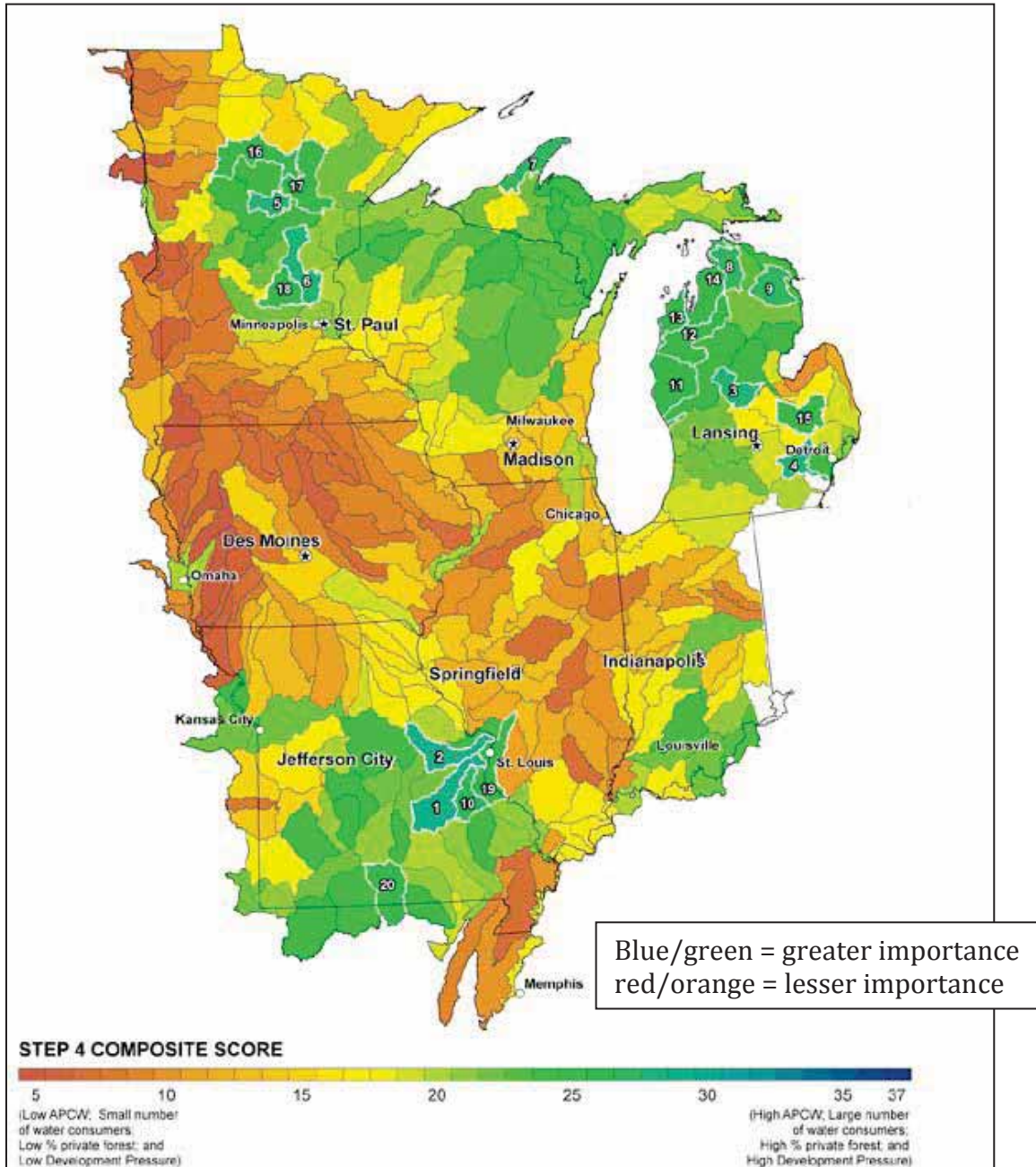

Figure 4.2. Important Forest Watersheds for Maintaining Drinking Water Supplies.
(Source: Barnes 2009)

C. Best Management Practices (BMP's)

When done correctly, forest management (harvesting, prescribed fire, forest stand improvement) has minimal impact on soil erosion or water quality. Unfortunately, forest management is not always done correctly. To promote soil and water quality during management operations, MDC and various partners have established two sets of voluntary Best Management Practices - "Missouri Watershed Protection Practices" and "BMP's for Harvesting Woody Biomass". These BMP's describe procedures for how and where to construct, use and retire logging roads, how to avoid over-harvesting biomass to the detriment of soil productivity, things to consider when conducting a prescribed burn or applying herbicide, and much more.

A good way to help ensure that BMP's are followed and used properly is to utilize the services of trained loggers and foresters. Loggers who have attended Missouri Forest Product Association's Professional Timber Harvester Training have been trained in using and installing BMP's. Most state and federally employed foresters, and some private consultant foresters have been trained in inspecting harvests for compliance with BMP's. The advantages of using forester expertise when conducting a timber harvest are clearly demonstrated below. In all cases, the presence of consulting or management foresters improved compliance with the voluntary guidelines and resulted in less potential for erosion, sedimentation, and stream disturbance.

Use and Effectiveness of BMP's in Missouri - 2001 to Present[9]

Correct Width of Streamside Management Zone

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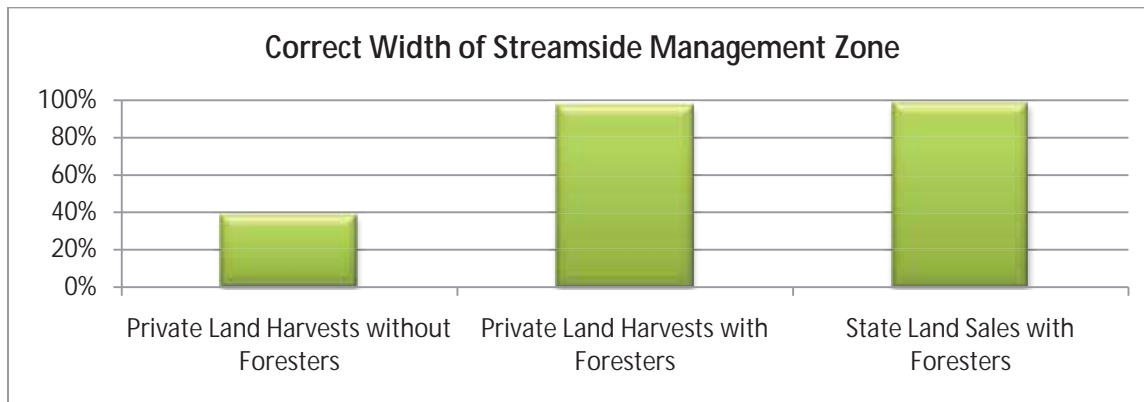
[9] Since 2001/2002, MDC and the Missouri Forest Products Association have conducted BMP monitoring on three types of harvests: 1) State land harvests (which always incorporate BMP's), 2) Private land harvests which used a forester (which typically incorporate BMP's), and 3) Private land harvests which did not use a forester (which often do not incorporate BMP's). These figures include the following acres monitored by MDC and Missouri Forest Products Association: Private Land Harvests without Foresters: 610; Private Land Harvests with Foresters: 1,482; State Land Harvests with Foresters: 14,894. Admittedly, the sample size is small for private land harvests without foresters. This is a reflection of the limited access we have to such harvests.

Practices Used to Avoid Non-Ephemeral Stream Disturbance

Private Land Harvests without Foresters · Private Land Harvests with Foresters · State Land Harvests with Foresters

Skid Trails Located and Used to Avoid Concentrated Runoff, Minimum Soil Displacement/Compaction

Private Land Harvests without Foresters · Private Land Harvests with Foresters · Public Land Harvests with Foresters

Adequate Erosion Control on Main Skid Trails: water bars, tops in trail, etc.

Private Land Harvests without Foresters · Private Land Harvests with Foresters · Public Land Harvests with Foresters

Erosion Control Features Operational: turnouts, ditches, culverts, etc.

Private Land Harvests without Foresters · Private Land Harvests with Foresters · Public Land Harvests with Foresters

Issue Theme Five: The Role of Fire in Missouri's Forests – Past, Present and Future

In a nutshell: Historically, fire played a large role in shaping Missouri's forests and woodlands. The exclusion of fire over the last 50+ years is significantly modifying the structure, diversity and function of many of these communities. For numerous reasons, wildfires can no longer be tolerated. However, in its absence, proactive management is often needed to restore and/or maintain Missouri's forest resources in a healthy, productive and wildlife friendly condition.

Desired Future Conditions:

1. Frequency and size of wildfires are kept to a minimum.
2. Homes, structures and communities are "Firewise".
3. Forest resources and ecosystem services are not adversely affected by wildfires.
4. Public and volunteer firefighters spend less time fighting wildfires, and therefore can direct time and financial resources to other priorities.
5. Fire adapted landscapes and natural communities are restored and/or maintained through the use of prescribed fire and/or other management tools.
6. Prescribed fire techniques are developed and practiced to maximize the benefits of prescribed fire while minimizing negative impacts.

A. Missouri's Fire History

For thousands of years, fire has been an important influencer to Missouri's landscapes and natural communities. Historically, Native Americans used fire frequently for improving wildlife habitat and hunting opportunities, enhancing travel conditions, and as defense against rival tribes. These fires resulted in a rich mosaic of prairie, glade, savanna, open and closed woodland and forest communities across the state.

As European settlers displaced Native Americans in the early 1800's, they not only continued the fire tradition, but increased it substantially to improve grazing opportunities for their free ranging livestock. In the late 1800's/early 1900's these fires were combined with a massive and unsustainable logging off of Missouri's forests, largely to support the building of the transcontinental railroad (Guyette 1999). These were bleak times for Missouri's forests, woodlands and associated plants and animals.

Eventually, the dire effects of unsustainable harvesting and wildfire on our forest and wildlife resources became apparent and unacceptable. A highly successful prevention and suppression campaign ensued.

The Forestry Division of the Missouri Department of Conservation (MDC) was created in large part, because of wildfire. George O. White, MDC's first State Forester, knew that if we were going to manage the forest resource of the state we would have to stop the wildfires that were burning approximately 1/3 of the Ozarks each year (MCC 1944).

MDC's Forestry Division was formed in 1940, followed by the adoption of the State Forestry Law in 1946 - providing authority to the State Forester for suppressing wildfires.

Fire prevention started with a traveling road show bringing a motion picture fire prevention message into the very heart of the rampant wildfire area. Smokey Bear would follow this up and introduce wildfire prevention to a new generation of future landowners. Attitudes started changing slowly at first, but noticeably.

The next big change started in the 1960's with the formation of Volunteer Rural Fire Departments.   This was made feasible by utilizing both state and federal funds and a program that made excess military equipment available to fledgling fire departments. Growth was slow initially but really picked up in the 1980's. These new fire departments not only provided a trained consistent resource of fire fighters but also created new attitudes. Now, it was not as acceptable for a person to start a fire knowing that their neighbor or brother would be coming out to extinguish it. Many attitudes were adjusted on the spot (MDC 2009).

Today, only about 0.1 percent of Missouri (~50,000 acres) burns each year by wildfire[10]. These fire suppression efforts have and continue to provide a great service in protecting people, property and the forest resources we hold so dear.
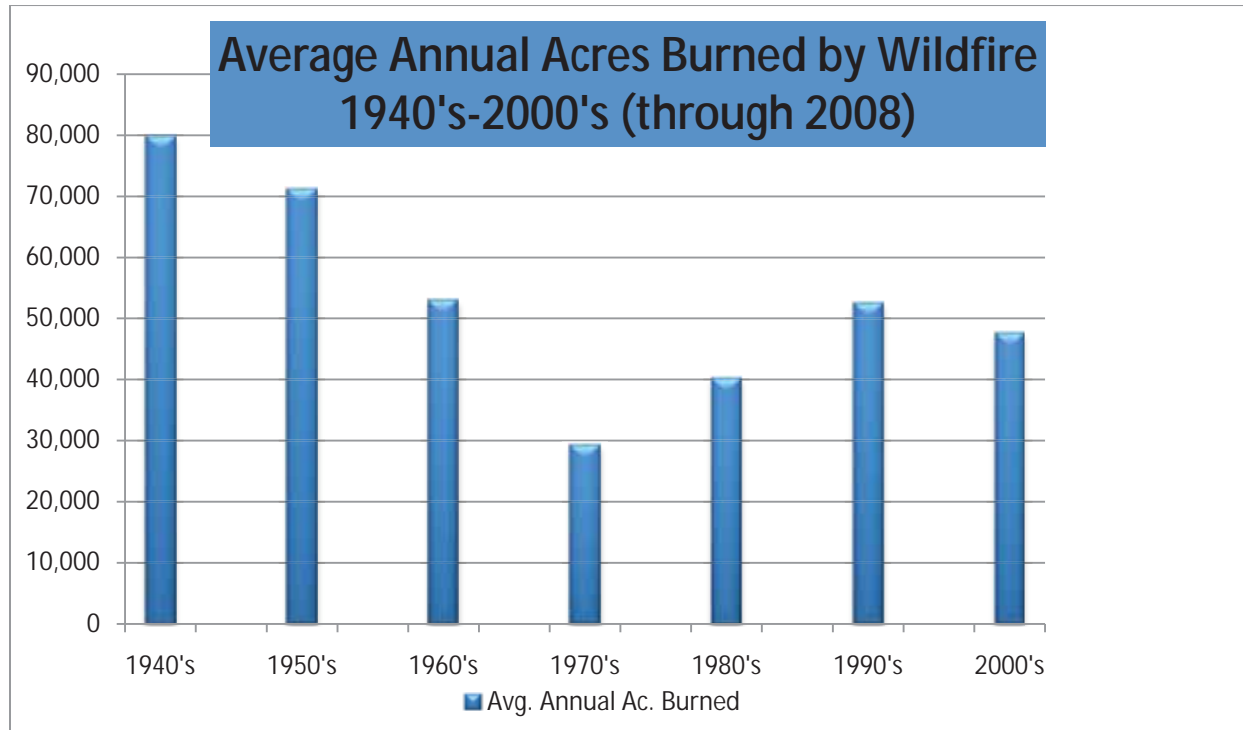
Figure 5.1 Average Annual Acres Burned by Wildfire: 1940's-2000's[8]

B. Missouri's Modern Wildfire Status

Although Missouri's acreage burned by wildfire has diminished greatly, wildfires have not gone away completely. Below are annual wildfire statistics for Missouri, averaged over the last ten years. The ten year average is provided to help account for the typical variability in wildfire seasons from one year to the next depending on yearly weather patterns.

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[10] Calculated by the Missouri Department of Conservation (MDC) using fire reports submitted to MDC. Figures do not include un-reported fires.

Figure 5.2 Wildfires per Year by Cause (averaged over 1999-2008)[11]

Cause	Number of Fires	Number of Acres
Lighting	18	158
Campfire	16	386
Smoking	74	914
Debris	1,360	17,588
Arson	329	15,955
Equipment	117	947
Railroads	12	181
Children	17	73
Misc.	641	9,502
Total	2,585	45,704

Figure 5.3 Wildfires per Year by Size (averaged over 1999-2008)[11]

Wildfire size (acres)	Number of Fires	Number of Acres
0-0.25	352	66
0.25-10	1,649	4,568
10-99	500	16,554
100-299	63	11,390
300-999	16	8,059
>1,000	5	5,068
Total	2,585	45,704

In modern times, the lion's share of Missouri wildfires are fought by the 902 local fire departments scattered across the state. However, MDC still fulfills an important role in fire suppression efforts:

- Serves as primary responder on about 6% of Missouri's wildfires. This mostly includes larger fires and geographic areas with limited fire department coverage.
- Provides firefighter assistance to fire departments on many other fires.
- Provides training on wildfire suppression and safety.
- Conducts and assists with numerous wildfire prevention efforts.
- Provides about $370,000/year of matching grant funds to fire departments for purchasing wildland fire suppression equipment.
- Administers the Federal Excess Property Program (FEPP) which provides excess federal equipment to fire departments. This program has recently been diminished from $4.1 million of equipment distributed in fiscal year 2007 to $0.3 million distributed in fiscal year 2009 due to the increasing popularity of the Fire Fighter Property Program.
- In the first two years of MDC's participation in the Fire Fighter Property (FFP) Program, $6.4 million of equipment was distributed in fiscal year 2008, and $11.6 million of equipment was distributed in fiscal year 2009.

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[11] Calculated by the Missouri Department of Conservation (MDC) using fire reports submitted to MDC. Figures do not include un-reported fires.

The nature of wildfires in Missouri is changing. Perhaps the biggest change has been the unprecedented expansion of the Wildland Urban Interface (WUI) in the last couple of decades. Maps and text describing the growth of Missouri's WUI can be found in Issue One. WUI has had significant impacts on wildfire trends – some good, some bad. On the one hand, the increased number of people living in or next to the forest has left far greater opportunity for fires to ignite and spread to areas that threaten people and their property. On the other hand, the added presence of people and cell phones means that wildfires in or near WUI tend to be reported much more quickly and can often be put out before they reach large size.

In order to help build preparedness and coordination among adjoining fire departments and partnering agencies (i.e. Mark Twain National Forest, MDC), some communities are developing **Community Wildfire Protection Plans, or CWPP's**. CWPP's lay out a framework for coordination between these partners for fires and other disasters of varying size and complexity. At this time, Missouri only has one CWPP in place (see Figure 5.4). However, interest in CWPPs is growing, and several communities are in the process of developing CWPPs.


Figure 5.4 Map of Missouri's Community Wildfire Protection Plan Coverage Areas
(Source: Missouri Department of Conservation)

C. Wildfire Priority Areas

In Chapter 4, Forest Opportunity Areas (FOAs) are presented as priority areas for focusing limited time and financial resources towards forest sustainability. The FOA assessment addresses most key issues identified in FRAS. However, the issue of wildfire is not adequately captured by FOAs. The objectives for preventing and suppressing wildfires go beyond forest sustainability – including protection of people and their property, and prevention of damage to other habitat types besides forests. Consequently, a separate set of priority areas is established here as Wildfire Priority Areas (WPAs) – priority areas for investing resources towards fire prevention and suppression.

WPA's are established using a Wildfire Priority Model which includes the following layers (see Figures 5.5-9 below):

1. **Annual Average Number of Fires by County.** Counties with greater numbers of fires each year receive higher priority for this layer, as they require significant resources for response and suppression efforts.
2. **Annual Average Acres Burned by County.** Counties with greater acreage burned each year receive higher priority for this layer, as they require significant resources for response and suppression efforts. This layer helps account for counties which may or may not have as many fires per year, but have larger fires due to remoteness or other factors.
3. **Acres of Wildland Urban Interface by County.** Counties with greater acreage of Wildland Urban Interface receive higher priority for this layer, as they contain greater potential for wildfires, and greater numbers of structures to protect from wildfires.
4. **U.S. Forest Service Northeastern Area Fire Risk Model by County.** Counties at greater risk, as determined largely by fire fuel modeling, receive higher priority for this layer.
5. **Acres of Increased Fire Fuel Loading Resulting from 3 Recent Storm Events by County.** Counties which were exposed to recent major widespread storm events (ice-2007, ice-2009, and wind-2009) receive higher priority for this layer. These events resulted in significantly increased fuel loading across widespread areas which has resulted in increased vulnerability to wildfire and complexity in fire suppression.

Our Wildfire Priority Model utilizes these five data layers by assigning each county a value of 0 to 1 for each data layer (0 = low priority, 1 = high priority). Each county then receives a composite score of 0 to 5 – determined by adding up the 5 data layer scores. This composite score is then used to compare overall priority level between counties. Priority levels are assigned using 3 "natural breaks", as shown in Figure 5.10.
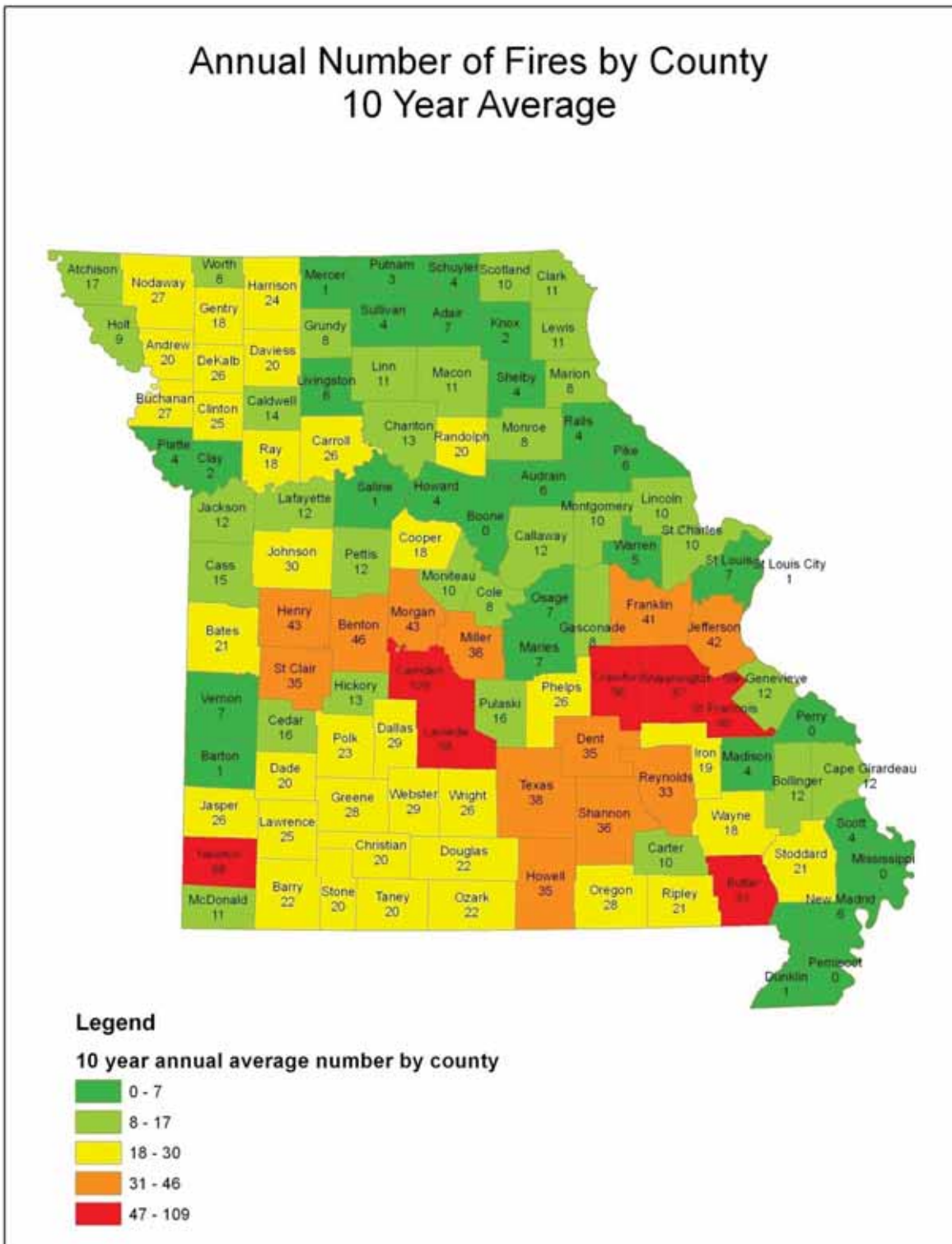
Figure 5.5 Annual Number of Fires per County – 10 Year Average
(Source: Missouri Department of Conservation – Wildfire Reporting Program)
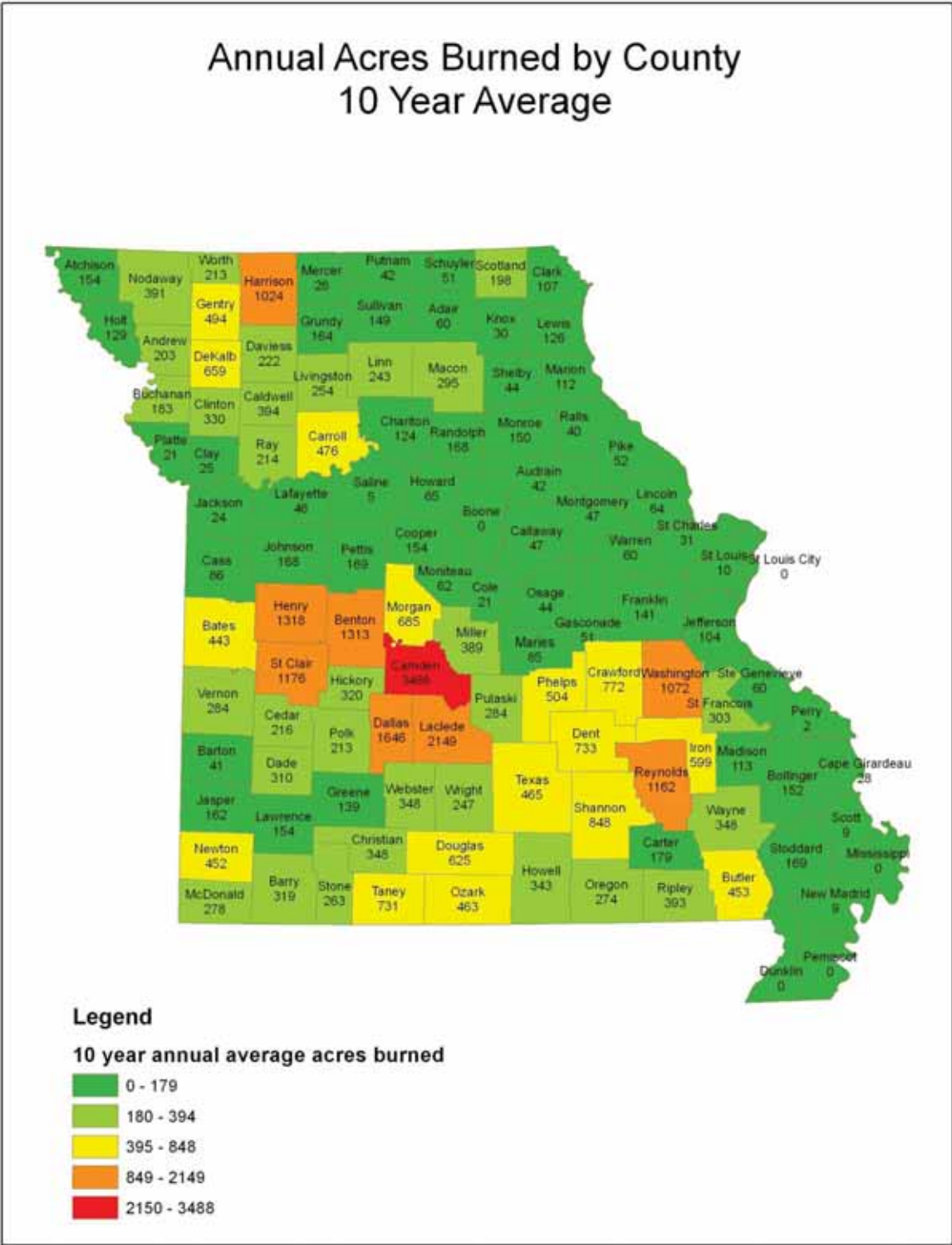
Figure 5.6 Annual Acres Burned by County – 10 Year Average
(Source: Missouri Department of Conservation – Wildfire Reporting Program)
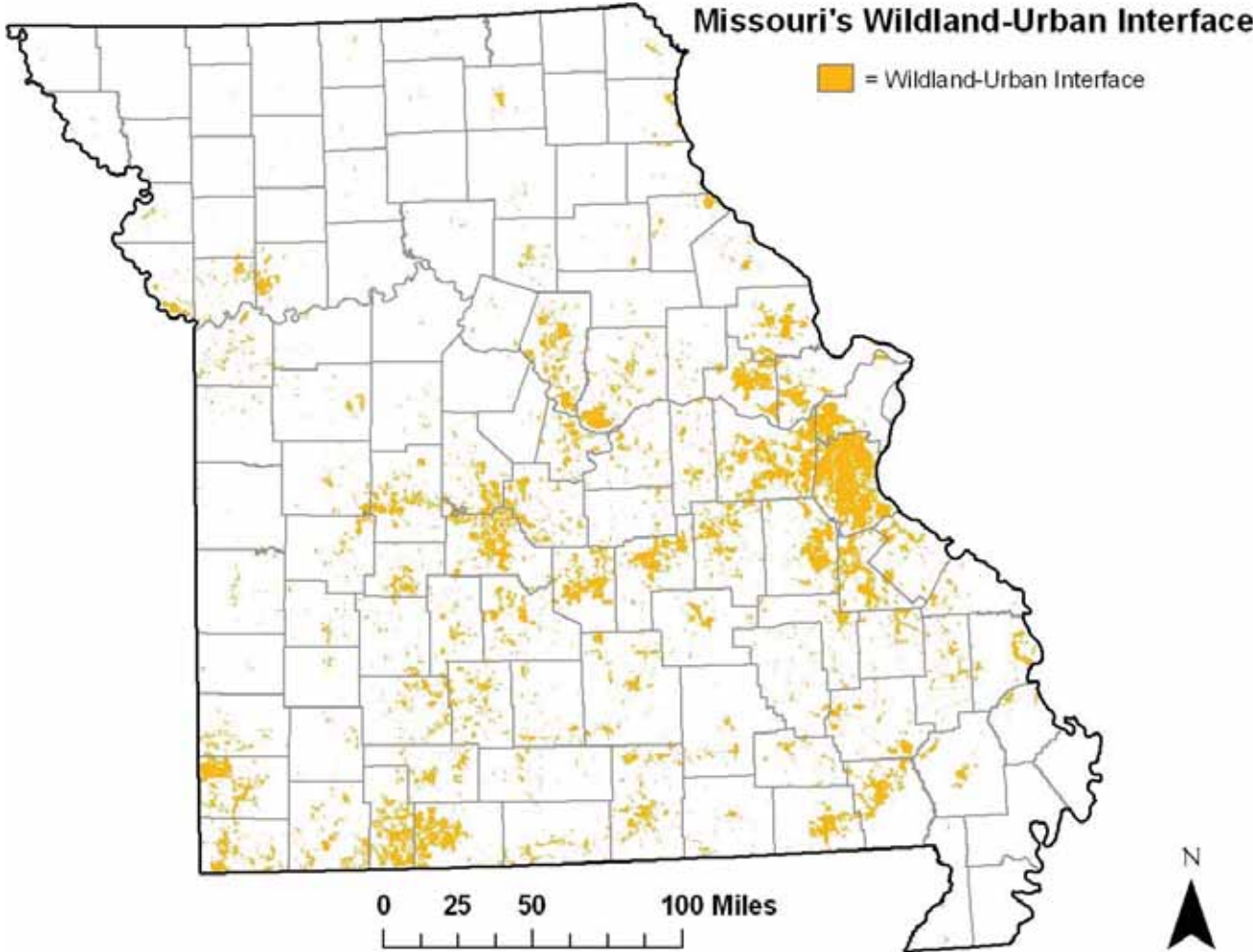
Figure 5.7 Missouri's Wildland-Urban Interface
(Source: Radeloff 2005)
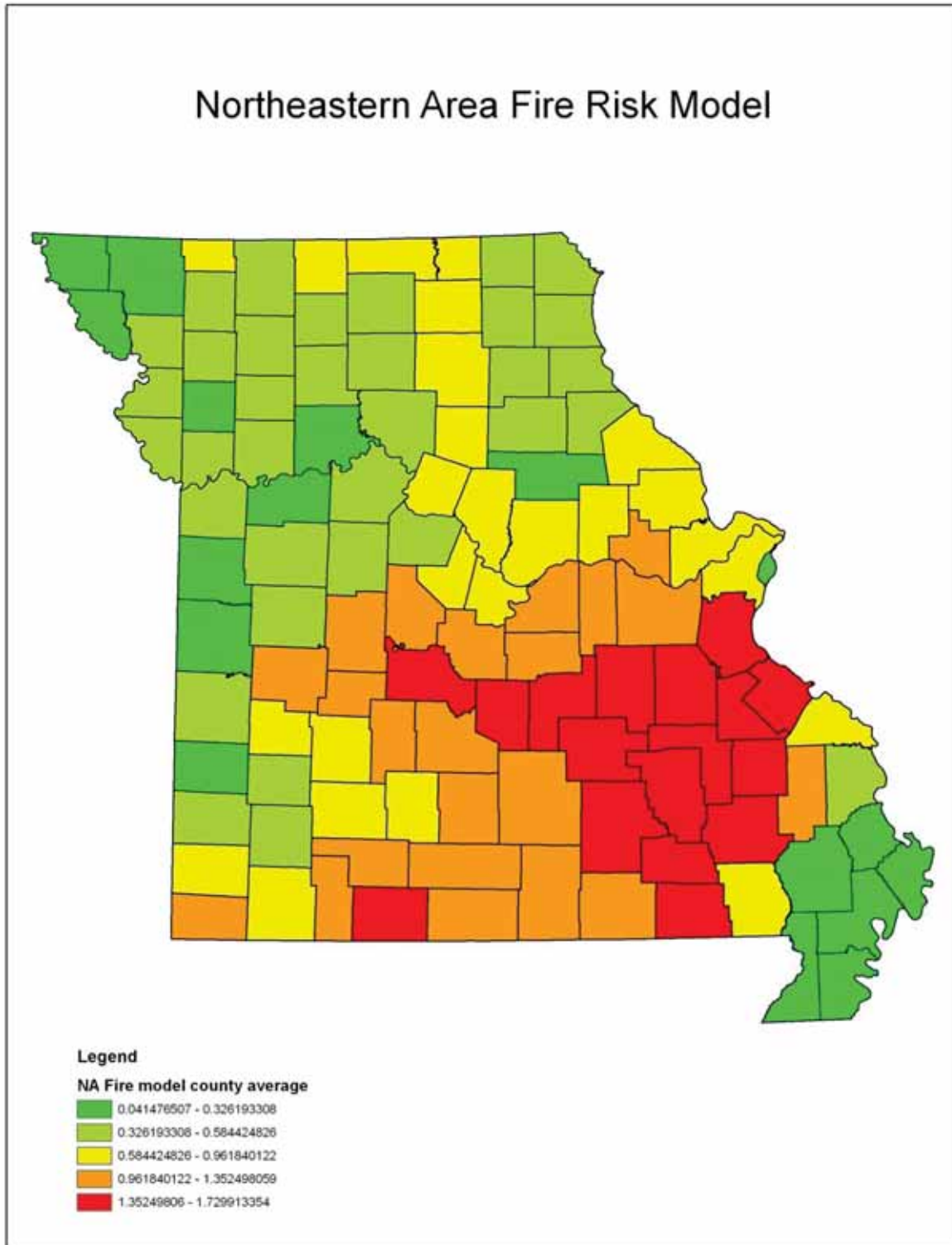
Figure 5.8 U.S. Forest Service Northeastern Area Fire Risk Model (2010) – By County
(green = least risk, red = greatest risk)
(Source: U.S.D.A. Forest Service – Northeastern Area Fire Risk Model)

Storm Events by County

Legend
County Storm Event Value
- 0
- 1
- 2
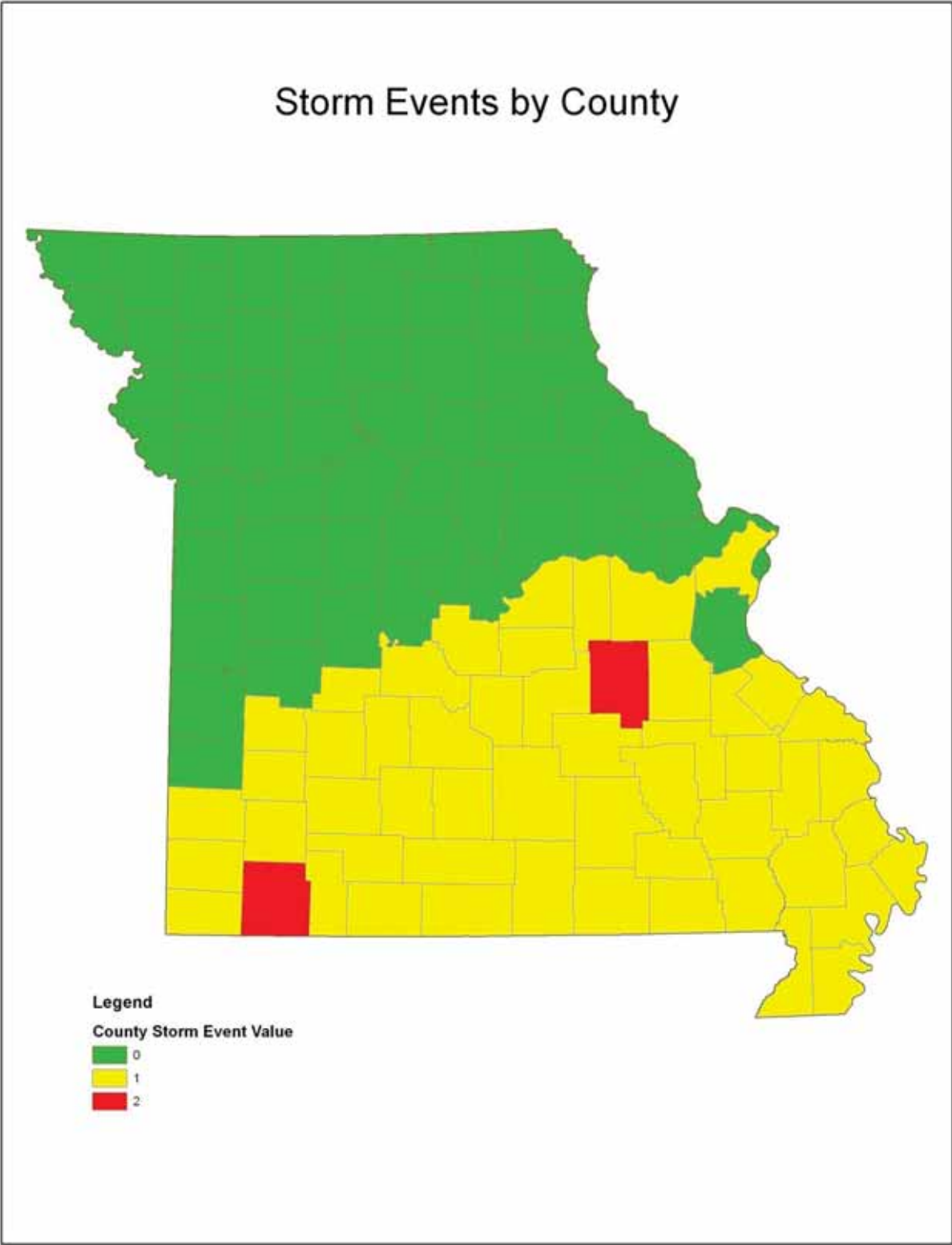
Figure 5.9 Number of Recent Major Storm Events Affecting Fuel Loading – By County
(green = 0 events, yellow = 1 event, red = 2 events)
(Sources: National Weather Service, U.S. Geological Survey and MDC)
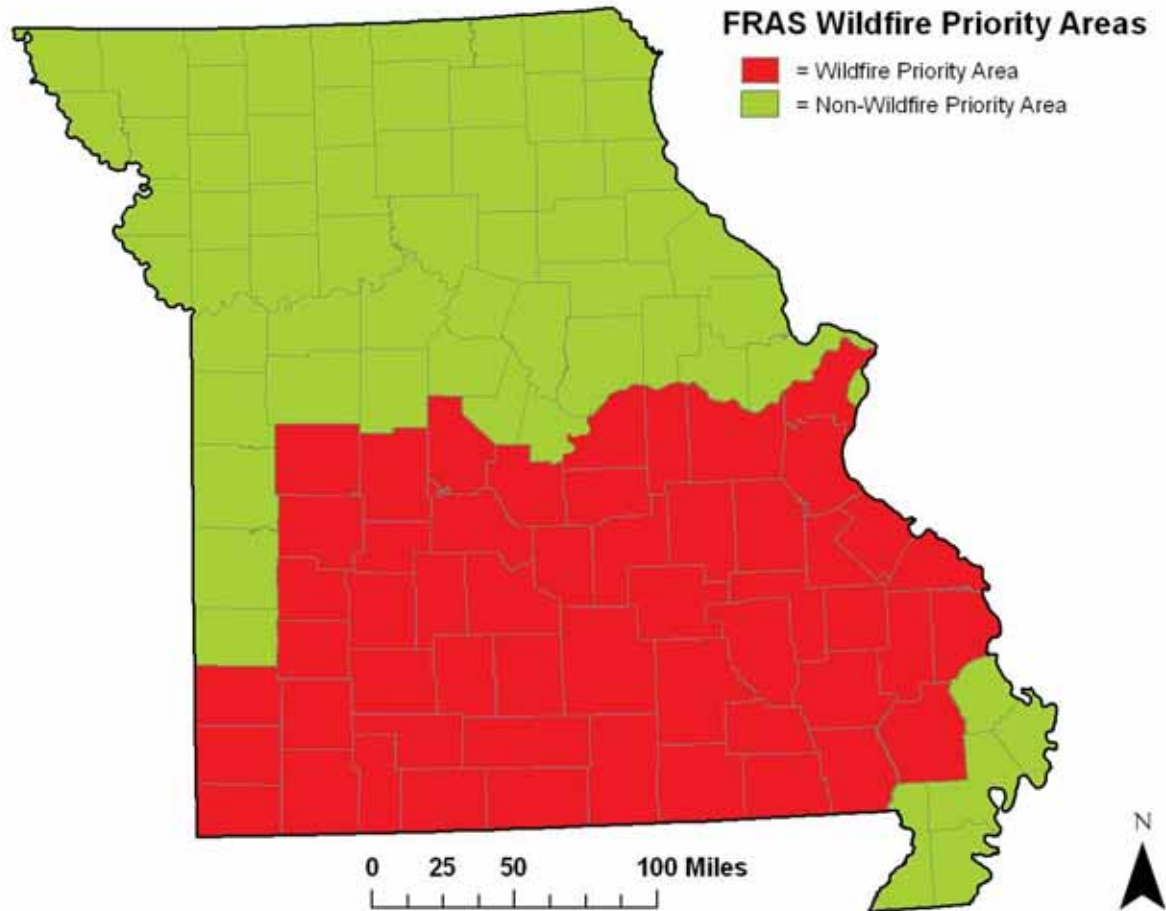
Figure 5.10 Composite Map of Wildfire Priority Areas
(Developed by the Missouri Department of Conservation)

D. Unintended Consequences

Although fire suppression activities have greatly improved Missouri's timber quality, improved public safety, and has had many other benefits, fire suppression has had some undesirable effects as well…

Case Study One: Increasing Presence of Shade Tolerant, Fire Intolerant Species.

For thousands of years, much of Missouri's forests and woodlands have evolved with frequent, low to moderate intensity fire disturbances, often burning once every 3-4 years. Therefore, most of our woodlands and forests contain an abundance of plant and animal species that are well adapted to or tolerate fire. In the last 50 years, fire has largely been eliminated from our landscapes. During this time, the presence of shade tolerant, fire intolerant species has increased dramatically. This includes species like sugar maple, red maple, cedar, elm, blackgum and ironwood.

Figure 5.11 shows the increase of sugar maple by percent change in the number of trees per diameter class. **From 2003-2008, the number of sugar maple trees increased significantly in every diameter class but one. The number of sugar maple trees in two classes increased by more than 25%**[12]. While sugar maple is a native species which occurred in Missouri historically, its presence is increasing dramatically.
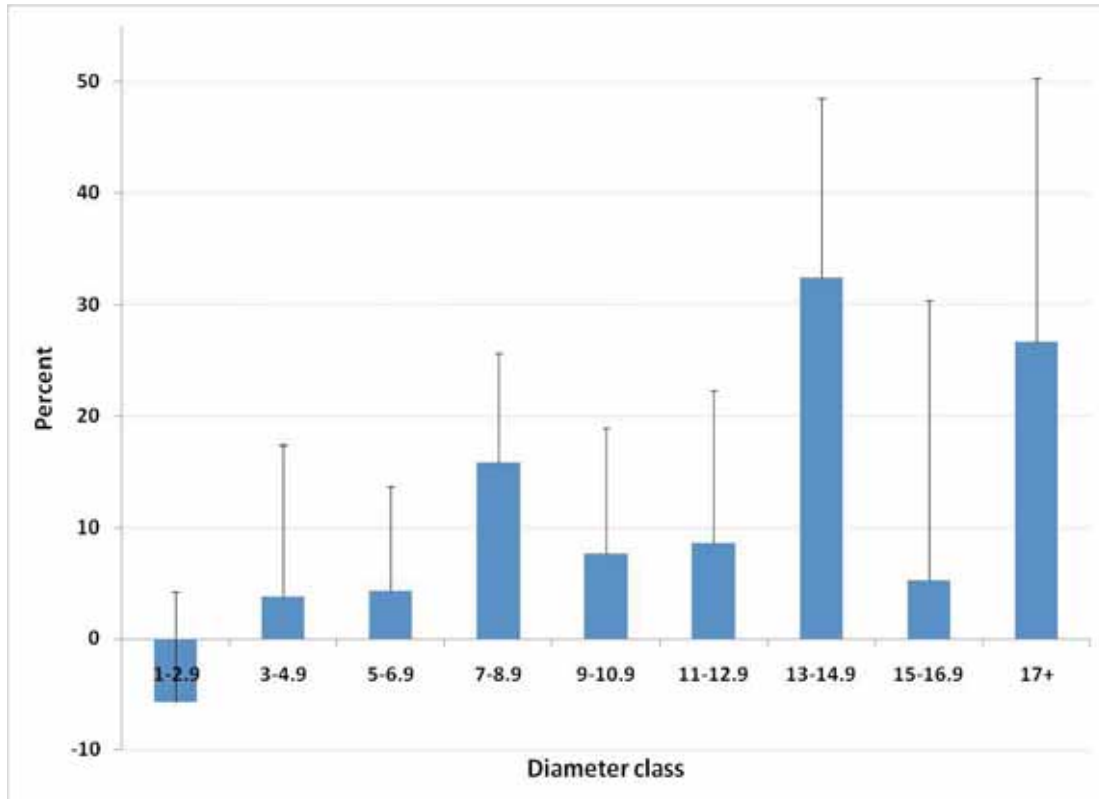
Figure 5.11 Percentage change in number of all sugar maple trees on timberland between the 2003 and 2008 inventories, by diameter class.
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Figure 5.12 shows the increase of sugar maple by basal area/acre. **From 1989-2003, there was a ~500,000 acre increase in timberland containing at least 10 square feet basal area/acre of sugar maple, and from 2003-2008 there was an additional ~100,000 acre increase**[10]. This equates to a current total of ~2 million forest and woodland acres with at least 10 square feet basal area/acre of sugar maple!

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[12] Source: U.S.D.A. Forest Service - Northern Research Station. Forest Inventory and Analysis
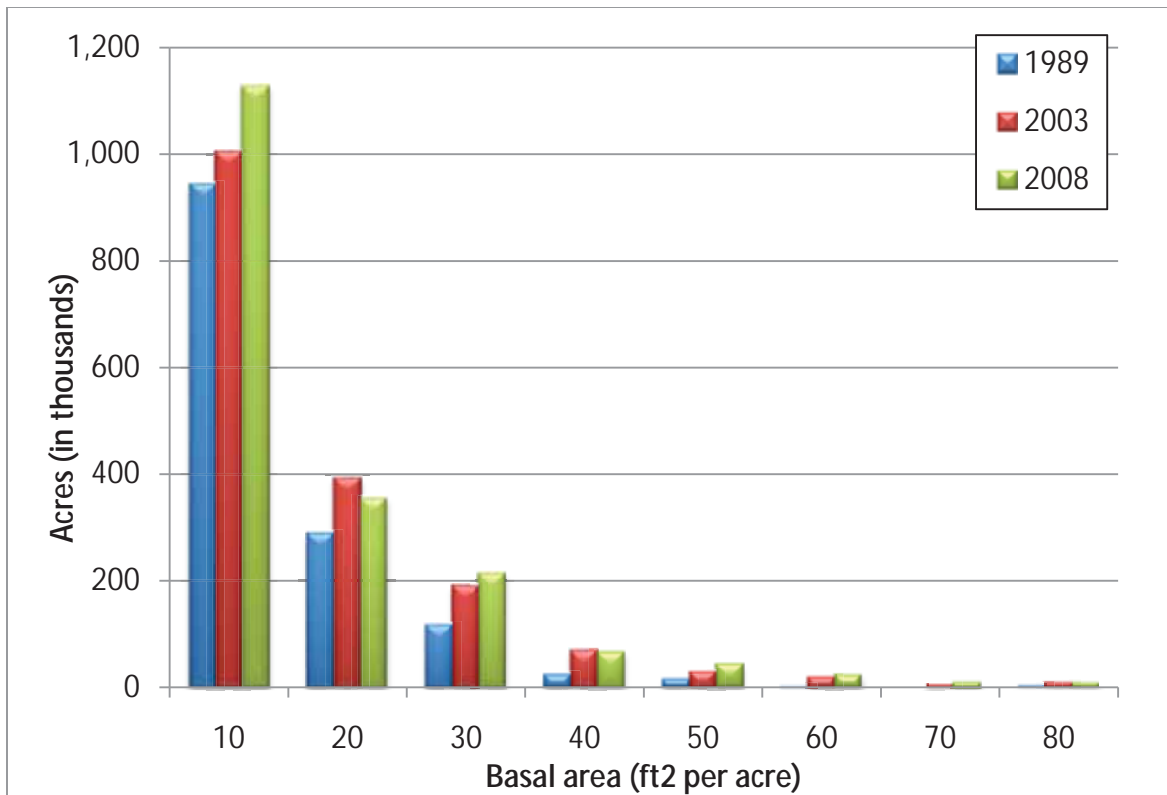
**Figure 5.12 Sum of timberland acres with sugar maple by
sugar maple basal area class, in 1989, 2003, and 2008.**
(Source: USDA Forest Service, Northern Research Station - Forest Inventory and Analysis)

At first glance, 10 square feet/acre may not sound like much, but in terms of natural communities, wildlife habitat and oak regeneration, this abundance is highly significant. Sugar maple trees have incredibly dense canopies. Therefore, a small amount of sugar maple in an understory can place so much shade on the ground that many trees, shrubs and herbaceous vegetation cannot survive, including oak regeneration. As sugar maple encroaches upon a forest or woodland, wildlife habitat is often greatly diminished for many species that require abundant ground layer vegetation for food and cover. Furthermore, as overstory oaks die over time, they are replaced by more shade tolerant species. Often times, these shade tolerant species do not have the same value for wildlife or for other purposes as the oak trees that typically dominate our forests and woodlands now. For instance, the acorns produced by oaks are a staple food source for many species of wildlife. Acorns are highly nutritious, and are available throughout the winter. Maple seed on the other hand lasts only a short period of time, and does not have the same nutritional value. As our oaks potentially decline in dominance, wildlife will have to adjust to other food sources which may not be as plentiful or nutritious as acorns.

Trends for sugar maple are used in this example because there is good data available. However, anecdotally, similar trends are forming with several other shade tolerant, fire intolerant species and on many additional acres than are shown here for sugar maple.

Management practices such as non-commercial thinning can be used to maintain oaks as an important component of these forests and woodlands into the future. However, this will require active management at a much greater scale than exists currently.

Case Study Two: Crowded Forests and Woodlands

In the absence of fire and other active management, Missouri's forests are becoming increasingly crowded (see figure 5.13). In crowded forests, trees are in greater competition with each other for limited resources such as space, light, water and nutrients. Consequently, over-crowding can have a number of negative implications. Trees grow slowly and become more vulnerable to insects and diseases. Production of acorns and other mast for wildlife is reduced. Ground vegetation which is important for wildlife habitat and natural community plant diversity becomes largely shaded out. Conversely, by restoring forests and woodlands to healthy tree densities, forests can quickly become more productive for forest products and wildlife, and more resilient to insects, diseases and climatic changes.
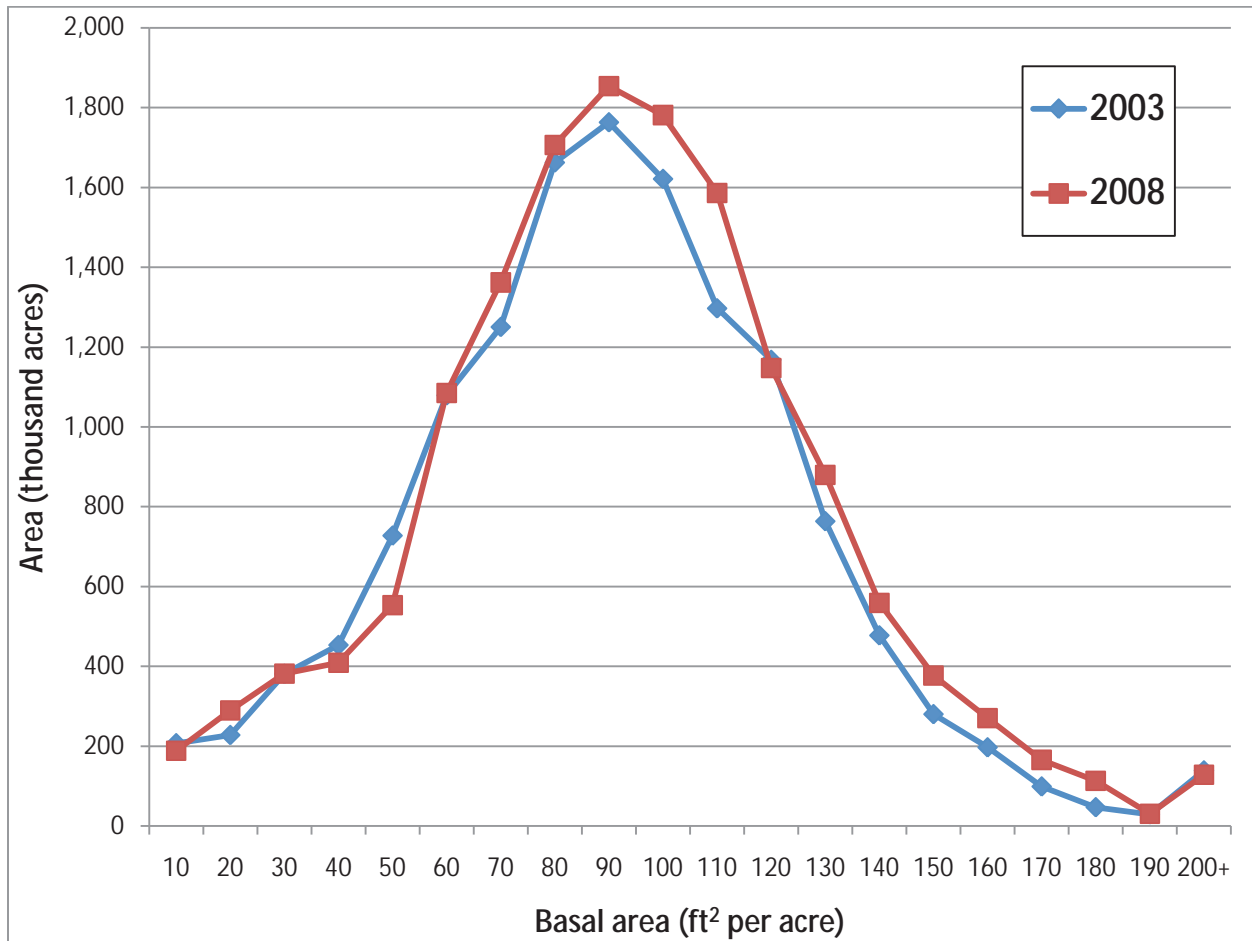
Figure 5.13 Area of forest land in Missouri, by basal area (ft²/ac), for the 2003 and 2008 inventories.
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Case Study Three: Structural Diversity

An important aspect of promoting wildlife diversity in Missouri's forests and woodlands is maintaining structural diversity. Some species of plants and animals require dense, late successional forests to thrive, some need early successional habitat provided by disturbances like severe wildfires and clearcuts, and some species need something in between these extremes or a mosaic of habitat conditions. Historically, structural diversity was created by a number of disturbances such as fire, wind, ice, insects and disease, etc. Public agencies often track and manage this structural diversity on publicly owned lands. However, we currently don't have a good way of tracking structural diversity across landscapes and ownerships. This is a data gap that should be pursued.

E. Prescribed Fire, and Other Management Practices

For a variety of reasons, it is no longer practical or desirable to allow wildfires to burn uncontrolled. However, in order to address some of the "unintended consequences" mentioned above and to keep forests and woodlands as healthy, productive and wildlife friendly as possible, it often becomes necessary to implement forest management practices of one kind or another:

"Prescribed" fire can be a great way to help restore and maintain forests and woodlands. Prescribed fires are fires conducted under carefully planned and controlled conditions. Firelines are established ahead of time to help keep the fire within the intended boundary. Prescribed fires are only conducted if predetermined conditions are met (weather, available equipment and people, etc.). Prescribed fires do have limitations though:

- Prescribed fires often do not perfectly mimic historic fires. For example, target trees to be thinned out have often grown larger and less vulnerable to fire, and prescribed fires are typically only conducted under relatively mild weather conditions. However, combined with other management practices (like TSI), prescribed fire can be a great restoration/maintenance tool.
- Prescribed fires can cause unintended damage to desirable trees, especially when they are not carefully executed.
- There are many places in which prescribed fire is not practical or desirable. For example, smoke management can often be an issue in wildland/urban interface settings.
- There are not many contractors available who offer this service to landowners, and many landowners are not comfortable or properly trained to conduct prescribed burns on their own.

Other common management practices which can help improve forests and woodlands include non-commercial thinning (Timber Stand Improvement) and harvesting. Some of the most successful forest/woodland improvement projects involve a combination of methods. Regardless of what practices are being considered, it is important to carefully plan them out for the specific forest or woodland being targeted to ensure that a landowner's objectives will be achieved.

Issue Six: Missouri's Growth, Harvest and Consumption of Forest Products

In a nutshell: Missouri's forest products industry is an important contributor to Missouri's economy, and supports a number of economic, social and environmental values. Ensuring that these values are maintained into the future means carefully balancing harvest and consumption rates with available growth, and making sure that harvest practices account for long term productivity and sustainability of all forest benefits and services.

Desired Future Conditions:
1. Missouri's forests and forest industry provide forest products demanded by the public, and contribute significantly to MO's economy.
2. Missouri's forests produce a volume of forest products equivalent to the amount Missourians consume.
3. The harvest of forest products, including potential new markets, is sustainable both statewide and regionally.
4. Harvesting maintains and enhances the health and productivity of forests, and does not compromise other forest services and benefits.
5. Forests are resilient to potential stressors (insects and disease, drought, climate change) to ensure sustained growth and yield over time.
6. Forest industry and communities which depend on it remain viable.
7. Trees are grown and utilized to their highest value.
8. Missourians are aware of how they use wood, how much they use, and where it comes from.

Missouri's forests are an important supplier of numerous wood products used not only in our state, but worldwide. Some of the many products originating from Missouri's forests are furniture and cabinets, flooring, barrels, tool handles, charcoal, pallets, shavings, firewood and much more. Through the production of these and other wood products, **Missouri's forest products industry contributes approximately $5.7 billion to Missouri's economy annually, supports 31,700 jobs, and generates $57 million each year in state sales tax** (MDC 2008)**!**

Besides the social and economic benefits of Missouri's forest products industry, there are some less obvious benefits as well. When done properly, the harvest of forest products can provide an economical means of improving forest health and wildlife habitat. Harvesting can be used to mimic historic disturbances which maintained diverse forest structure and composition, important to both forest health and wildlife.

Forest products can have several environmental advantages over alternative resources:
- Trees and forests are renewable resources. As trees are harvested, new trees quickly emerge and fill in the gaps left behind.
- Harvesting trees is generally much easier and leaves less of a human footprint compared to the extraction of other resources such as metals, coal and oil.
- Forest products are generally biodegradable and/or recyclable.
- Forest products and biofuels help reduce greenhouse gasses through carbon storage in forest products and through avoided use and extraction of fossil fuels. Carbon released from tree harvesting is quickly taken back up by new forest growth.

Despite all of the benefits and opportunities associated with forest products, they have their limitations too. First, there is a limit to how much volume of timber can be harvested without reducing opportunities for future generations. Second, the harvest of forest products is only beneficial if it is done using management practices which ensure the long term health, sustainability and productivity of the forest. Forest management decisions need to ensure that all of the benefits forests provide can be sustained into the future.

A: Growth, Yield and Consumption Rates

Sustaining the economic, social and biological benefits of Missouri's forest products industry requires maintaining a careful balance of forest growth, natural mortality, harvesting, and consumption.

By coincidence, about 1/3 of earth's land surface is forested, as is 1/3 of Missouri's land surface. Considering that Missouri's population density is relatively low (compared to the global population), we have the benefit of more forest per capita than the world as a whole (presently about 2.5 acres per capita and falling; global forest land is 1.6 acres per capita and falling) (Shifley 2007).

Acres of Forestland per Person in Missouri
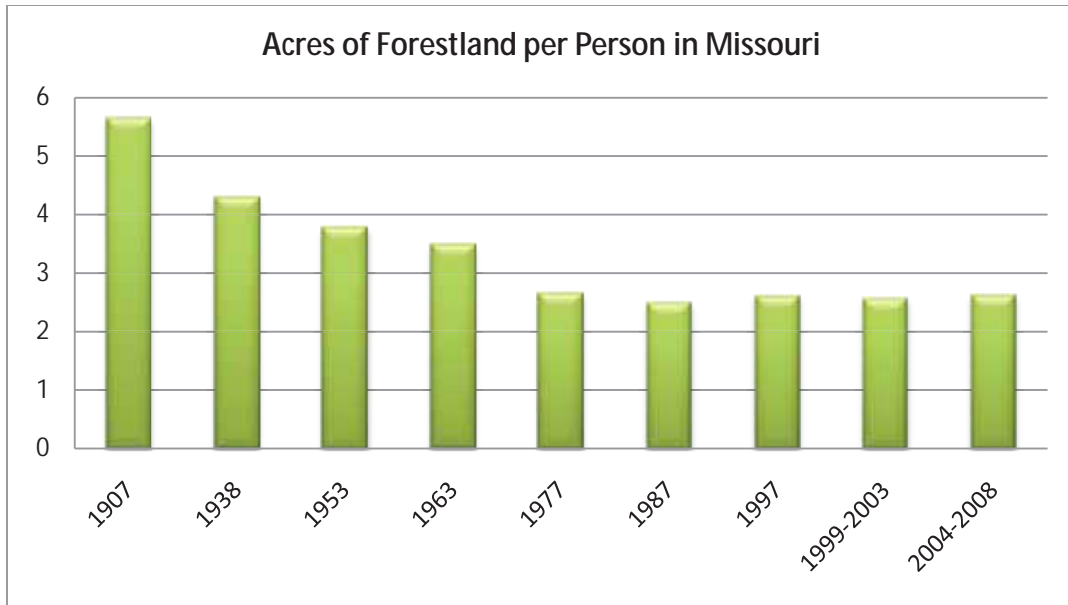
Figure 6.1 Acres of Forestland per Person in Missouri
(Source: U.S. Department of Commerce, Census Bureau; and,
USDA Forest Service, Northern Research Station - Forest Inventory and Analysis)

Given that Missourians have more forests per capita than most of the global population, it could be inferred that our demand for wood products should be satisfied mostly from within Missouri. However, **Missourians are currently consuming over twice as much wood as we are harvesting**. Thus, we are importing forest products and exporting the positive and negative impacts of harvesting (Shifley 2007).

Figure 6.2 Growth, Removals and Consumption of Forest Products/Year: 2004-2008

	Net Growth/Year[13]* (million ft³)	Removals/Year[13] (million ft³)	2005 Wood Consumption[14] (million ft³)
Missouri	536	199	411
United States	26,744	15,533	20,985

*Net growth = Total growth minus natural mortality.

In 2005, the U.S. annual wood consumption rate was approximately 71 cubic feet per person[14], far more than the global average of 21 cubic feet per person (based on 1995 figures, Gardner-Outlaw 1999). Because of increased paper recycling and increased processing efficiency, the U.S. consumption per capita in roundwood equivalent has actually decreased from 83 ft³ per capita in 1987[13]. However, despite this decrease in per capita consumption, **total consumption is expected to increase in the future due to projected increases in population and potential emerging markets for biofuels.**

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[13] Missouri data is from USDA Forest Service, Northern Research Station Forest Inventory and Analysis Program (annual averages for 2004-2008); United States data is from 2007 Resource Planning Act Report (includes 2006 data only)
[14]Data was calculated using U.S. Census Data; (Howard 2007); and calculations by Gus Raeker

Fortunately, **Missouri's forests are growing more volume than is being harvested**:

Net Annual Growth and Removals of Growing Stock on Timberlands in Missouri
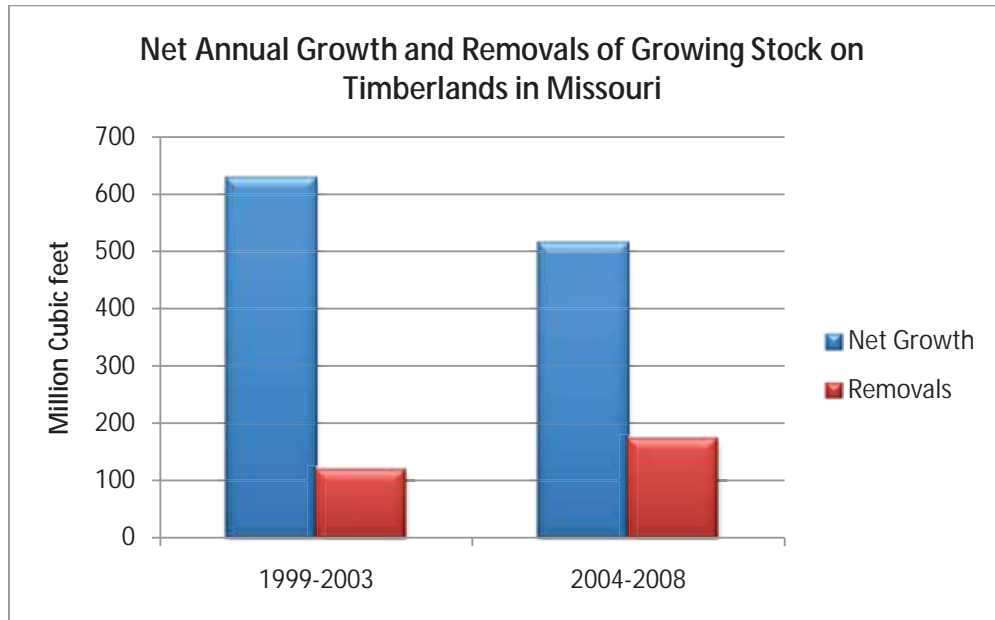
Figure 6.3 Net Annual Growth and Removals of Growing Stock on MO Timberlands
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Therefore, **Missouri's growing stock volume has steadily increased over the last 50 years**. This accumulated growth allows us to sustainably harvest considerably more volume of timber each year than what was possible fifty years ago and will help us meet various economic, social and biological needs now and into the future.

Growing Stock Volume on Timberland in Missouri
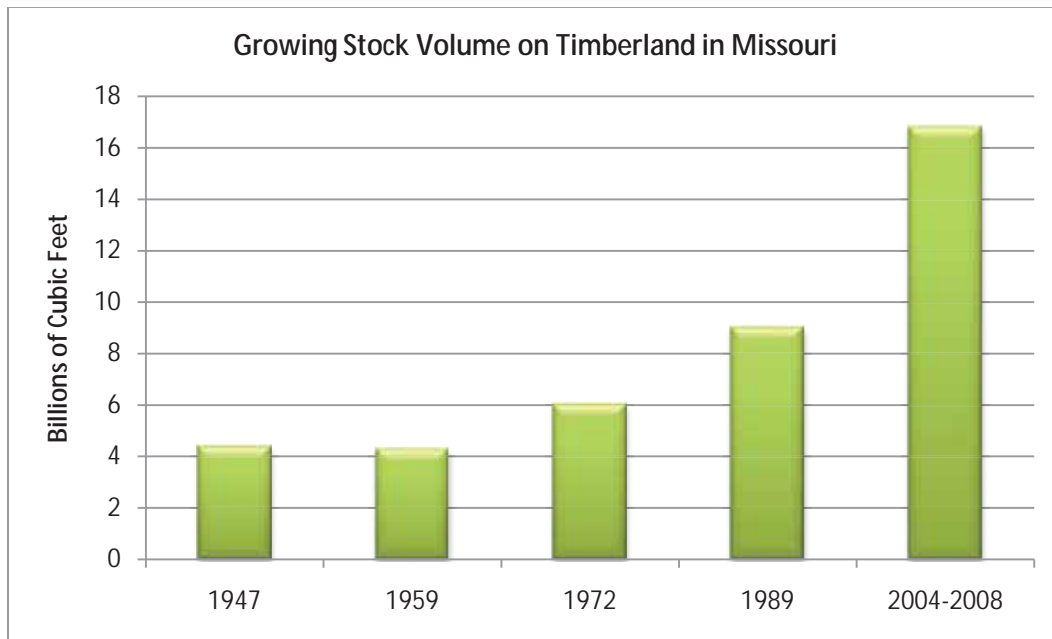
**Figure 6.4 Growing Stock Volume on Timberland in Missouri, 1947-2008**
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

While this increasing growing stock volume is certainly encouraging, we do need to keep a couple of things in mind. First, just because this added growth exists does not mean that it is all available for harvest:

- Some of this added growth takes place on forests which are inaccessible for harvesting due to steep slopes, road access, etc.
- Some of this growth takes place on forests in which harvesting is either not allowed, or not desired by the landowner. **The 2006 Woodland Owners Survey reveals that only 19 percent of family forest owners plan to harvest timber in the next 5 years. The same survey also states that only 19 percent of family forest owners consider production of sawlogs or other timber products to be an important reason for owning forestland**[15] (Butler 2008).
- Some of this growth is in trees which will never grow to a merchantable size.

Furthermore, although we have experienced some positive net volume growth in recent years, this trend could change in the near future:

- Anecdotally, we have recently seen large increases in red oak decline and mortality. Current and projected decline and mortality will likely have a significant impact on our net forest growth over the next 10 years.
- We continue to see a significant amount of "highgrade harvesting" across Missouri's forested landscapes. Highgrade harvesting involves removing the most valuable and productive trees, and leaving behind the least valuable and least productive trees. Since these are the trees which will dominate the future forest, Missouri's future productivity and average tree quality could decrease significantly as a result.

Finally, while the above statistics look at the statewide level, it is important to also look at harvest rates at smaller scales within the state. The following map shows that harvesting levels are much greater in some parts of the state than others. Thus, some locations in Missouri may suffer severe harvest pressure while other locations likely have an abundance of added net growth. Potential overharvest is especially of concern in the heart of the Missouri Ozarks in SE Missouri. If harvesting outpaces net growth for long, there may not be much of a resource left to work with in the future. Many communities in this area are highly dependent on the forest products industry and could suffer if there were a major decline in available growth for harvesting.

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[15] Data includes landowners who ranked production of forest products as very important (1) or important (2) on a seven point scale.
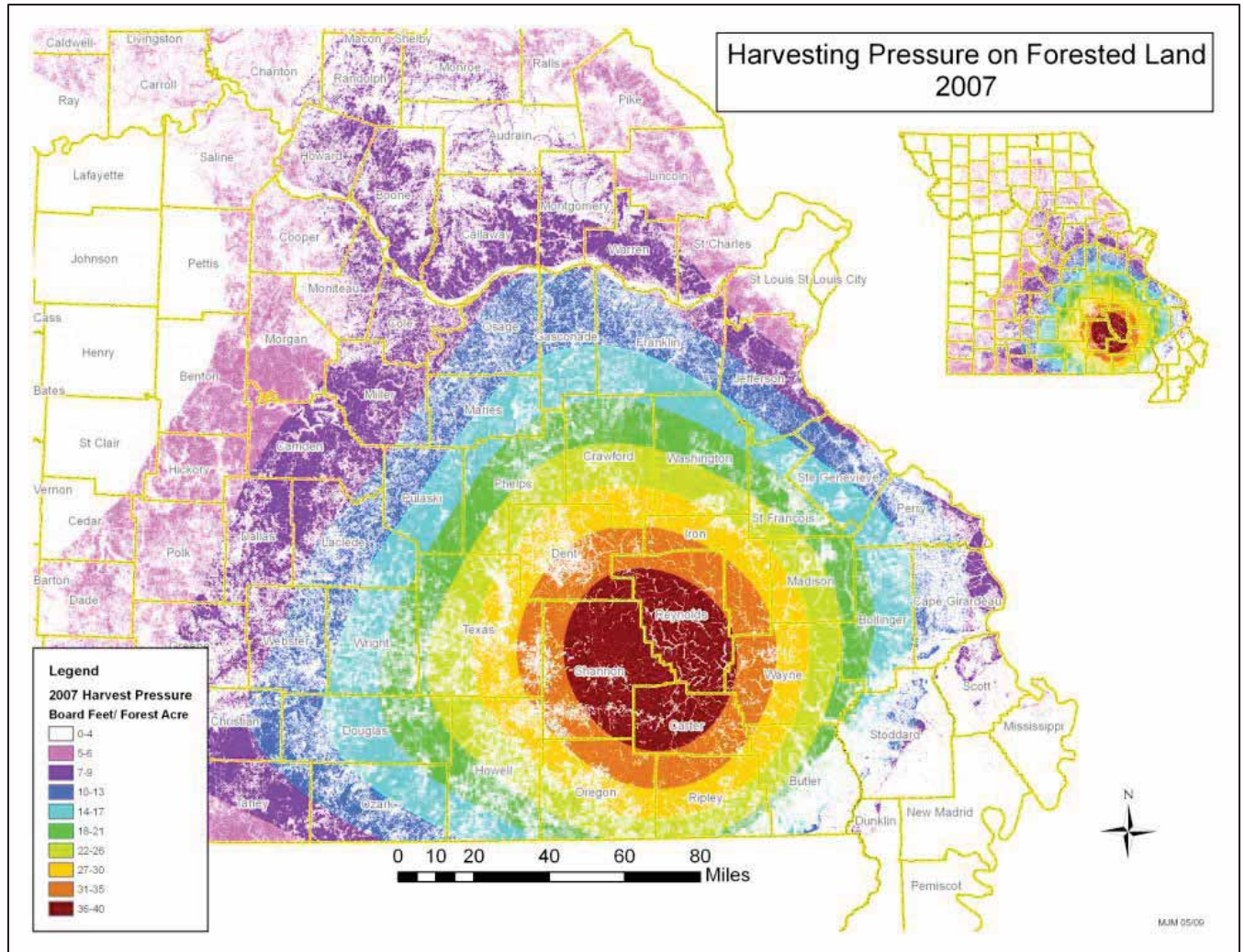
Figure 6.5 Harvest pressure on Missouri's Forested Land – 2007
(Source: Created by Mike Morris and Steve Westin of MDC using Timber Product Output Data)

The trends described in this section underscore the need for Missourians to think about our forest product needs, and how they will be met into the future. With the demands we place on our forests growing every day, we need to develop methods to ensure that our forest product needs will continue to be met. Some of these methods could include:
1. Wise use and recycling.
2. Increased forest growth through improved management.
3. Increased number of forested acres in production through tree planting, natural regeneration and agro-forestry.
4. Increase, through sustainable methods, the volume of wood being harvested.
5. Increased efficiency of converting wood into products.
6. Engineer products that extend the utility of a given amount of harvested timber. (Shifely 2007)

B: Maintaining Demand for Missouri's Forest Products

In Section A, we established that Missouri has enough volume of timber to support a productive and sustainable forest products industry. Equally important, however, is ensuring that our forest resource can provide the types of products that consumers demand. As with all other durable goods, people have needs and preferences for certain products over others. If the trees grown in Missouri's forests cannot satisfy public demands, then our forest products industry and the economic, social and biological benefits associated with it could suffer significantly.

One emerging example is the increasing demand for "green-certified" forest products. "Green-certified" forest products are tracked from the time they are harvested from the woods to the time they are placed on the store shelf to ensure that they have been harvested in a sustainable manner. With heightening interest and awareness in environmental issues, consumer demand for certified forest products has grown substantially and will likely continue to grow. Even if trees are harvested in a completely sustainable manner, they cannot qualify as certified unless the forest is enrolled in a certification program such as the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), or American Tree Farm System, and the logs have gone through a rigorous "chain of custody" tracking system. Missouri currently has a very small amount of certified forest lands or available chain of custody tracking infrastructure. In order to maintain market share in the future, Missouri's certified acres may need to increase substantially, as well as chain of custody tracking infrastructure. Forest certification programs could prove to be useful tools for promoting sustainable forest management.

Maintaining demand for Missouri's forest products will also require assurance that Missouri's forests can supply logs of desired species, size and quality. Proper management of forests to maximize per log size and quality, and preferred species composition will not only help maintain our current market share, but increase its value as well.

C: Potential Emerging Markets

In addition to Missouri's existing forest products markets, there is significant potential for new markets to develop. One key example is the potential development of new markets for woody biomass to generate electricity, combustion heat, bio-oil and cellulosic ethanol. This potential market could provide a great mechanism for cost effectively removing poor quality trees from crowded forests to improve health and productivity. Many of these trees currently have little or no economic value and minimal potential for future value. Fuel and energy derived from biomass is also sometimes viewed as "green" in that it is renewable and will replace fossil fuels that would otherwise be extracted from the ground.

It is very important that any new markets established in Missouri, biofuels or otherwise, do not elevate local and statewide harvest rates to unsustainable levels. Furthermore, it is important that forest management decisions consider the importance of other services provided by forests, such as wildlife habitat, and allow trees to grow to their highest value and best possible use.

D: Mortality Issues

Trees die from many other causes besides harvesting, even in healthy, well-managed forests. Common causes can include insects and diseases, severe weather events, excessive competition and age. As trees die from natural causes they quickly degrade to the point that they are unavailable for harvesting. Under ideal conditions, natural mortality is kept at a low but stable level which is small enough to avoid significantly impacting timber resources, but large enough to meet other forest needs such as snags for wildlife.

Unfortunately, we sometimes do not have much control over mortality in the short term. A prominent example is red oak decline. Red oak decline, which primarily effects scarlet oak, black oak and northern red oak, is caused by several factors including the maturity and density of these trees, red oak borers, armillaria root rot, periods of drought, and the fact that many of these trees are growing on droughty sites that historically were dominated by shortleaf pine. While it may be possible to improve the health and vigor of some of these trees, many of them are past the point of no return. The resulting spike in mortality and decline has and will continue to have a significant impact on the forest products industry.

As trees decline, they must be harvested quickly or else they will become too rotten or degraded for utilization. With a large influx of red oak decline-caused mortality, a lot of Missouri's red oaks need to be harvested in a short period of time if they are ever going to be utilized. However, as the harvest of red oak increases, supply outstrips demand and prices plummet. It becomes uneconomical to harvest such trees, so many of them will be left in the woods to eventually rot away and recycle back into the soil. These trees will still serve other useful purposes such as for wildlife habitat. However, because of red oak decline, a considerable volume of growing stock will no longer be available in the future.

Although we cannot stop mortality, there are things we can to do to keep our woods as healthy and resilient as possible in order to minimize future large scale die-offs. Some examples include:
- Maintaining a high diversity of tree species. Many insects and diseases are species specific. By maintaining greater diversity in both the trees in the overstory as well as the understory vegetation, our woods will not be totally devastated if one species is heavily impacted by a forest health problem.
- Maintaining appropriate stocking. Crowded forests are much more vulnerable to decline and mortality. Every acre only has so much water, nutrients, sun and space. Trees in crowded stands vigorously compete with each other and have less energy available to fight off insect and disease issues, etc.
- As forests are harvested and new forests emerge, it is important that methods are used to ensure that tree species which inhabit the new forest are desirable and well-suited to the site. For a variety of reasons, this process does not always happen on its own. A common example includes oak dominated forests which have developed understories of sugar maple due to the elimination of wildfire. As overstory oaks are harvested in such forests, the remaining sugar maple trees quickly gain dominance unless management practices are used to avoid this conversion. While

sugar maples are attractive in the fall, they rarely produce quality forest products on Missouri soils and have much less wildlife value compared to oak forests which traditionally dominated these sites.

E: Sustainable vs. Unsustainable Forest Management Practices

Management decisions made for a particular forest can have a profound impact on its health, long term productivity and the benefits that forest will provide for years to come. If management decisions and actions are well informed and planned, they can improve the health and value of a forest significantly. However, poor management decisions can have equally negative impacts.

Management decisions that promote healthy, productive and sustainable forests typically…
- …utilize the guidance and expertise of a professionally educated forester.
- …are based on long-term goals and values.
- …consider many variables such as wildlife habitat, water quality and recreation.
- …incorporate Best Management Practices and other investments which will increase long term values derived from forests.
- …use trained loggers that have proven to do low-impact harvesting.

One prominent example of an <u>unsustainable</u> forest management practice mentioned earlier is "highgrade" harvesting. Highgrading involves harvesting only the most valuable trees, and leaving behind trees which are generally stunted, of poor health, quality and/or genetics, and are often of undesirable species. These remaining trees have very low potential to improve the economic or ecological value of the forest. However, since they are the only trees remaining, they will dominate the future forest. Thus, long-term productivity and ecosystem service benefits can be severely compromised.

Sustainable forestry practices are not always the most profitable in the short term compared to less sustainable practices. However, working with a resource that can take 80 or more years to reach economic maturity requires long-term planning. This planning effort can help landowners maximize long-term profitability, wildlife habitat, and the myriad of other benefits derived from forests.

F: Establishing Trust among Landowners, Foresters, Loggers and Mill Owners

One issue that significantly influences the process of buying and selling timber is trust or the lack thereof. Landowners, foresters, loggers, mill owners and consumers are often worried that they are getting taken advantage of by someone else. In most situations, this lack of trust is completely unwarranted. In fact, the whole issue of trust is somewhat ironic considering that the forest products industry built itself - quite successfully - on a series of handshakes. However, reassuring all partners of the integrity of a transaction is essential to improving the viability of the forest products industry. Forest certification, master logger certification and establishing a chain of custody are a few promising tools that could add transparency to the harvesting process and help establish this trust.

Issue Seven: Forest Health Threats - Plants, Animals, Diseases and Weather

In a nutshell: Missouri's forest resources are vulnerable to a number of current and potential forest health stressors. Exotic and invasive plants (i.e. honeysuckle, garlic mustard, ironwood), insects and diseases (i.e. emerald ash borer, gypsy moth, thousand cankers disease), large animals (i.e. feral hogs, livestock, overpopulated deer), and extreme weather events are posing increasingly detrimental impacts to our forests. Proactive measures are needed in order to avoid preventable forest health issues and minimize harm from health stressors that arise.

Desired Future Conditions:
1. MO's forests are able to sustainably provide important ecosystem services.
2. MO's forests remain well balanced in type, species composition, age and size distribution.
3. MO's forests continue to provide valuable habitat to the plants and animals which depend on them.
4. Forest management options are not compromised by exotic/invasive plants, animals and diseases.
5. The geographical extent and potential future threat of various exotic and invasive plants, animals and diseases are well understood.
6. Methods for most effectively and efficiently preventing and dealing with exotic/invasive plants, animals and diseases are well known and practiced.

A. Exotic Invasive Plants

Numerous exotic invasive plant species are becoming a nuisance to the extent that they crowd out native plants, impede tree regeneration, reduce forest management options, degrade forest health and wildlife habitat quality, and minimize recreational opportunities. Of Missouri's more than 800 non-native plant species, some 37 have become a nuisance to the extent that they crowd out native flora and impede tree regeneration[16]. Some of the worst culprits include bush honeysuckle, garlic mustard, Japanese honeysuckle, Japanese stiltgrass, autumn olive, wintercreeper, and multiflora rose.

Better data are needed to help quantify the extent of these infestations. Certain areas are especially prone to exotic plant infestations. Urban habitats often have extensive populations of exotic plants, and infestations are common in Wildland Urban Interface areas as well. Exotic plant infestations are more variable in rural landscapes (Figure 7.1). Additionally, areas closer to forest edge are often more vulnerable to exotic plant infestations (Figure 7.2). These areas are typically subjected to more exposure to people, livestock, or various disturbances which can encourage exotic plant species.

Controlling exotic plants ranges from simple to nearly impossible, cheap to cost prohibitive, and beneficial to a waste of time. Strategies should account for these scenarios to ensure maximum benefit from limited resources.   Additionally, continued research is needed to determine the most cost effective and successful methods for controlling exotics.
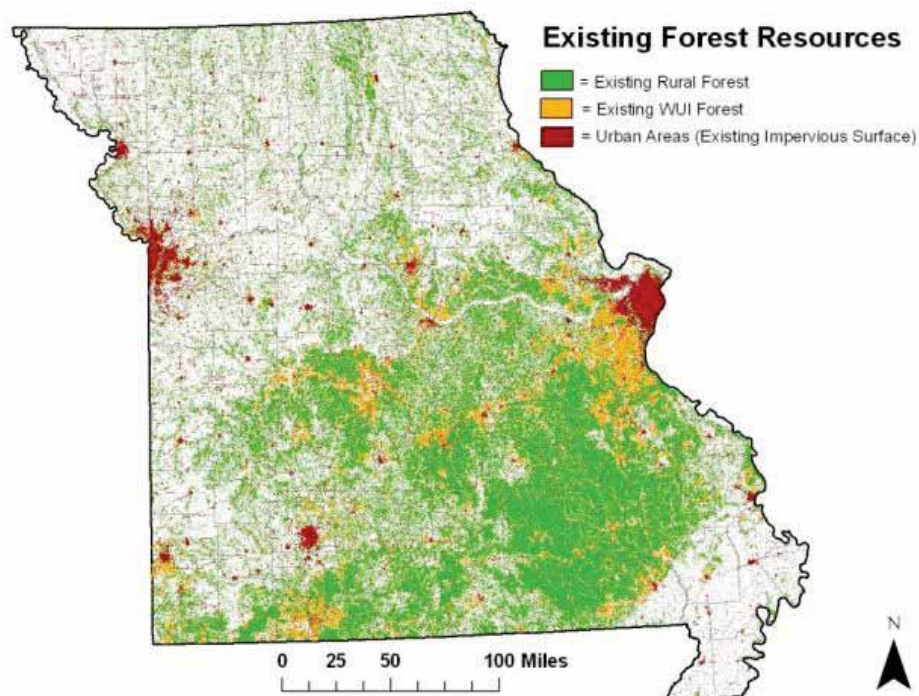
Figure 7.1 Map of Existing Forest Resources[17]

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[16] Information provided by Paul Nelson, Ecology and Land Management Planner with the Mark Twain National Forest.

[17] Map generated by MDC using 2001 National Land Cover Data and (Radeloff 2005).
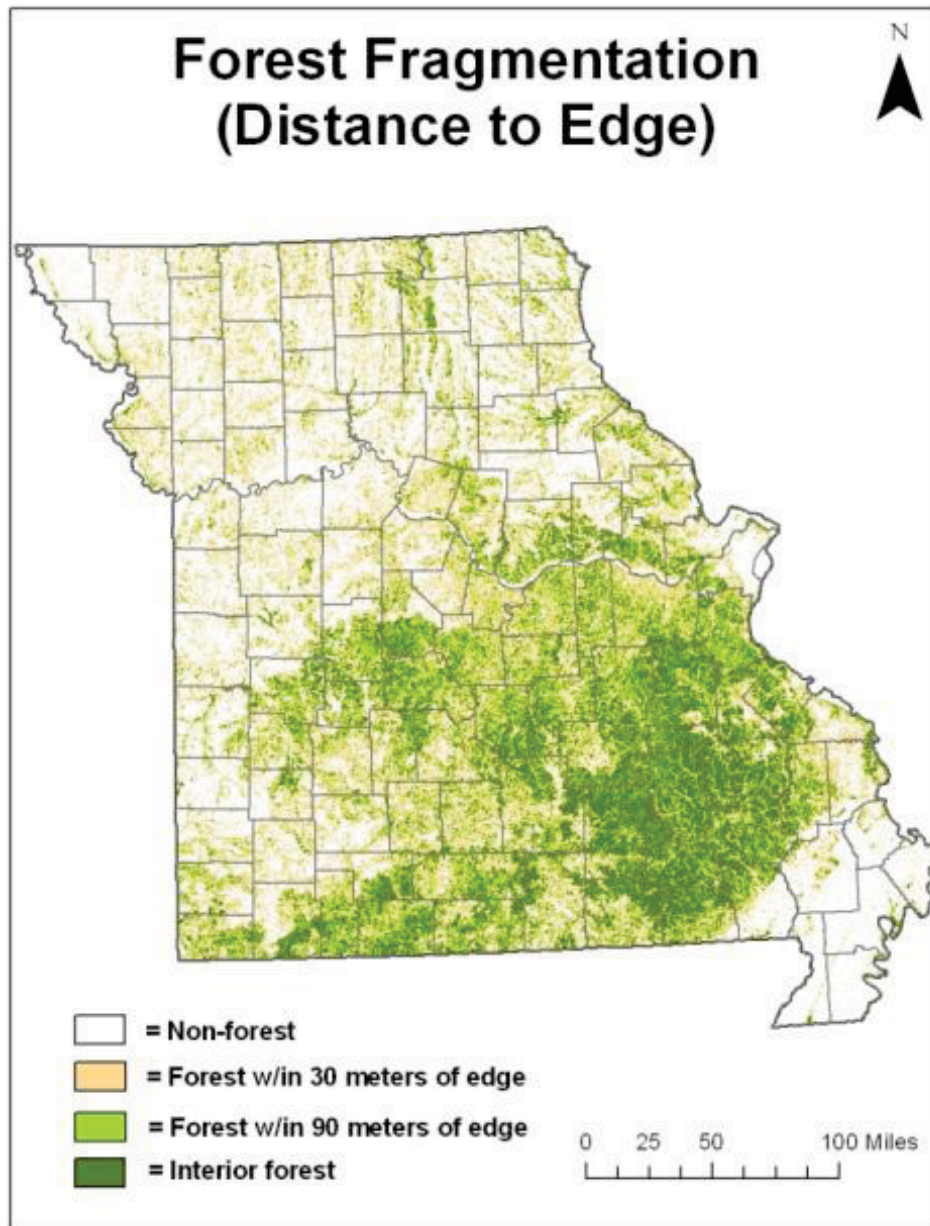
Figure 7.2 Map of Forest Fragmentation
(Source: Riemann 2007)

B. Native Invasive Plants

Plants don't have to be exotic to be invasive. Due to changing land use patterns, we are having similar problems with many native species such as red and sugar maple, ironwood and eastern redcedar, as discussed in Issue Theme Five. In the absence of fire and other historic disturbances that kept them suppressed, these native invasive species can overwhelm plant communities which have traditionally dominated the landscape. Native invasive plants often follow different distribution patterns than exotics, and tend to be most prevalent in areas in which fire has been excluded for a longer period of time.

C. Insects and Disease

Missouri trees and forests face a large number of insect and disease pests. Damage from these pests can range from cosmetic inconvenience to widespread destruction of entire forest communities, and everything in between. Sometimes these pests act independently, and sometimes they work in concert with a complex of other forest health stressors. Some of our most prominent insect and disease threats are exotic species which have not yet developed many natural predators to keep their numbers in check (i.e. emerald ash borer, gypsy moth, Asian longhorn beetle). However, native insects and diseases can cause major damage as well, especially when paired with other stressors such as drought or site disturbance (i.e. red oak borer, oak wilt).

Prevention, detection, and suppression strategies are different for each insect and disease. However, it is always a good idea to:
- Maintain high diversity of tree species.
- Plant species that are well suited to the site.
- Maintain overall tree/forest health (i.e. proper spacing).
- Stay on the lookout for new insect and disease outbreaks.
- Avoid transporting insects and diseases (i.e. don't move firewood).

There are far too many forest insects and diseases to mention in any detail. Instead, three prominent case studies are described.

Case Study One: Red Oak Decline and Shortleaf Pine Restoration Opportunities

In Missouri's rural and Wildland Urban Interface forests, perhaps the biggest "insect and disease" threat currently impacting our forests is red oak decline. We are witnessing wide scale decline and mortality of red oak group trees (red, black, scarlet, etc.) due to a complex combination of factors such as the age of the trees, red oak borers, armillaria root rot, drought, and trees growing on sites better suited to shortleaf pine. Missouri contains a large amount of red oak group trees, and therefore red oak decline is expected to have a significant impact on Missouri forests in the coming years.
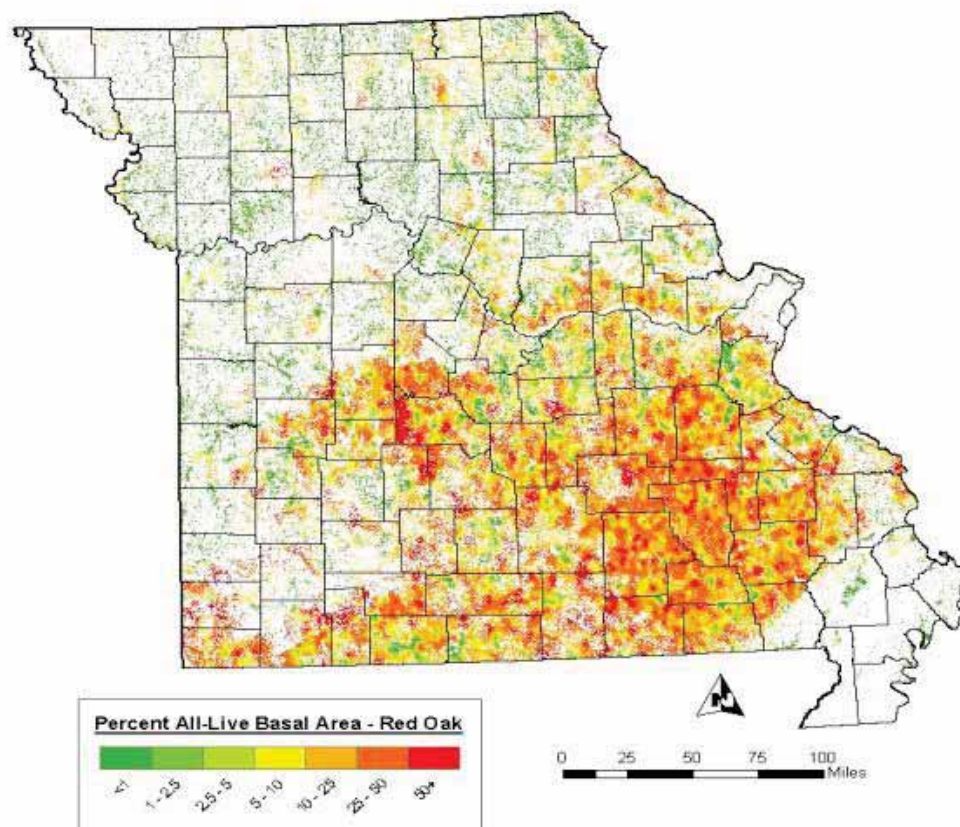
Figure 7.3 Percent of Total Basal Area in Red Oak Species Susceptible to Oak Decline, **1999-2003**

(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Figure 7.4 shows that Missouri's total volume of red oak is actually increasing. However, figure 7.5 shows that the total number of red oak group trees is diminishing, as is the number of smaller diameter red oak group trees. This tells us a couple of things. First, the increased volume growth is concentrated in larger diameter trees which are becoming increasingly vulnerable to red oak decline. Therefore, the impacts of red oak decline are likely to accelerate considerably in the coming years. Second, as red oak mortality in large trees increases, there will be fewer small new red oaks to take their place. While red oaks are beneficial trees, some shift in species may not be all that bad...
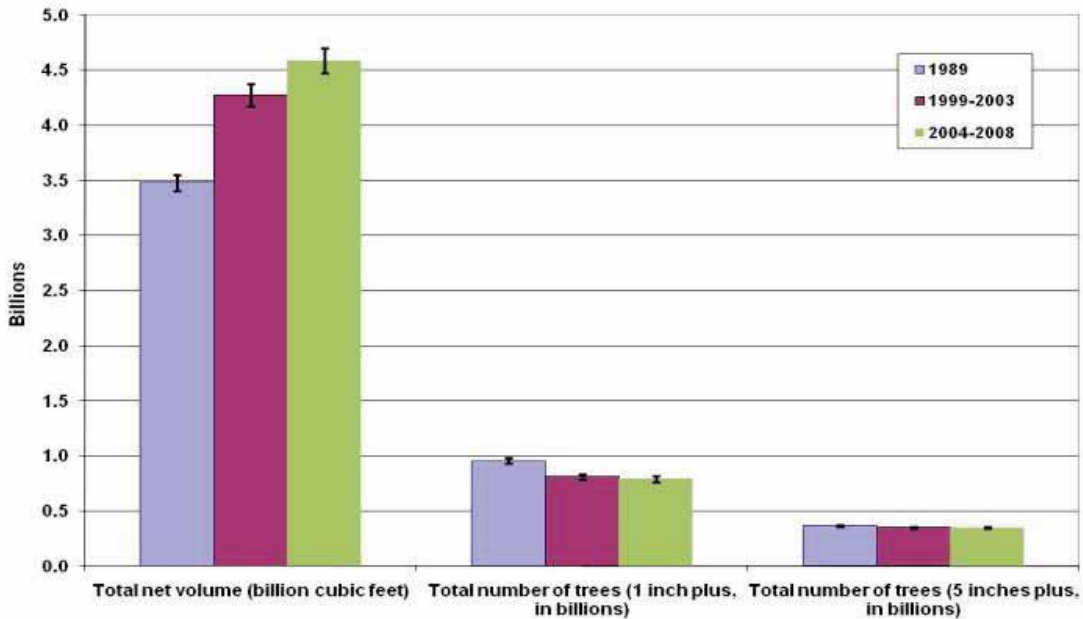
Figure 7.4. All-live volume of major upland oak species considered susceptible to oak decline (scarlet oak, southern red oak, northern red oak, black oak) and total number of trees 1 inch and larger and 5 inches and larger on timberland in Missouri, 1989, 1999-2003, and 2004-2008.

(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)
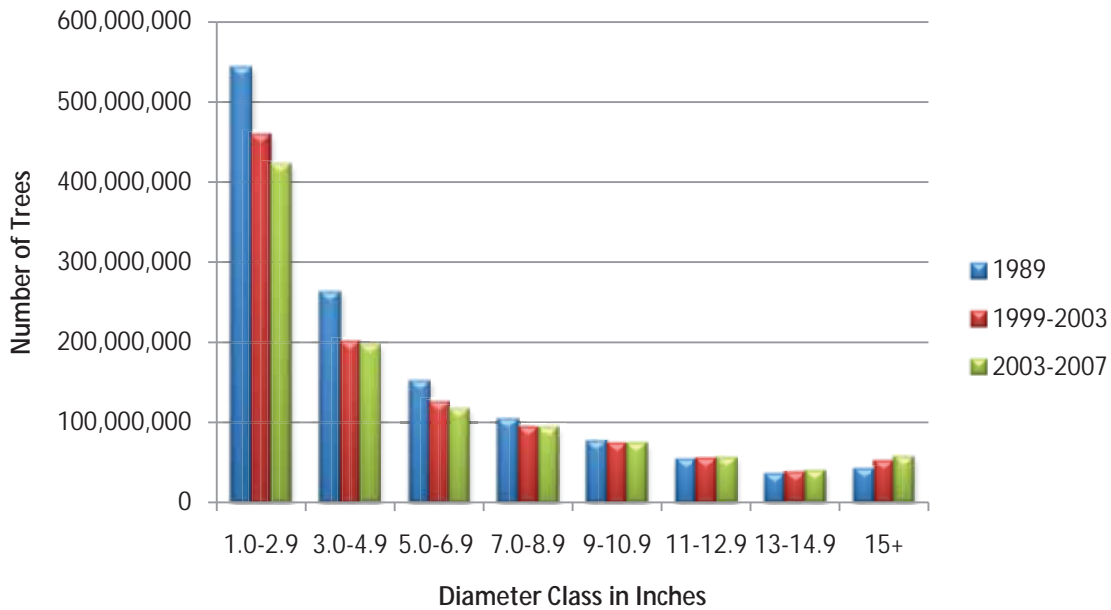
Figure 7.5 Number of Red Oak Group Trees by Diameter Class - 1989, 1999-2003, and 2003-2007

(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Red oak decline is happening throughout the state, but the hardest hit areas are typically sites which were historically dominated by shortleaf pine (prior to being cutover, grazed and burned repeatedly in the late 1800's/early 1900's). Of the 6 million acres of shortleaf pine Missouri once contained, only 1.5 million acres exist today. The red oak group trees currently found on these sites generally became established because they were better able to tolerate the harsh land management practices that took place at the turn of the century rather than because they were best suited to the site.

As these red oak trees die, a great opportunity presents itself to restore shortleaf pine back onto some of these sites. Restoring pine on these sites is not easy. It requires a combination of management practices such as tree thinning, tree planting, and prescribed fire. However, these efforts have many rewards. Natural communities are restored to their historic conditions, which could benefit many wildlife species that depend on them (i.e. pine warbler, brown-headed nuthatch, and possibly the recovery of the red-cockaded woodpecker once found in Missouri). Also, restoring shortleaf pine will help increase tree species diversity. Therefore, if some disease comes through and wipes out a lot of oak, our woods will still contain a lot of healthy trees. Finally, according to the USFS Climate Change Tree Atlas, while the projected future habitat suitability for many oak species is expected to decline due to climate change, the suitability for shortleaf pine is expected to increase. Therefore, restoring shortleaf pine to the landscape could help make our woodlands more adaptable to potential changes in climate.

Shortleaf Pine Distribution in Missouri

■ Historic Distribution from General Land Office Records (1820-1850)
■ Current Distribution from MoRAP Land Cover 1992
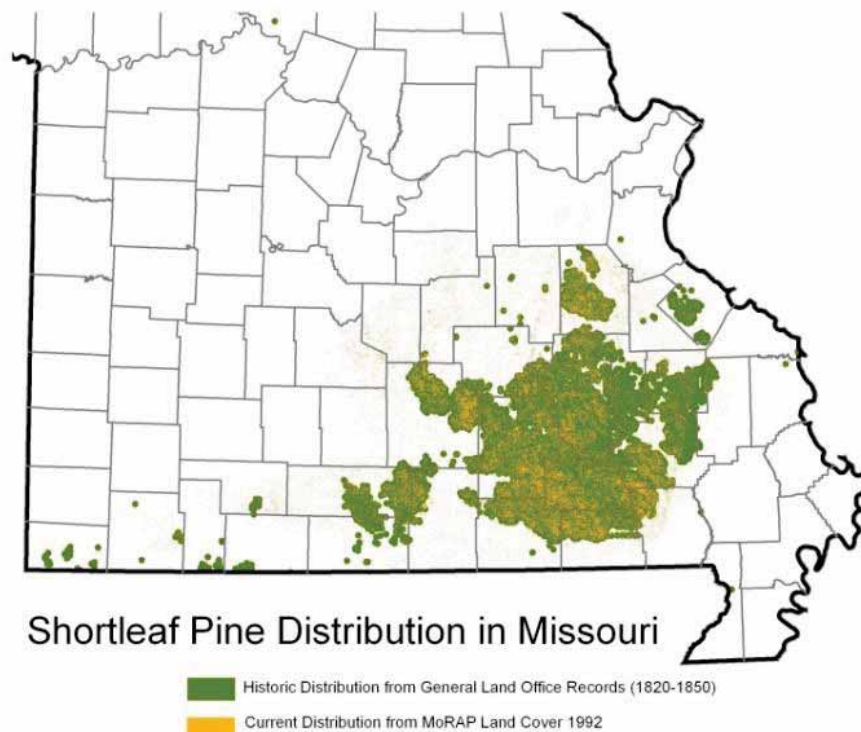
Figure 7.6 Current and Historic Distribution of Shortleaf Pine in Missouri[18]

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[18] Map generated using General Land Office Records (1820-1850) and Missouri Resource Assessment Partnership Land Cover Data - 1992

In fact, FIA data shows that some resurgence of shortleaf pine is already taking place. From 1989 to the present, there has been a significant increase in the net volume of shortleaf pine and total number of trees. The increase in number of trees is consistent throughout most tree diameter size classes, but includes a noticeably large jump in the number of 1-3" diameter trees. This could indicate that some of Missouri's shortleaf pine restoration efforts are starting to pay off.
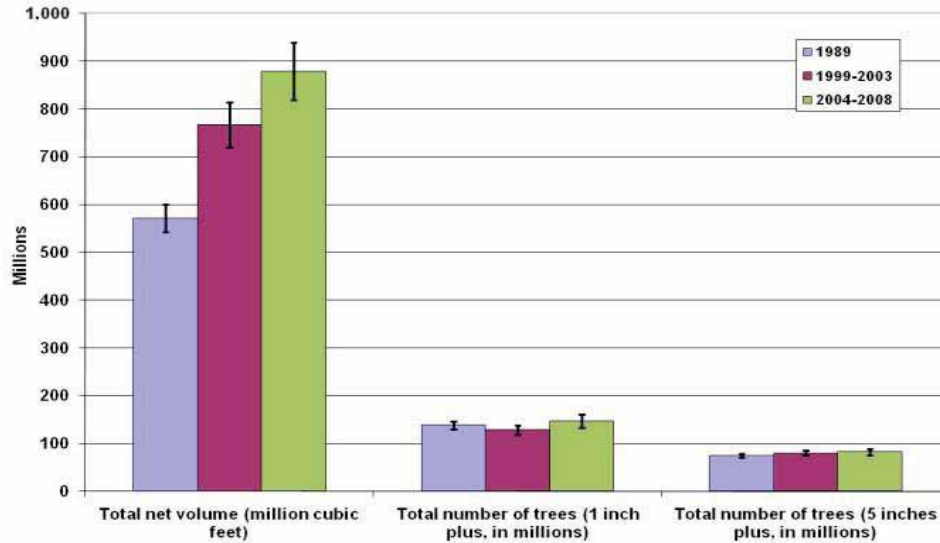
Figure 7.7 Total net all-live volume and total number of trees 1 inch and larger and 5 inches and larger of shortleaf pine in Missouri, 1989, 1999-2003, and 2004-2008.
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)
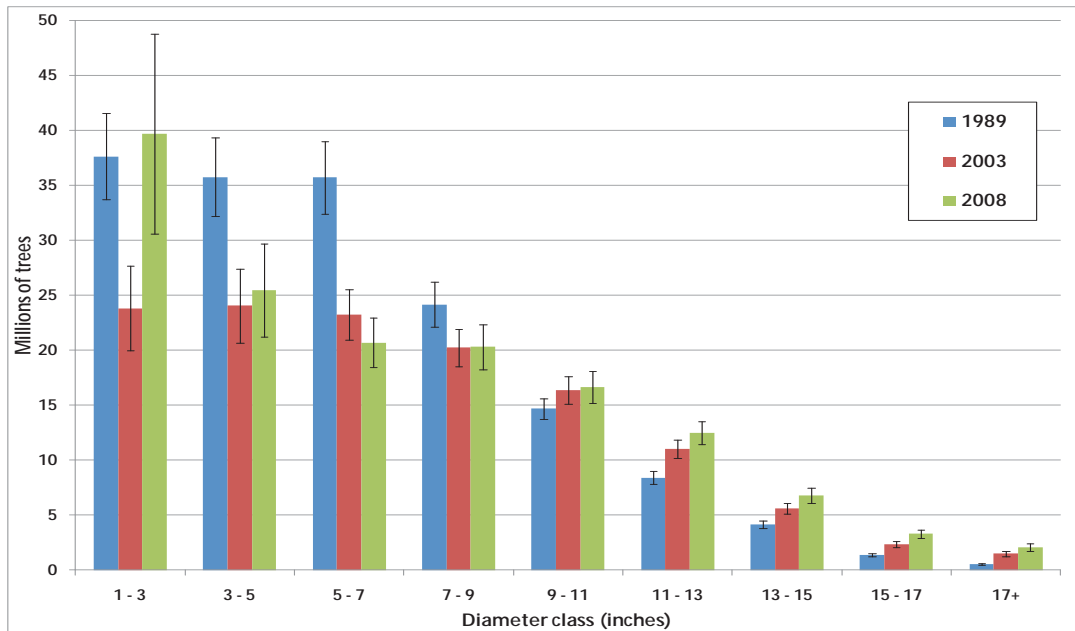
Figure 7.8 Diameter distribution of shortleaf pine trees in Missouri, 1989, 1999-2003, and 2004-2008.
(Source: USDA Forest Service, Northern Research Station – Forest Inventory and Analysis)

Case Study Two: Emerald Ash Borer

In 2008, Missouri's first (and hopefully only) outbreak of Emerald Ash Borer (EAB) was discovered in Wayne County of Southeastern Missouri. EAB is a small green exotic insect native to Russia, China, Japan and Korea. This pest was first discovered in SE Michigan in 2002. By March, 2010 it had been detected in all of the areas shown in red in figure 7.9. As the name implies, EAB is a boring insect which feeds exclusively on ash trees and has been 100% fatal to infected trees so far. All ash trees are believed to be vulnerable to EAB regardless of species, size or general health. As a result, there is wide concern that most if not all of Missouri's ash trees could be eliminated.

Roughly 3 percent of Missouri's forest trees are ash species. Although this loss would be significant, the greatest concern is the potential impacts of EAB in Missouri's urban areas. MDC surveys reveal that approximately 14% of Missouri's street trees and 21% of park trees are ash. The percentage rises to well above 30% in some parks and residential subdivisions.

Several Missouri partners are working aggressively to deter EAB or minimize its impacts. Eradication efforts are underway in Wayne County. Extensive monitoring is being done to see if EAB has spread to other parts of Missouri. Communication strategies are being implemented to keep the public on the lookout, to avoid inadvertently spreading the insect (e.g., transporting firewood), and to promote planting other species to minimize future impact. Only time will tell how successful these efforts will prove to be.
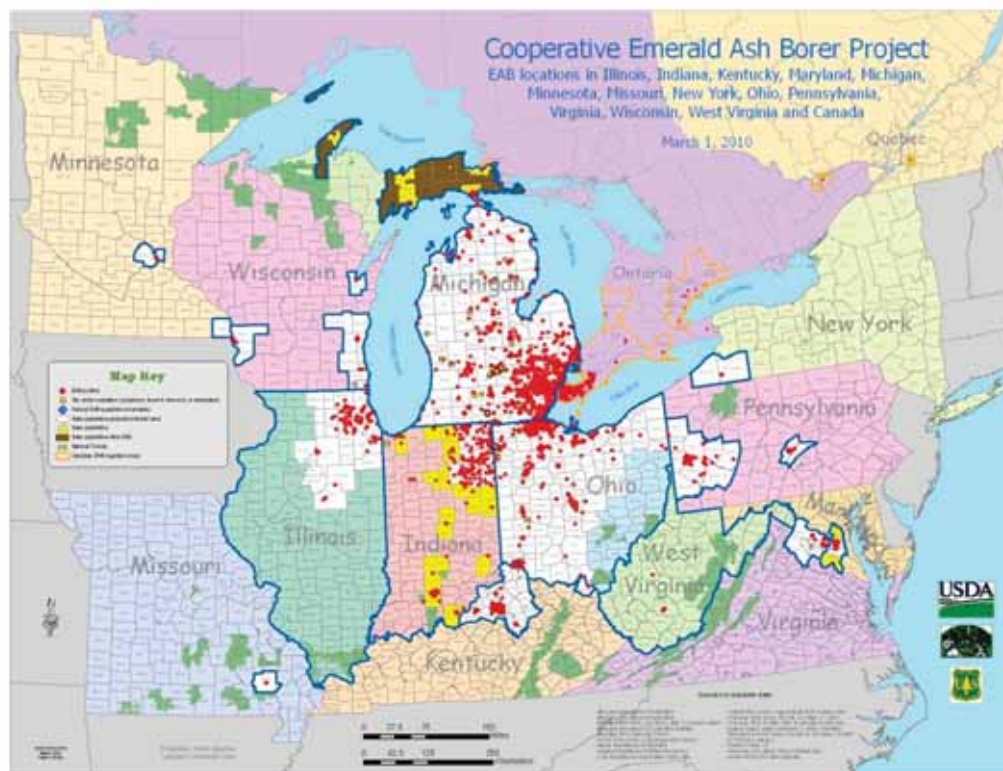
Figure 7.9 Map of Emerald Ash Borer Locations, October, 2009
(Source: USDA Animal and Plant Health Inspection Service)

Case Study Three: Gypsy Moth

The gypsy moth was introduced to the East Coast in 1869 and since then has been spreading slowly westward. When it arrives, the gypsy moth could be especially devastating to Missouri forests because one of its favorite foods is oak leaves. Mortality in our forests will likely be high due to the age of our forests and because most of our forests have a high percentage of oak species. The Departments of Conservation and Agriculture and numerous other state and federal agencies cooperate on a monitoring program to detect any introductions of gypsy moth. Each year, several moths are found that have been accidentally brought into Missouri from infested states. Spot infestations of gypsy moth were found in the 1990s in Dent County and in northern Arkansas near Branson. These infestations were controlled, delaying the introduction of gypsy moth into Missouri for the time being. Education programs are teaching citizens how to recognize the gypsy moth and instructing them to inspect their vehicles and belongings after visiting an infested state.

The following map shows the extent of gypsy moth in the northeast United States in 2006. The counties under quarantine generally have an established gypsy moth population.
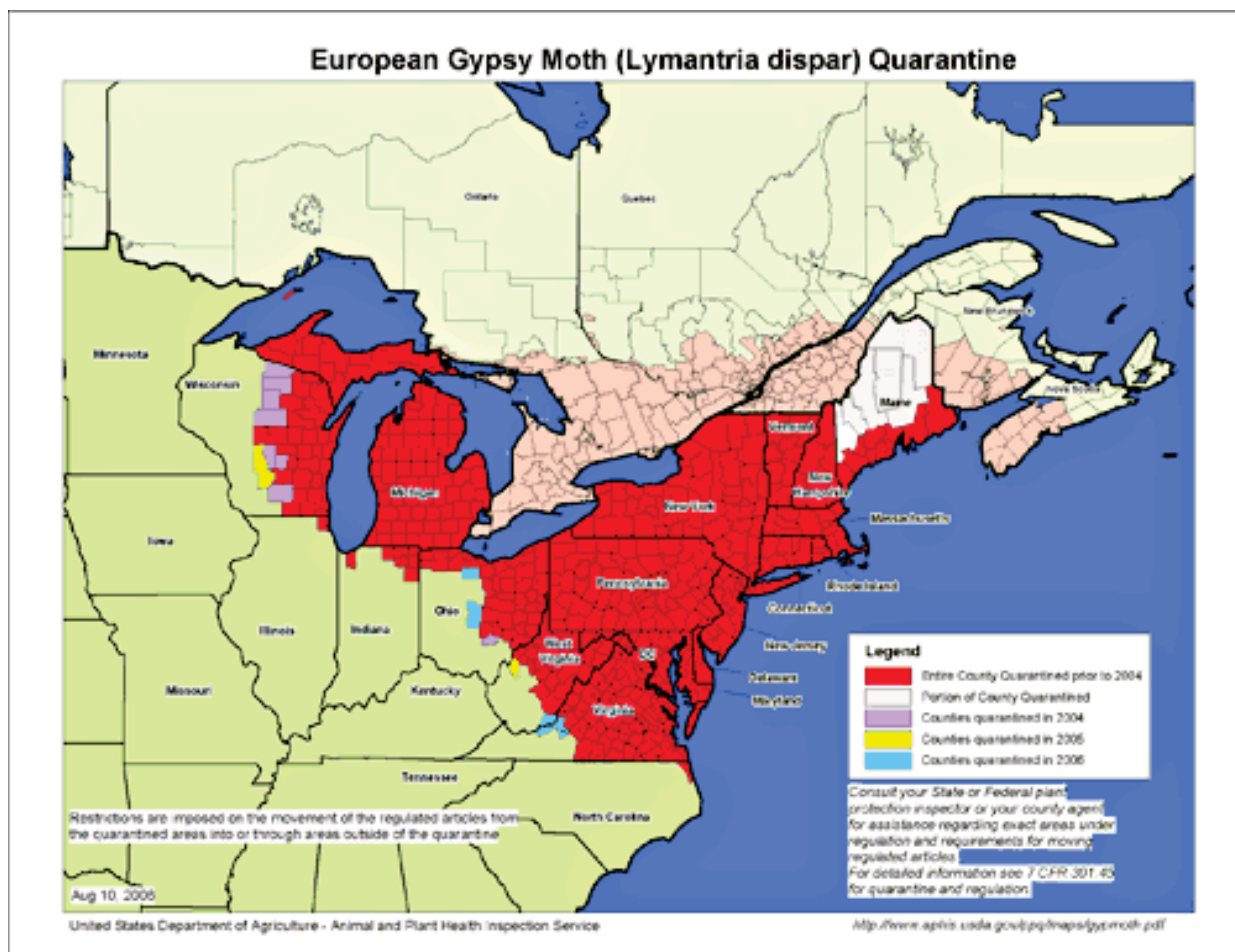
Figure 7.10 Map of Gypsy Moth Quarantine Area – August, 2006
(Source: USDA Animal and Plant Health Inspection Service)

D. Feral Hogs

Feral hogs may not be a huge threat to trees directly. However, they spend a lot of time in forests, are very destructive to many natural communities associated with forests (glades, fens, etc.), compete with wildlife for forage and acorns, and feed on many kinds of forest wildlife (i.e. ground nesting bird eggs, reptiles, amphibians). Extensive efforts are currently underway in Missouri to minimize the threat of feral hogs.
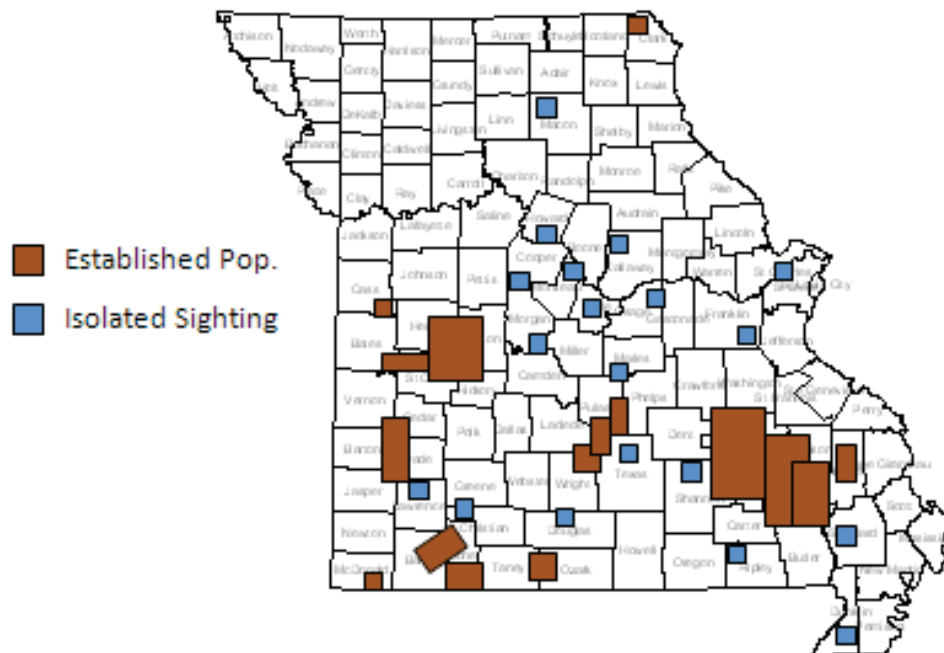
Figure 7.11 Map of Feral Hog Distribution – November 2008
(Source: Missouri Department of Conservation)

E. Grazing – Deer and Livestock

When European settlers established themselves in the Missouri Ozarks in the 1800's, they made free ranging livestock a common feature of the landscape. Livestock are not nearly as common in Missouri's forests as they once were, but still have access to a lot of forestland. Livestock get little gain from forests, and can actually be harmed from many forest plants and acorns. Livestock grazing can also be highly destructive to forests:
1. Livestock eat most vegetation they can reach, including tree regeneration, and herbaceous vegetation needed by wildlife for food and cover.
2. The vegetation livestock avoid is typically thorny, undesirable plants (honey locust, multiflora rose, gooseberry, cedar, etc.) which will eventually take over grazed forests.

3. Livestock trample tree roots which causes decay that eventually spreads into the main trunk of the tree.
4. Livestock compact forest soils, and often destroy creek banks.
5. Livestock sometimes eat exotic vegetation found in hay and pastures and then distribute seeds in the forest through their manure causing new infestations.

Similar affects described above for livestock can also be caused by high populations of white-tailed deer. This is most often seen in urban and wildland urban interface areas which still have suitable habitat for deer, but no longer have significant hunting pressure.

F. Weather Considerations

Obviously, the weather is not something we have a lot of direct control over. However, weather can have significant influence on forest health. In the last 5 years, Missouri has experienced incredible extremes in weather patterns and events. Three years of extreme drought were followed by two of the wettest years on record. Severe freezing rain events have caused widespread damage to trees and forests. Tornadoes, microbursts, and other wind events have wreaked havoc on several of our communities and our forests. In fact, on May 8, 2009, one single storm leveled 113,000 acres of forest in the Ozarks.

Although there is not much we can do to stop the weather, we spend a lot of time dealing with its aftermath. Strategies will need to be developed or continued to ensure that Missouri's forest resources are as resilient to weather events as possible, and that Missouri's agencies and people are well prepared and available to respond quickly to disasters when they occur.

Issue Theme Eight - The Role of Trees in Improving Quality of Life and Sustainability in Cities

In a nutshell: Urban and community trees and forests provide numerous social, economic and environmental benefits. They decrease stormwater runoff, improve air quality, reduce the heat island effect, provide wildlife habitat and aesthetics, decrease energy demands, and much more. Maintaining and enhancing urban forest resources will require better quantification of benefits, existing condition and maintenance needs so that local decision makers can more easily plan and justify investments in urban forest infrastructure.

Desired Future Conditions:
1. Healthy and sustainable urban/community trees and forests support desirable and environmentally healthy places of residence for Missouri citizens.
2. Urban and community trees and forests contribute significantly to minimizing stormwater runoff, improving air quality, reducing heat islands, reducing energy consumption, and more.
3. Trees and forests are recognized as an important component of city and community infrastructure needing to be maintained and adequately funded.

A. Planting, Protecting and Maintaining Urban Trees Doesn't Cost, it Saves...

Trees not only make cities cool, green and beautiful, they also perform a number of vital services that would otherwise cost cities money. Trees clean air by reducing carbon monoxide, ozone and other pollutants. They reduce stormwater runoff volumes and associated problems through filtration, interception and evapo-transpiration. They lower energy demands by shading buildings and cooling the air, and perform numerous other functions as well. Faced with the costs of engineering clean air, handling stormwater and cooling buildings, many cities are discovering that planting, protecting and maintaining trees is a real bargain.

The following study helps demonstrate this point. In 2004, the USDA Forest Service Northeastern Area and the Pacific Southwest Research Station collaborated on a research study with the Minneapolis Parks and Recreation Board to determine whether the accrued benefits of public trees in the Midwest justified their annual expenditures (McPherson 2005). The research study found that every tree planted in the right place and given the proper care provided $3 to $7 in annual benefits for every dollar invested in their care. This study figured that street trees in this large metropolitan area:

- *Saved citizens $6.8 million dollars in energy costs.*
- *Reduced 55,125 tons of carbon dioxide valued at $827,000.*
- *Removed 2 lbs. of air pollutants per tree.*
- *Intercepted an average of 1,685 gallons of stormwater per tree saving $9.1 million dollars in stormwater treatment city wide.*
- *Added $7.1 million dollars to aesthetics and property values.*

The same study concluded that:
- *Healthy public trees in their 20th year after planting provide an average annual net benefit (benefits minus costs) of $60/tree.*
- *One hundred healthy yard trees offer a 40-year net benefit of $272,000.*
- *One hundred healthy public trees offer a 40-year net benefit of $232,000.*

Other research shows that tree-filled neighborhoods have lower levels of domestic violence, and are safer and more sociable (Sullivan 1996), and that tree-lined commercial districts report more frequent shopping, longer shopping trips, a customer willingness to pay more for parking, and a customer willingness to spend 12% more for goods (Wolf 1999). Clearly trees benefit cities.

Just as streets, sidewalks and sewers are parts of a community's crucial infrastructure, so are publicly owned trees. And just like all other components of a community's infrastructure, urban and community trees require care and maintenance in order to function properly in the future.

B. Public Attitudes towards Urban and Community Forestry

A 2004 Missouri Department of Conservation (MDC) survey of randomly selected Missourians, "Urban Forestry in Missouri Communities: Attitudes and Knowledge of Missouri Citizens", showed that the following issues were important to them (Treiman 2005):

- Quality of natural resources
- Having trees lining streets and in parks
- Making sure fewer trees are lost during development
- Managing stormwater runoff
- Respondents also felt that Missouri communities weren't doing very well in addressing tree-loss during development and in managing stormwater runoff.
- Caring for new trees after planting, removing trees that might break and cause injury or property damage, and planting trees were identified as "important" activities in a community tree program.
- Missourians in communities with a population greater than 5,000 showed a marked concern for protecting or replacing trees during development through passage of a tree preservation ordinance.
- Residents in communities with a population of 50,000 or more, in the St. Louis and Kansas City suburbs and the cities of St. Louis and Kansas City show strong support for a ballot issue establishing a tree fund supported by a tax of $5.00 or less per household.

C. Missouri's Community Forests are Changing

Two urban tree inventories were conducted by MDC in 44 Missouri towns in 1989 and 1999. A comparison of results shows significant changes in Missouri's community forests. While some of these changes are positive, it is clear that Missouri's community tree infrastructure needs help:

- Communities have more street trees. In 1989, there were 46.2 trees per mile, and in 1999 there were 62.9 trees per mile.
- However, average tree condition declined. In 1989, 66 percent of community trees were good or excellent vs. 1999 when only 24 percent were good or excellent. This underscores the need to maintain trees throughout their life and then remove them when they become a hazard.
- Missouri's community forests are becoming more diverse.   The top six tree species constituted 37 percent of those trees surveyed in 1999, as compared to 48 percent found in 1989. Utilizing a good diversity of tree species is important for reducing the vulnerability of an urban forest to serious insect and disease threats which target specific tree species such as Emerald Ash Borer.

Most common species found in 1989 and 1999 survey (percent of total trees inventoried in that survey year)

Species	1999	1989
Silver maple (*Acer saccharinum*)	10.5%	13.4%
Pin Oak (*Quercus palustris*)	6.1%	6.0%
Green Ash (*Fraxinus pennsylvanica*)	5.9%	5.5%
Sugar maple (*Acer saccharum*)	5.9%	10.0%
Siberian elm (*Ulmus pumila*)	4.6%	8.5%
Sweetgum (*Liquidambar styraciflua*)	4.2%	4.7%
Total % of trees in the top 6 species:	37.2%	48.0%

- The average value of a Missouri street tree increased $642, based on the Council of Tree and Landscape Appraisers' formula.
- In 1999, 12 percent of all urban trees were "topped," making them vulnerable to pests and diseases and shortening their life span. Topping allows decay to flourish resulting in a tree that is structurally weak and prone to storm damage. Topping results in trees that are a community hazard. Despite extensive efforts of the Missouri Community Forestry Council to put an end to this practice, tree topping continues to be a major urban forestry problem today.

D. The Status of Community Forestry Programs

A 2002 MDC survey of community public officials, "Community Forestry in Missouri: Attitudes and Knowledge of Local Officials" (Treiman 2004), showed that:

- Most communities budget no dollars for tree care. They manage their community trees by responding to crises, such as ice storm damage or trees down across a road.
- Most communities do not have a full-time person employed to care for trees and are unlikely to have even one person who deals with trees occasionally.
- Most communities do not employ anyone with a degree in forestry, horticulture or related subject.
- Most communities do not have a public tree ordinance or a written community-forest management plan.

In other words, most communities take a very passive approach to community tree management, generally responding only to emergencies. In order for urban and community trees and forests to provide maximum economic, social and environmental benefits which will be sustained into the future, this infrastructure must be managed proactively.

E. Benchmarks For Measuring Success

While there remains much work to be done to develop proactive urban forestry programs in Missouri communities, it does appear that some progress is being made. The number of communities certified in the Tree City USA Program has grown from 66 in 2003 to 80 in 2009. Collectively, 43% of Missouri's population resides within these 80 communities.

The *Tree City USA* program is sponsored by The National Arbor Day Foundation in cooperation with the USDA Forest Service and the National Association of State Foresters. It provides direction, technical assistance, public attention and national recognition for community forestry programs. To qualify as a *Tree City USA*, a community must meet four standards:

1. Designate by ordinance a tree board or forestry department to be legally responsible for care of public trees.
2. Adopt a tree-care ordinance that determines public tree care policies for planting, maintenance and removals. The ordinance also designates the board or department responsible for writing and implementing an annual community-forestry work plan.
3. Show an annual expense of at least $2 per capita for tree management.
4. Hold an Arbor Day event, complete with an Arbor Day proclamation.

These four standards set the framework for a sustained community forestry program that proactively manages its tree infrastructure.
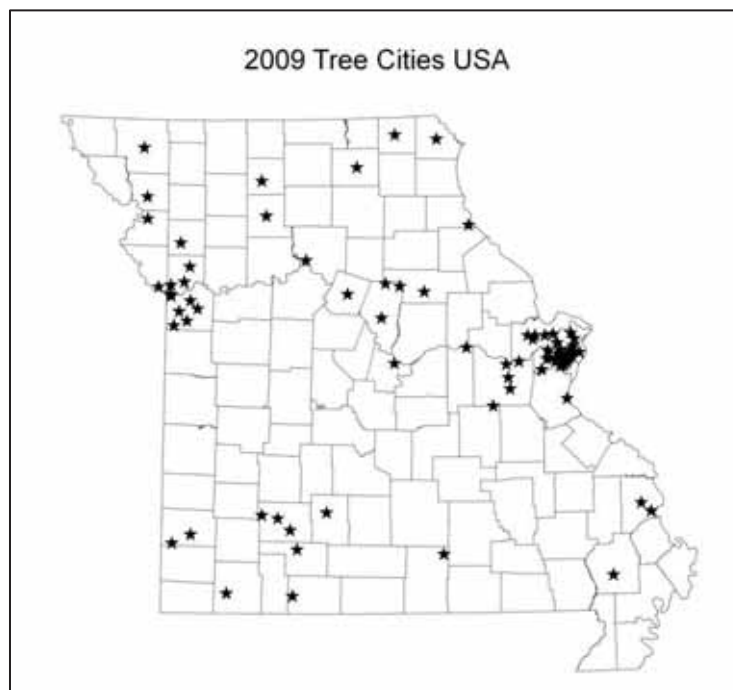

Figure 8.1 Location of Tree City USA Communities – 2009
(Source: Missouri Department of Conservation)

The U.S. Forest Service uses a similar, but different benchmark system for categorizing communities based on the following performance items:

1. Community has a **tree ordinance and/or policies** which are codified and followed. The intent is that the ordinance and/or policies guide the community in the proper care, establishment and protection of community trees and forests.
2. Community uses **professional staff** that has education, training and experience in the fields of urban forestry, arboriculture and/or horticulture. Profession staff is defined as someone with a degree in urban forestry or a closely related field (e.g., forestry, horticulture, arboriculture, etc.) and/or an International Society of Arboriculture Certified Arborist or equivalent professional certification.
3. Community has a **current tree inventory or management plan** which outlines the future management of the community's trees and forest.
4. Community has an **advocacy or advisor organization** which ensures that community residents and program stakeholders are informed, educated, and engaged in the development and implementation of a sound community forestry program at the local level.

In federal Fiscal Year 2009, 63 Missouri communities were meeting all four elements and were considered to be "Managing" their urban forest resources. 131 communities were meeting one to three elements and were considered to be "Developing" their urban forestry program. 272 communities did not meet any of these criteria (includes only communities with at least 1,000 residents).

Finally the impact of the utility industry on the urban forest cannot be overlooked. Interest and growth in the *Tree Line USA* program has been slow and steady in Missouri with 10 companies certified in 2009. *Tree Line USA* is sponsored by The National Arbor Day Foundation in cooperation with the National Association of State Foresters. It provides direction, public attention and national recognition to utility providers who strive to meet the dual goals of dependable utility service and abundant, healthy trees along our streets and highways. To qualify for *Tree Line USA* certification, a utility provider must meet three standards:

1. Provide quality tree care by formally adopting work practices that are incompliance with American National Standards Institute (ANSI) A300 Standards for Woody Plant Maintenance.
2. Annually train workers to ensure that the work undertaken is carried out in accordance with ANSI A300.
3. Have a tree planting and public education program

F. Proper Tree Care Practices

Urban trees need to be properly planned and maintained from the time they are planted until the time that they are removed. There are many "tricks of the trade" that will largely determine whether a tree will prosper or not. This includes such items as:

- Choosing the "Right Tree for the Right Place".
- Utilizing proper techniques for planting, mulching, watering and pruning.
- Knowing how to diagnose tree insect and disease problems and remedies.
- Knowing how to identify hazard trees and limbs, and when to remove a tree.

Unfortunately, many people do not have this knowledge and do not utilize the services of someone trained in tree care. As a result many trees die prematurely or otherwise do not live up to their potential. Some common mistakes include planting a large growing species in a small space (e.g. under overhead power-lines or in a narrow strip between street and sidewalk.), planting a shade loving species out in the sun, tree topping and burying the trunk in mulch. Improving the health, sustainability and benefits of urban forests will require improving communication and utilization of proper tree care practices with municipalities, tree care companies, utility companies and homeowners. Public, private and non-profit foresters and arborists are available to provide this guidance and services.

G. Partnerships

Empowering communities to sustainably manage their tree infrastructure is a task that can best be achieved in partnership with others. Success is only possible through the effective use of collaborative and synergistic partnerships - working with statewide organizations (i.e. Missouri Community Forestry Council), local partnerships, not-for-profit organizations (ie. Forest ReLeaf of Missouri and Bridging the Gap) and Missouri citizens.

The Missouri citizenry in particular is a powerful force that is underutilized in urban areas. A few communities have discovered this hidden power and are using it to enhance their efforts, as is revealed in Figure 8.2. For example, the City of Columbia supports a citizen tree education program called the Columbia TreeKeepers. In calendar year 2009 this volunteer workforce donated 1,403 hours. It is hoped that other communities will tap into this powerful resources to assure a healthy and sustainably managed urban forest resource in their community.
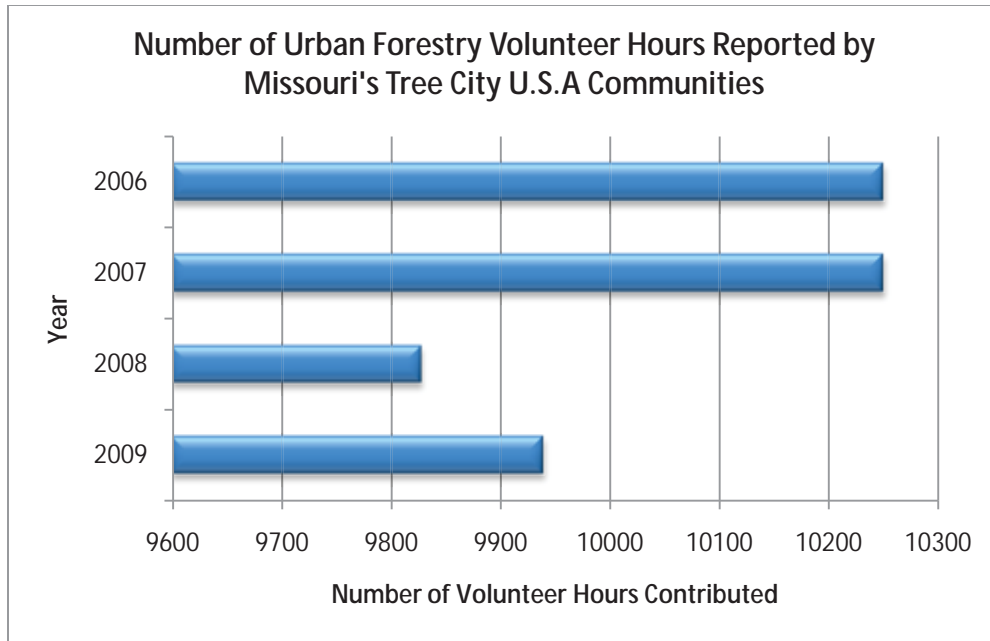
Figure 8.2 Number of Urban Forestry Volunteer Hours Reported by Missouri's Tree City U.SA Communities.
(Source: Missouri Department of Conservation)

Issue Nine: Public Lands which are Managed for the Greatest Public Good

In a nutshell: Public lands and other protected lands are important assets which are highly valued by society. Beyond the normal benefits and services provided by forests, public forest lands are especially important because they are typically managed under agency mandates for sustainability and conservation, and are generally protected from conversion to other uses such as urban development. Furthermore, due to size, location and management objectives, public forests offer many of Missouri's best opportunities to maintain biodiversity and provide high-quality recreational opportunities. Sustaining the benefits of public forest land will require maintaining sufficient funding for management, and carefully balancing the demands of a diverse public and the needs of a healthy forest resource.

Desired Future Conditions:
1. Public lands are inviting, and provide numerous benefits and services.
2. Public lands provide convenient and desirable opportunities to enjoy Missouri's forests.
3. Citizens are aware of public lands and their availability, benefits and issues.
4. Public lands provide sufficient infrastructure (parking lots, trails, etc.), which can be maintained efficiently and sustainably.
5. Public lands are managed sustainably to provide multiple benefits (recreation, wildlife habitat, ecosystem services, timber, aesthetics, etc.).
6. Public land management serves as a model for private landowners to view sustainable management practices and outcomes.
7. Citizens understand the need to actively manage public forests (thinning, prescribed fire, harvest, etc.) in order to improve and maintain their health and benefits.

A. The Importance of Publicly-Owned Forestland

Missouri's publicly-owned forestland is of great importance for a variety of reasons. For starters, public forests are managed under agency mandates which ensure that these forests are being managed sustainably for the greatest public good – providing a wide array of services ranging from recreation to clean water and quality wildlife habitat. While many privately-owned forests are also managed sustainably, private forestland is generally much more vulnerable to threats such as poor harvesting practices, parcelization, and conversion to other uses such as pasture or development.

Public forests provide a wide range of recreational opportunities available to everyone - hiking, camping, hunting, fishing, wildlife viewing, mushroom hunting, and much more. For many people, public land presents their only opportunity to enjoy the great outdoors. The 2003 Conservation Opinion Survey (UMC 2004) underscores the importance of these recreational opportunities with the following findings:

- **Over one-half of Missourians listed "Outdoor activities" as the most enjoyed category of activity**, followed by "Reading or watching TV" and "Structured sports".

- **Missourians are active in a wide variety of outdoor recreation pursuits**. In the last 12 months 75% indicated they participated in "Pleasure driving to enjoy the scenery", 69 percent "Watching birds or wildlife", 51 percent "Fishing", 50 percent "Hiking", 28 percent "Using a public boat launch ramp", and 26 percent "Hunting".

- **59% of Missourians reported "Using Missouri Department of Conservation areas" in the last 12 month**. This question was specific to MDC areas, and did not include other public ownerships.

- In addition, the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation conducted by the U.S. Census Bureau concluded that **Missouri has more than 2.2 million wildlife watchers, 1 million anglers, and 608,000 hunters**.

Last, but not least, due to their relatively large size, strategic location and management objectives, public forests provide some of our best opportunities for maintaining Missouri's biodiversity. Few privately owned tracts offer the same opportunities for large landscape scale management for healthy natural communities and the associated plants and animals they support.

For these and other reasons, Missourians hold their public forests near and dear to their hearts. This is made evident by the following statistics, also from the 2003 Conservation Opinion Survey (UMC 2004):

- **91% of Missourians agree that "It is important for outdoor places to be protected even if you don't plan to visit the area"**.

- **73% of Missourians agree that land should be acquired for fish, forest and wildlife conservation.**

B. Availability of Public Forestland and Recreation Opportunities

Missouri has approximately 2,635,965 acres of forest in public ownership - 17% of Missouri's total forestland[19]. In addition to public land, **Missouri also has approximately 216,000 acres of privately-owned forestland under conservation easements or owned by a foundation** to ensure that they will remain intact and sustainably managed in perpetuity. These lands provide many of the same benefits as public land.

Publicly Owned and Other Protected Lands

■ = Federally owned public land (USFS, COE, USFWS, NPS, DOD)
■ = State owned public land (MDC, DNR)
■ = Privately owned protected land

0   25   50   100 Miles
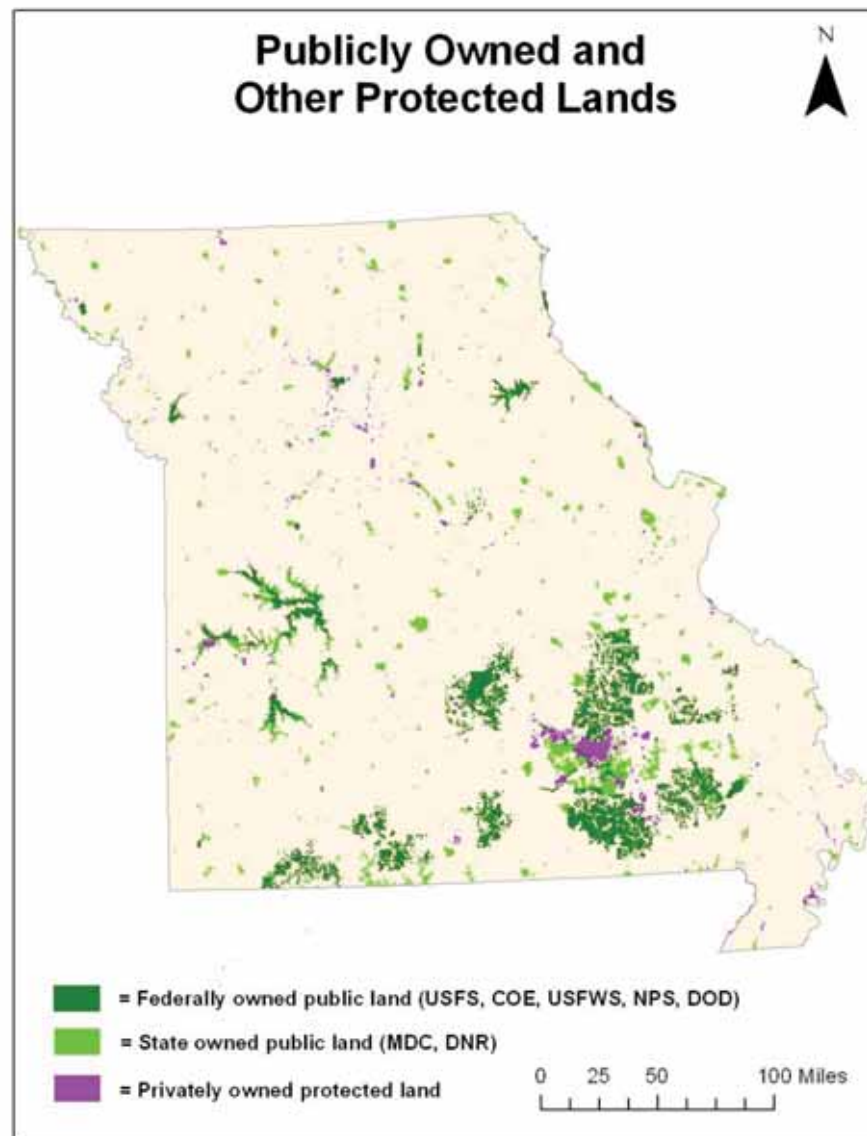
Figure 9.1 Map of Missouri's Publicly Owned and Other Protected Land[20]

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[19] These figures were calculated by MDC using MDC's public land data and 2001 National Land Cover Data. By necessity, these numbers were calculated using different data than was used in Issue Theme One, derived from (Butler 2008). Therefore, there is a 1% difference between the two calculations of percentages of privately and publicly-owned land.
[20] This map was created using MDC's public land data and by data provided by Ozark Regional Land Trust, The Nature Conservancy, and by the USDA Natural Resource Conservation Service.

Publicly-owned forests are held and managed by several different public agencies. Each of these agencies has slightly different missions and management protocols. This administrative "diversity" helps ensure that a wide variety of opportunities, benefits and services are derived from public forests. However, all of these agencies highly value forest health and sustainability.

Figure 9.2 Forestland Acreage by Public Agency[21]

Public Agency:	Acres of Forest
MO Dept. of Conservation – Conservation Areas (acreage listed does not include acres leased to MDC)	605,204
U.S. Forest Service – Mark Twain National Forest	1,457,877
National Park Service – Ozark National Scenic Riverways	76,851
U.S. Fish and Wildlife Service – National Wildlife Refuges	25,037
U.S. Army Corps of Engineers	303,280
MO Dept. of Natural Resources – State Parks	114,548
U.S. Dept. of Defense - Installations	53,168
Total:	2,635,965

The Missouri Department of Conservation (MDC) manages 1,237 Conservation Areas across the state (including several which are not forested). These vary widely from stream accesses of 1 or 2 acres, to large conservation areas of 40,000 acres. The mission of MDC is "To protect and manage the fish, forest, and wildlife resources of the state and enhance their values for future generations; to serve the public and facilitate their participation in resource management activities; and to provide opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources." (MDC 2010)

The U.S. Forest Service's Mark Twain National Forest (MTNF) is divided into 12 districts. Each district includes a concentration of several tracts with various in-holdings scattered throughout. Management of MTNF follows a vision of "Courageous Conservation: a sustainable future, a legacy of restoration". This vision includes the following goals: 1) Protecting ecosystems across boundaries; 2) Connecting citizens to the land; 3) Walking the talk for sustainability; and 4) Revolutionizing effectiveness and efficiency (USDA FS ER 2005).

The National Park Service manages Ozark National Scenic Riverways, which includes significant stretches of Jack's Fork and Current Rivers. The Mission of the National Park Service is: "...to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (NPS 2010)

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[21] This table was created using MDC's public land data, 2001 National Land Cover Data, and by data provided by Ozark Regional Land Trust, The Nature Conservancy, and by the USDA Natural Resource Conservation Service.

The U.S. Fish and Wildlife Service manages nine National Wildlife Refuges in Missouri, most of which contain at least some forestland. The Mission of the U.S. Fish and Wildlife Service's National Wildlife Refuge System is: "To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (USFWS 2010)

The Missouri Department of Natural Resources manages 50 State Parks scattered across the state, most of which contain at least some forestland. The Mission of the Missouri Department of Natural Resources State Park System is "To preserve and interpret the state's most outstanding natural landscapes and cultural landmarks, and to provide outstanding recreational opportunities compatible with those resources." (MDNR 2009)

The U.S. Army Corp of Engineers owns and manages numerous lakes in Missouri including adjacent forestlands, and also owns several major river bottom lands, some of which are leased to MDC. The Civil Works Operations Division Mission of the U.S. Army Corp of Engineers is "To operate and maintain projects that provide river and harbor navigation, flood damage reduction, water supply, hydroelectric power, recreation, environmental restoration, and wildlife protection; protect the Nation's waterways and wetlands; and undertake disaster relief and recovery work." (USACE 2010)

The US Department of The Army Forestry Program "supports military readiness by helping to shape the training mission landscape and by providing superior and sustainable training opportunities for America's warfighters. Army forests are recognized as an integral part of Army training lands, supporting the mission while providing biological diversity, wildlife habitat, air and water quality, soil conservation, watershed protection, and recreational opportunities."[22]. The Army's largest public land holding in Missouri is Fort Leonard Wood.

C. Public Land Management Challenges:

Balancing competing interests and demands: A tricky aspect of managing state-owned forestland in Missouri is that there are 5.9 million+ bosses, and each one has a different vision for how public forests should be managed. Some people want more timber to be harvested while others don't think a tree should be touched. Some people want to have increased opportunities to hunt while others are adamantly opposed to it. Usually, there is a middle ground that can satisfy the majority of people. However, it will never be possible to fully satisfy the demands of everyone.   These competing demands underscore the importance of the previously described agency mission statements which allow decisions to be based on and supported by predetermined guiding principles.

Public perception of public land management activities: Although public land agencies conduct forest management activities for good reasons, these reasons are not always obvious to the public. It is important that public land managers do a better job of communicating to the public what they are doing and why, and provide opportunity for feedback. For example, when conducted in a sustainable manner, harvesting trees can help

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[22] This is not an official U.S. Department of Army Mission Statement. Instead, this information was provided upon request by Army Environmental Command as direction for their Forestry Program.

restore critical habitat for sensitive migratory bird species, improve forest health, and facilitate the regeneration of important plant species which need a lot of sunlight. These harvests mimic historic disturbances which no longer exist (i.e. wildfires). Without proper communications, citizens can easily assume that such harvests are simply being done to make money. By establishing better dialogue, land management agencies can go a long way towards creating better understanding and respect with the public, even if we still disagree at the end of the day.

Funding: Most land management agencies have significant funding limitations. Funding requests for public land management are in competition with other programs and other agencies. This competition results in limits on the services and amenities agencies can provide. Insufficient funding also reduces the ability to complete important practices for improving the health and sustainability of forests, and can inhibit needed maintenance of existing infrastructure.

Balancing public land availability with available funding: Across all ownerships, Missouri has 2,982 blocks of public land and permanently protected private land. Providing such a large number of public and protected lands across the state ensures that all Missourians are within a relatively short drive of public forestland and related outdoor recreation opportunities. However, this wealth of public and protected land results in a large amount of maintenance and administrative costs for the agencies and organizations that administer these areas. It would take a lot less work to manage this same acreage if it were concentrated into just 100 areas, although this scenario would greatly limit public accessibility. Finding a balance is a difficult and ongoing process. Figure 9.3 reveals Missouri's current breakdown of protected land by the number of tracts and acreage for several tract size classes.
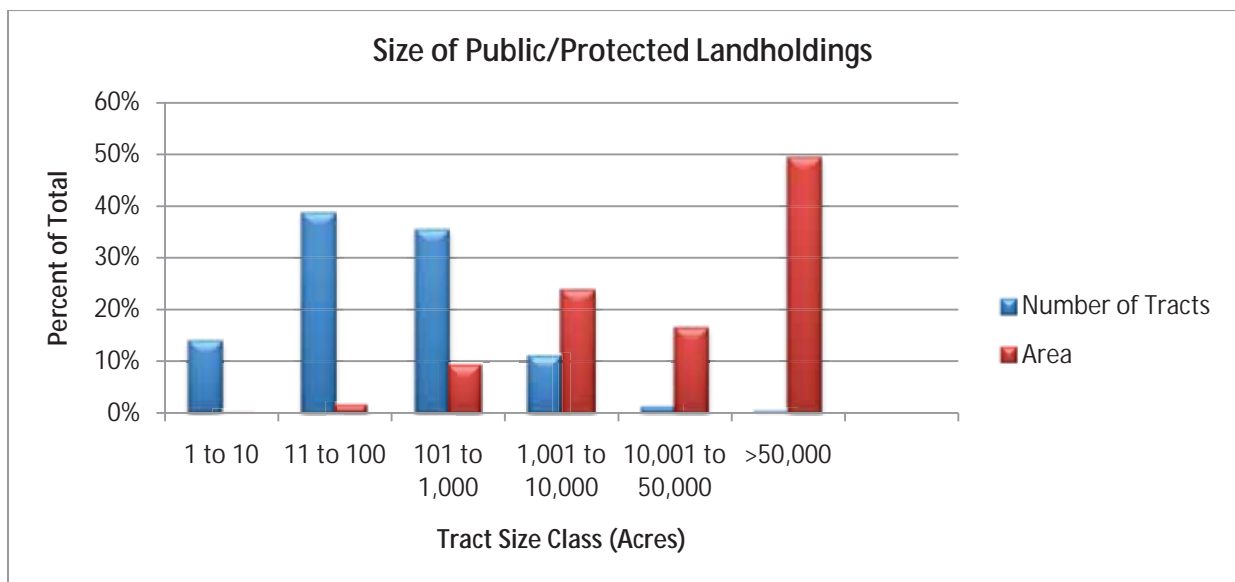
Figure 9.3 Size of Public/Protected Landholdings
(Source: Missouri Department of Conservation, using MDC's public land data and data from land trusts and the Natural Resources Conservation Service)

One indicator of the amount of administrative challenges that will be faced on a given tract is the average length of boundary per acre. The greater the boundary length per area on a tract, there is increased potential for conflicts with adjoining owners, increased maintenance costs, greater threat of introduction of exotic plant species and fragmentation of adjacent habitats, and decreased management options on the protected tract (i.e. prescribed fire). Figure 9.4 shows the significant difference in average boundary length per public/protected landholding acre per landholding size class.

Landholding Size Class (Acres)	# of Public/Protected Landholdings	Average Boundary Length Per Landholding Acre (meters/acre)
1 to 10	368	177
11 to 100	1022	56
101 to 1,000	938	25
1,001 to 10,000	286	11
10,001 to 50,000	25	10
>50,000	8	8

Figure 9.4 Number of Public/Protected Landholdings and Average Boundary Length per Landholding Acre

(Source: Missouri Department of Conservation, using MDC's public land data and data from land trusts and the Natural Resources Conservation Service)

Issue Ten: Maintaining Biodiversity (a.k.a. Wildlife Diversity)

In a nutshell: Missouri's forests and woodlands support a great diversity of plants and animals. Missouri's Comprehensive Wildlife Strategy (CWS) was created to maintain and enhance this diversity. Threats and opportunities facing Missouri's forest and woodland biodiversity are virtually identical to the forest sustainability issues described in great detail throughout this Assessment. Therefore, CWS and FRAS will work together very closely towards achieving overlapping visions. Issue Ten provides a brief overview of CWS, and describes three additional tools and resources MDC and various stakeholders are using to maintain and enhance diversity: Missouri's ecological classification systems, Forest Land Action Guidelines, and the Missouri Natural Areas Program.

Desired Future Conditions:
1. Forest natural communities are restored and/or maintained through proper management.
2. Forests are well balanced in type, age and size distribution.
3. Populations of Species of Conservation Concern and Threatened and Endangered Species are stabilized.
4. Populations of all Missouri flora and fauna are sustained by healthy and well-functioning natural communities and landscapes.

A. Background

Biodiversity, sometimes also referred to as "wildlife diversity", is the variety of native plants and animals for a given geographic region, from genetic variation within the same species through arrays of species, genera, families and still higher levels of biological organization including natural communities (Nigh 1992). Terrestrial natural communities, whether some type of forest, woodland, savanna, glade, prairie, stream edge, wetland or cave, are recognizable associations of plant and animal species within particular habitats and the environmental conditions (e.g., soils, geology, topography) and disturbance conditions (e.g., fire, flood, windstorms) under which they adapt and live (Nelson 2005).

The Missouri Natural Areas Program has classified some 85 distinct kinds of terrestrial natural communities, including 33 forest and woodland communities (Nelson 2005), and many additional aquatic natural communities (Pflieger 1989), all of which provide habitat for Missouri's diverse array of species. Missouri's natural communities support over 2,000 native vascular plant species (Yatskievych 1999), over 150 native breeding bird species (Jacobs 1997), 108 native reptile and amphibian species (Johnson 2000), 67 native mammal species (Schwartz 2001), 200 native fish species (Pflieger 1997), 65 native mussel species (Oesch 1995), 32 native crayfish species (Pflieger 1996), and over 130 native dragonfly and damselfly species (Trial 2005). Missouri ranks 21st in the nation in a ranking of the aggregate native species diversity of vascular plants, mammals, birds, reptiles, amphibians, and freshwater fishes of the 50 states (Stein 2000).

While these species reside in a wide variety of habitats and natural communities, many depend partially or wholly on healthy woodlands and forests - including everything from a ruffed grouse which never leaves the woods, to an Ozark hellbender that lives in Ozark streams, but depends on forests and woodlands for clean water.

Threats and opportunities facing Missouri's forest and woodland biodiversity are virtually identical to the forest sustainability issues described throughout this Assessment. Rather than repeat all of this information, Issue Ten will instead provide an overview of four prominent tools and resources that MDC and various stakeholders are using to maintain and enhance this diversity:

1. Managing to conserve thousands of native species on an individual basis would be a daunting, if not impossible task. A much more productive approach is to maintain healthy landscapes and natural communities upon which these plants and animals depend. A description of **Ecological Classification Systems** used by many partner agencies and organizations in Missouri is described in Section B below, and helps put landscapes and natural communities into context.

2. Section C describes **Missouri's Comprehensive Wildlife Strategy (CWS)**. CWS is a process of: 1) identifying landscapes which present Missouri's best opportunities to conserve wildlife diversity; and 2) collaborating with conservation partners to maintain and enhance wildlife diversity within these landscapes.

3. Subsequently, in Section D we delve into these landscapes to consider natural communities, and describe an effort Missouri has underway to better identify and manage for their health – Missouri's **Forest Land Action Guidelines (FLAG)**.

4. Finally, Section E provides a brief overview of **Missouri's Natural Area Program**.

B. Missouri's Ecological Classification Systems

In order to better organize and describe natural systems, many partner agencies and organizations in Missouri utilize two prominent resources for ecological classification. Paul Nelson's "The Terrestrial Natural Communities of Missouri" classifies 85 distinct natural communities in Missouri, including 33 forest and woodland natural communities (Nelson 2005). This reference book was developed in partnership and collaboration with the Missouri Natural Areas Committee which consists of MDC, Missouri Department of Natural Resources, The Nature Conservancy, United States Fish and Wildlife Service, Mark Twain National Forest and National Park Service.

The second resource is Missouri's Ecological Classification System (ECS), modeled after the U.S. Forest Service's approach to ecological classification[23]. This interagency-sponsored product is a hierarchical ecological framework which helps describe the relationship between Missouri's natural communities and landscapes.

ECS first breaks the state up into four distinct **Ecological Sections**. It is because these sections converge in Missouri that we have such high levels of species diversity. Each Ecological Section has its own geologic history, soils, topography and weather patterns that have resulted in characteristic assemblages of plants and animals. The four sections - the Central Dissected Till Plains, Osage Plains, Ozark Highlands, and Mississippi Alluvial Basin, are described below.

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[23] Section B's description of ECS is paraphrased from (Nigh 2002).
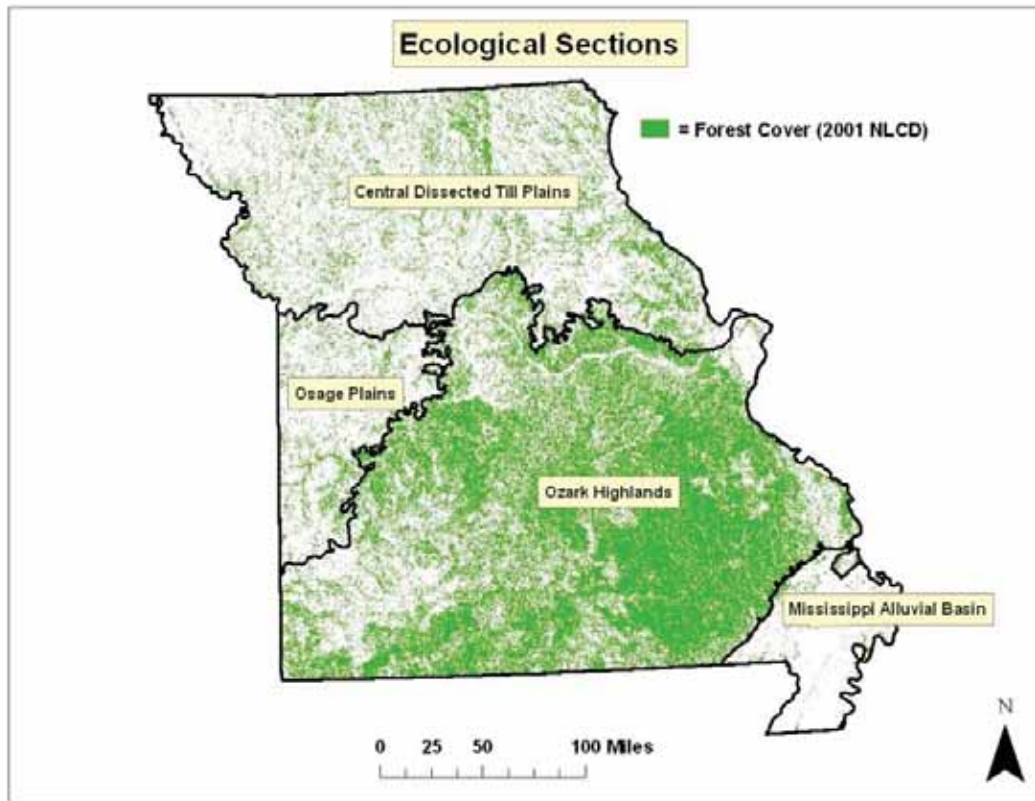
Figure 10.1 Missouri's Ecological Sections[24]

The **Central Dissected Till Plains** includes most of north Missouri. Soils are mainly comprised of pre-Illinoisan glacial till, which was deposited over 400,000 years ago, with variable loess deposition and fluvial influence. Historically, much of this landscape consisted of prairie, especially in the uplands. Sideslopes consisted of transitional savannas and woodlands, and bottomlands and other protected areas consisted of well-drained forests and poorly-drained wetlands (prairie and forest). Most of this section today is devoted to agriculture. Existing natural communities tend to be somewhat fragmented and isolated. Forests and woodlands make up a relatively small component of the landscape (varying from 5 to 15% of the landcover). However, the forests and woodlands found here tend to be highly productive.

The **Osage Plains** are located in West Central Missouri, and consist of unglaciated soils. This section was historically dominated by tallgrass prairie and extensive wetland complexes. In modern times, most of this section is devoted to agriculture. In fact, over 60 percent of the section is currently in fescue pasture. Forests and woodlands are very limited, and are found mostly on steeper slopes and valleys.

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[24] Map produced by Missouri Department of Conservation using 2001 National Land Cover Data and MDC's Ecological Classification System Data.

The **Ozark Highlands Section** is Missouri's most heavily forested section, and makes up most of the southern half of the state. The Ozark Highlands is essentially a plateau that has been undergoing weathering for a quarter billion years. This process has resulted in a highly diverse landscape containing over 200 endemic species in the Ozark Highlands Section[25]. The highest and least rugged parts of the Ozarks tend to be flat to gently rolling plains that were formerly covered with prairies, savannas and open woodlands. Near drainages, the plains give way to rolling hills and then to rugged, highly dissected hills. These hills historically supported oak and oak-pine woodlands and forest with countless springs, caves, fens, cliffs and glades scattered throughout. Many species are associated with these features and the high quality Ozark streams running throughout the landscape. Much of the area which was historically in forest and woodland is still in forest and woodland cover, though they have been degraded significantly by unsustainable harvesting practices, livestock grazing, and altered fire regimes.

The **Mississippi Alluvial Basin** is found in Missouri's extreme southeast corner – the "Bootheel" – and consists mostly of alluvial soils with the primary exception of Crowley's Ridge. Historically, most of this section was poorly drained and consisted of marshes, swamps, and bottomland forests. Earlier in the twentieth century, most of these bottomlands were drained and converted to cropland. However, there are still substantial, isolated patches of timbered areas that can serve as cores for maintenance of the wildlife diversity indigenous to this region.

Within Ecological Sections, Missouri is further divided into 31 **Subsections** (Figure 10.2). Subsections are delineated with the same criteria as Sections (climate, geomorphology, topography, soils and potential vegetation types), but at a finer scale. Sixteen of these subsections are located in the Ozark Highlands. Of the 31 subsections, several reside mostly in neighboring states, with only a small portion extending into Missouri. Examples of subsections include the Current River Hills in the Ozark Highlands and the Mississippi River Alluvial Plain in the Mississippi Alluvial Basin.

Subsections are then further divided into **Landtype Associations (LTA's**. LTA's are delineated by similar criteria to sections and subsections, but at an even finer scale. LTA's can be thought of as landscapes of natural community assemblages with distinctive management challenges and opportunities. Examples of LTA's include the Upper Chariton River Woodland/Forest Hills, the Linn Oak Woodland Dissected Plains, and the Big Piney River Oak-Pine Woodland/Forest Hills.

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[25] The Ozark Highlands stretch from southern Missouri across northern Arkansas and contains small portions of Illinois, Kansas, and Oklahoma.
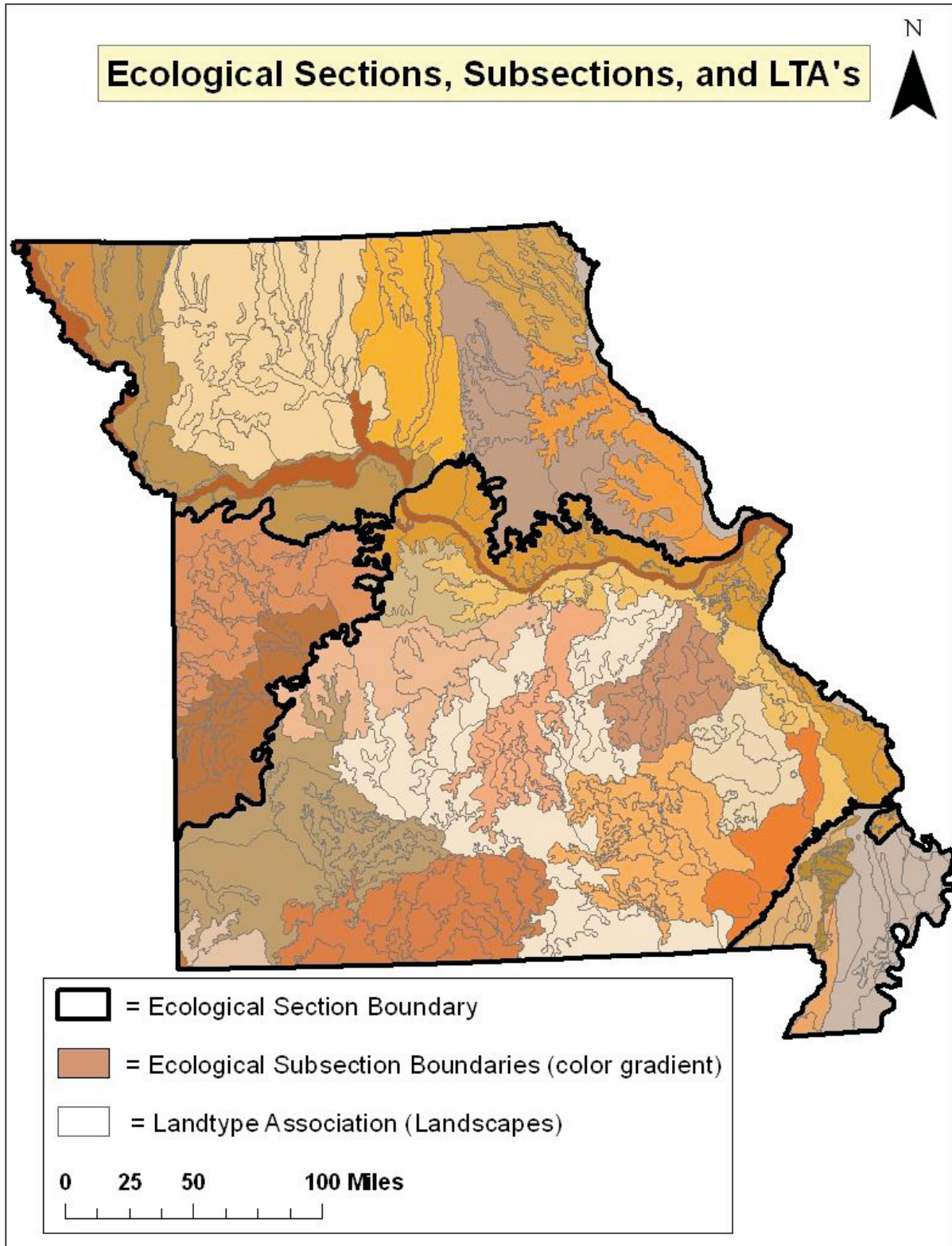
**Figure 10.2 Map of Missouri's Ecological Sections, Subsections, and LTA's[26]**

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[26] Map produced by Missouri Department of Conservation using MDC's Ecological Classification System Data

Since there are over 300 LTA's in Missouri, LTA's are sometimes lumped into 25 **LTA Types**, which are shown below in Figure 10.3. LTA Types are groupings of LTA's with similar characteristics and management needs. Detailed profiles of these LTA Types can be found at: http://mdc4.mdc.mo.gov/Documents/13728.pdf

MISSOURI LANDTYPE ASSOCIATION TYPES (LTA TYPES)

Central Dissected Till Plains Section

T1	TP Alluvial Plains (Pg 5)
T2	TP Loess Prairie Hills and Blufflands (Pg 7)
T3	TP Loess Woodland/Forest Breaks (Pg 9)
T4	TP Low Prairie Plains (Pg 11)
T5	TP Prairie Plains (Pg 13)
T6	TP Prairie/Woodland Dissected Plains (Pg 15)
T7	TP Prairie/Woodland Hills (Pg 17)
T8	TP Woodland/Forest Hills (Pg 19)

Osage Plains Section

O1	OP Alluvial Plains (Pg 21)
O2	OP Prairie Plains (Pg 23)
O3	OP Prairie/Savanna Scarped& Dissected Plains (P 25)

Ozark Highlands Section

Z1	OZ Alluvial Plains (Pg 27)
Z2	OZ Dolomite Glade/Woodlands (PG 29)
Z3	OZ Forested Rugged Hills and Breaks (Pg 31)
Z4	OZ Igneous Knobs (pg 33)
Z5	OZ Oak Savanna/Woodland (Dissected) Plains(35)
Z6	OZ Oak Woodland Dissected Plains & Hills(Pg 37)
Z7	OZ Oak Woodland/Forest Hills (Pg 39)
Z8	OZ Pine-Oak Woodland Dissected Plain (Pg 41)
Z9	OZ Prairie Plains (Pg 43)
Z10	OZ Prairie/Savanna (Dissected) Plains (Pg 43)
Z11	Oz Oak-Pine Woodland/Forest Hills (Pg 45)

Mississippi Alluvial Basin Section

| M1 | MB Alluvial Plains (Pg 47) |
| M2 | MB Crowley's Ridge Hills (Pg 49) |
| M3 | MB Sand Ridges, Plains & Hills (Pg 51) |

Figure 10.3 Missouri's LTA Types[27]

[27] Map produced by Missouri Department of Conservation using MDC's Ecological Classification System Data

According to Missouri's ECS, LTA's are then divided into Ecological Land Types (ELT's). However, ELT's have not been established for most of Missouri. For the purposes of FRAS, we will instead divide LTA's into **natural communities**. Nelson's "Terrestrial Natural Communities of Missouri (2005)" describes 33 forest and woodland natural communities in great detail. While each is distinct, MDC's Forestry Division lumps these communities into 21 **Forest and Woodland Community Management Types** that have similar management issues and opportunities. These Forest/Woodland Community Management Types are listed below in Figure 10.4 and described in detail at: http://mdc4.mdc.mo.gov/applications/MDCLibrary/MDCLibrary2.aspx?NodeID=2340

Figure 10.4 Missouri's Forest/Woodland Community Management Types

Forest/Woodland Community Management Types	Nelson's (2005) Terrestrial Natural Community Type(s) and page number references
I. Upland Forests and Woodlands on Unglaciated Landscapes	
Mixed Oak-Hickory Forests	Dry-Mesic Chert, Sandstone, Sand, or Igneous Forest (pp. 125, 130, 137, 141)
White Oak Forests	Dry-Mesic Limestone/Dolomite Forest (pp. 119) Dry-Mesic Chert, Sandstone, Sand, or Igneous Forest (pp. 125, 130, 137, 141) Dry-Mesic Bottomland Forest (pp. 145)
Pine-Oak Forests	Dry-Mesic Chert, Sandstone, or Igneous Forest (pp. 125, 130, 141)
Oak-Mixed Hardwood Mesic Forests	Dry-Mesic Limestone/Dolomite Forest (pp. 119) Dry-Mesic Chert, Sandstone, Sand, or Igneous Forest (pp. 125, 130, 137, 141) Dry-Mesic Bottomland Forest (pp. 145)
Mixed Hardwood Mesic Forests	Mesic Limestone/Dolomite or Sandstone Forest (pp. 122, 135) Mesic Sand Forest (pp. 139)
Limestone/Dolomite Woodlands	Dry Limestone/Dolomite Woodland (pp. 180) Dry-Mesic Limestone/Dolomite Woodland (pp. 183)
Post Oak Woodlands	Dry Chert, Sandstone, Sand, or Igneous Woodland (pp. 186, 194, 201, 206) Upland Flatwoods (pp. 213)
Mixed Oak Woodlands	Dry Chert, Sandstone, or Igneous Woodland (pp. 186, 194, 206) Dry-Mesic Chert, Sandstone, Sand, or Igneous Woodland (pp. 190, 198, 204, 209) Dry-Mesic Bottomland Woodland (pp. 223)
Pine and Pine-Oak Woodlands	Dry Chert, Sandstone, or Igneous Woodland (pp. 186, 194, 206) Dry-Mesic Chert, Sandstone, or Igneous Woodland (pp. 190, 198, 209)
II. Upland Forests and Woodlands of Glaciated Landscapes or Unglaciated but with very deep loess deposits	
Mixed Oak-Hickory Loess/Glacial Till Forests	Dry-Mesic Loess/Glacial Till Forest (pp. 113)
White Oak Loess/Glacial Till Forests	Dry-Mesic Loess/Glacial Till Forest (pp. 113)
Oak-Mixed Hardwood Mesic Loess/Glacial Till Forests	Dry-Mesic Loess/Glacial Till Forest (pp. 113) Mesic Loess/Glacial Till Forest (pp. 115)
Mixed Hardwood Mesic Loess/Glacial Till Forests	Mesic Loess/Glacial Till Forest (pp. 115)
Burr Oak Loess/Glacial Till Woodlands	Dry Loess/Glacial Till Woodland (p. 173)
Mixed Oak Loess/Glacial Till Woodlands	Dry Loess/Glacial Till Woodland (pp. 173) Dry-Mesic Loess/Glacial Till Woodland (pp. 176) Dry-Mesic Bottomland Woodland (pp. 223)
White Oak Loess/Glacial Till Woodlands	Dry-Mesic Loess/Glacial Till Woodland (pp. 176) Dry-Mesic Bottomland Woodland (pp. 223)
III. Bottomland Forests and Woodlands	
Bottomland Woodlands	Bottomland Flatwoods (pp. 217) Mesic Bottomland Woodland (pp. 226) Wet-Mesic Bottomland Woodland (pp. 229)
Riverfront Bottomland Forests	Riverfront Forest (pp. 157)
Mixed Hardwood Mesic Bottomland Forests	Mesic Bottomland Forest (pp. 147)
Wet Bottomland Forests	Wet-Mesic Bottomland Forest (pp. 150), Wet Bottomland Forest (pp. 153)
Swamps	Swamp (pp. 431)

Clarification of Forests vs. Woodlands

Until recently, the terms "forest" and "woodland" were used somewhat interchangeably, and still are at times. However, in an effort to better distinguish and manage natural communities, the terms "forests" and "woodlands" are now often used to describe two distinct natural community types. In Nelson's "The Terrestrial Natural Communities of Missouri", forests and woodlands have the following definitions:

Forest: An area dominated by trees with the potential to form a closed canopy and interspersed with multilayered shade-tolerant sub-canopy tree species, shrubs, vines, ferns and herbs. Trees attain heights of 60 to over 100 feet. The ground flora is rich in spring ephemerals.

Woodland: A natural community with a canopy of trees ranging from 30-100 percent canopy closure with a sparse understory and a dense ground layer rich in forbs, grasses and sedges. Canopy height ranges from 20-90 feet depending on site conditions.

Distinguishing between forests and woodlands can be tricky at times. For one thing, forests and woodlands are part of a natural community spectrum. Figure 10.5 below shows the "Upland Forest to Prairie Continuum". While this chart helps provide helpful classifications, there is certainly overlap between classifications.

Furthermore, in the absence of fire and other disturbances, many areas which traditionally consisted of woodland have recently taken on more of a forest function and appearance. Distinguishing between forests that have traditionally been forests versus woodlands which have grown up into a forest like appearance takes some practice. However, restoring historic woodlands can have terrific benefits for wildlife diversity and the overall health of the natural community.

For the purposes of Missouri's Forest Resource Assessment and Strategy, the term "forest" is generally used to refer to both forests and woodlands. Exceptions are clearly stated.

Figure 10.5 The Upland Prairie-Forest Continuum*[28]

Attributes	Mesic Forests	Dry-mesic Forests	Dry-mesic Woodlands	Dry Woodlands and Flatwoods	Savannas	Prairies
Vegetation layers	Multiple ≥ 4	Multiple ≥ 3	2 to 3	2 to 3	2	1
Canopy Height-ft	90+	70-90	60-90	20-60	20-60	Not applicable
Tree Form	Narrow crowns, clean trunks	Narrow crowns, clean trunks	Somewhat spreading crowns, some lower spreading branches	Spreading crowns, some lower spreading branches	Wide-spreading crowns, lower branches typical	Not applicable
Canopy closure	90-100	90-100	80+	30-80	10-30	0-10
% Understory Cover	50-100, dense	50-100, dense	30-50, patchy	10-30, scattered	5-10, sparse	0-10
Ground Layer Cover	Dense in spring, patchy to sparse by mid-summer	Dense to patchy in spring, patchy to sparse by mid-summer	Dense to patchy in spring, patchy to dense by mid-summer	Patchy to dense all season	Dense all season	Dense all season
Ground Layer Plants	Rich diversity of spring ephemerals, and ferns; few summer/fall forbs	Moderate to low diversity of spring ephemerals, and ferns; few summer/fall forbs	Moderate to low diversity of spring ephemerals, and ferns; abundant C3 grasses, sedges, and summer/fall forbs	C3 and C4 grasses, sedges, diversity of forbs all season	C4 grasses, sedges, diversity of forbs all season	C4 grasses, sedges, diversity of forbs all season
Topography and Landform	Protected valleys, ravines, bluff bases, lower slopes of northerly aspects, fire shadow areas	Mid and upper slopes of northerly aspects, ravines, other aspects in fire shadow areas	Mid and upper slopes of southerly aspects, fire prone landscapes	Steep upper slopes of southerly aspects, narrow ridges, broad ridges, fire prone landscapes	Level to gently rolling topography, steep loess hills, broad ridges	Level to gently rolling plains, steep loess hills, broad ridges
Soils	Deep (≥ 3') loams, nutrient rich, high organic matter, deep leaf litter	Moderate depth (24-36") silt loams, moderate organic matter, moderately deep leaf litter	Moderate depth (20-36") silt loams, moderate organic matter, shallow leaf litter	Shallow depth (<20"), droughty, often rocky and or nutrient poor; fragipans or claypans	Wide range of soil types from shallow to deep, variably rocky	Wide range of soil types from shallow to deep, variably rocky
Fire Regime - (Restoration/ Maintenance)	Very infrequent, low intensity (historically every 30+ years?)	Infrequent, low intensity (historically every 20+ years?)	Low to moderate intensity fires (2-3 years / 3-10 years)	Low to moderate intensity fires (1-3 years / 3-7 years)	Moderate intensity fires (1-4 years / 3-5 years)	Moderate to high intensity fires every 1 to 3 years
Dominant Trees	Red oak, sugar maple, ash, basswood, walnut	White, red, and black oaks, hickories	White, black, scarlet, chinkapin oaks, hickories, shortleaf pine	Post, blackjack, chinkapin, bur, white oaks, shortleaf pine	Bur, chinkapin, post, swamp white, and white oaks	Not applicable
Characteristic Plants	Spicebush, Paw Paw, Trilliums, Bloodroot, Dutchman's Breeches	Meadow Rue, Trout Lily, Christmas Fern, Black Cohosh, Dwarf Larkspur	Bristly Sunflower, Asters, Goldenrods, Bee Balm, Sedges, Native C3 Grasses	Leadplant, Asters, Wild Quinine, Goldenrods, Pale Purple Coneflower, Native Lespedezas	Compass Plant, Rattlesnake Master, Rigid Goldenrod, Native C4 Grasses	Compass Plant, Rattlesnake Master, Rigid Goldenrod, Native C4 Grasses
Basal Area (ft²/ac)	90-100	80-100	50-80	30-60	<30	<10

* Note: This chart describes idealized conditions for stands that best represent their pre-settlement character. For most sites, these descriptions represent desired future conditions in terms of structure.

[28] Developed by Mike Leahy and Tim Nigh of MDC, and Paul Nelson of U.S. Forest Service – Mark Twain National Forest

C. Missouri's Comprehensive Wildlife Strategy:

In order to best conserve species, natural communities and landscapes, Missouri has created and adopted a statewide Comprehensive Wildlife Strategy (CWS). CWS focuses on maintaining and improving key landscapes and natural communities in order to conserve the assemblages of plants and animals found within them. By restoring and managing high quality natural communities, we can most effectively stabilize populations of Species of Conservation Concern (SOCC), and keep other species from becoming SOCC.

Similar to FRAS, a key component of CWS is the acknowledgement that we do not have the resources or ability to restore and maintain every acre. Furthermore, CWS recognizes that not all landscapes have the same potential for restoration and maintenance of wildlife diversity. Therefore, CWS incorporates several terrestrial and aquatic assessments to determine the best geospatial opportunities for conserving Missouri's various natural community assemblages. These assessments include MDC terrestrial and aquatic assessments and assessments by partner organizations (Mark Twain National Forest, The Nature Conservancy, Audubon Missouri, etc.). The end result is a map of **Conservation Opportunity Areas (COA's)** shown below as Figure 10.6.

CWS includes two classifications of COA's:

The broader classification includes geographies referred to as **Priority for "All Wildlife" Conservation**. These areas include specific landscapes and natural communities which present our best opportunities for conserving Missouri's diversity of natural community types and the plant and animal assemblages they represent.

Nested within this broader classification are 36 **Conservation Opportunity Areas with Action Plans**. These 36 COA's are not necessarily of higher natural quality than the broader designation. However, these landscapes have stakeholder groups actively collaborating on their conservation efforts. Many of these stakeholder groups have been highly successful at accomplishing important conservation on the ground. CWS and FRAS share many common goals and strategies, and will work together closely for the collective benefit of both of these initiatives.

Detailed action plans of these 36 COA's can be found in "Conserving All Wildlife in Missouri – A Directory of Conservation Opportunity". Further information can also be found at: http://www.statewildlifeactionplans.org/
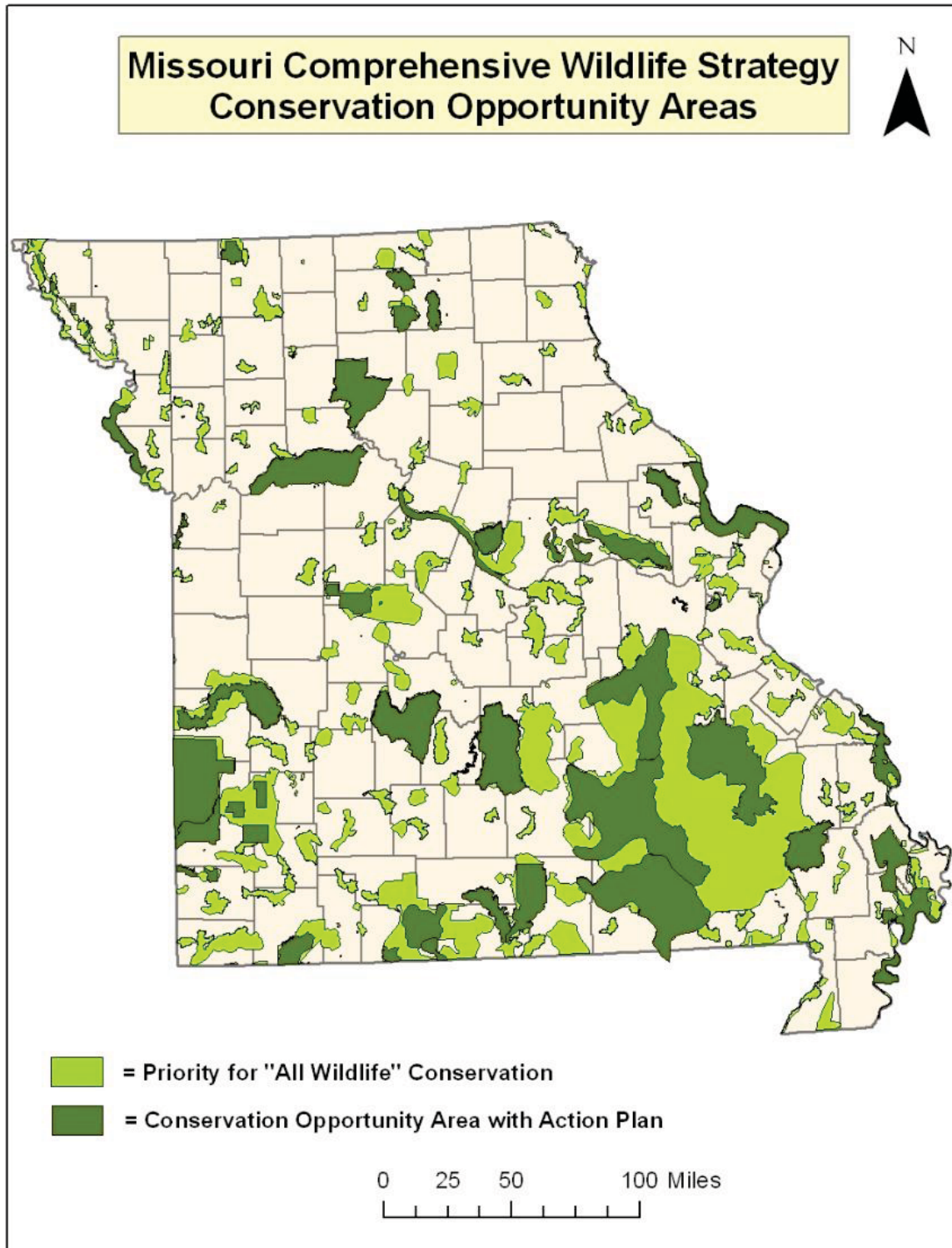
**Figure 10.6 Missouri Comprehensive Wildlife Strategy –
Conservation Opportunity Areas**
(Source: Missouri Department of Conservation)

D. Natural Community Management and "Forest" Land Action Guidelines

Through CWS, we have established which landscapes should be targeted for conserving Missouri's wildlife diversity. The next step is to determine what work needs to be done within these landscapes. Landscapes typically consist of a mosaic of several different natural communities. It is at this natural community level that we generally evaluate a forest or woodland to determine its management needs.

Missouri's forests and woodlands have evolved for thousands of years with frequent disturbance. Disturbances often were in the form of fire, but also included severe drought, floods, tornadoes, insect and disease outbreaks and more.   Many of these events would thin out trees of poor health or weaker competitors. Some were severe enough to be "stand replacing" events in which existing trees would succumb and a new forest or woodland would emerge. These disturbances helped create mosaics of late successional forests, open grassy woodlands and savannas, and everything in between. In the process, diverse habitat was maintained which supported a wide variety of plants and animals.

Without disturbance, forests and woodlands typically become overcrowded (too many trees in a given area), herbaceous vegetation on the forest floor gets shaded out, and trees like pine and oak which generally tolerate wildfire slowly become replaced by shade tolerant species which don't tolerate wildfire. In the process, species diversity can decline significantly. Undisturbed forests may benefit a handful of species of plants and animals. However, many other species which are better adapted to historic conditions are negatively impacted and often become species of conservation concern.

In many situations, it is no longer practical or desirable to allow these historic disturbances to take place. For instance, there are enough houses and buildings scattered across our forests that we can no longer let fires burn uncontrolled. However, in many situations, we can conduct natural community management activities that will mimic historic disturbances and help maintain conditions needed for many species of plants and animals. Practices can include prescribed fire, exotic species control, non-commercial thinning, timber harvests, and more.

Of course, not all disturbances are desirable. The character of Missouri's woodlands and forests was dramatically altered in the late 1800's and early 1900's as vast stands of virgin timber were cut over, and the resulting bare land was subjected to decades of open range overgrazing, poor agricultural practices, and excessive burning to stimulate forage. While forests and woodlands in the region have recovered somewhat since, proactive management is still needed to recover from these historic practices.

In order to help land managers identify natural community types, and determine what management practices will best meet their objectives, MDC has recently put together a web based document called the **Forest Land Action Guidelines (FLAG)**. FLAG provides detailed information about identifying natural community types, and then for each community type, information is available to guide managers to best manage the community for various purposes such as natural community health and wildlife diversity. Based on

experiences gained, managers can enter in narratives of their management successes and failures to facilitate adaptive resource management. FLAG can be found at: http://mdc4.mdc.mo.gov/applications/MDCLibrary/MDCLibrary2.aspx?NodeID=2335

E. Missouri Natural Areas

A key component of natural community conservation in Missouri is to recognize and designate the best examples of Missouri's natural communities as Missouri Natural Areas designated by the inter-agency Missouri Natural Areas Committee. Since 1977 the Missouri Natural Areas Committee has striven to conserve and protect the biological diversity of Missouri through the natural community approach by designating Missouri Natural Areas, defined as biological communities or geological sites that preserve and are managed to perpetuate the natural character, diversity and ecological processes of Missouri's native landscapes. Today there are 180 Missouri Natural Areas on a variety of land ownerships. Designated natural areas act as key components of over 80% of COAs and are key sites for ecological restoration and function as reference sites. The process of inventorying, restoring and designating Missouri Natural Areas is ongoing.

<u>Issue Eleven</u> - Logistical Framework for Sustainability

In a nutshell: Today's actions will largely determine the future health and sustainability of our forest resources and the benefits these resources will provide. Sustaining forest resources requires adequate funding and a diversity of partnerships and people collaborating on the implementation of strategies which are as efficient, effective and synergistic as possible. Above all, sustainability of Missouri's forest resources requires that Missouri citizens understand and appreciate the value of forest resources, the issues facing them, the opportunities they present, and the role people play in determining the future of the forest.

<u>Desired Future Conditions:</u>
1. Public agencies efficiently and effectively work towards sustainability of Missouri's forest resources and the services they provide.
2. Various public and private forest stakeholders collaborate effectively to generate new ideas and knowledge, feed off of each other's strengths, and increase dialogue.
3. Sufficient funding is available and widely supported by Missouri citizens to ensure the sustainability of Missouri's forests and the services they provide.
4. Missouri citizens understand and appreciate the value and diverse benefits of Missouri's forest resources, and the threats facing their sustainability.
5. Missouri citizens understand and support the need for proactive management to maintain the health and sustainability of Missouri's forest resources.
6. Missouri citizens understand the role they play in determining the future sustainability of Missouri's forest resources.

A. Financial Considerations

Providing a sustainable future for Missouri's forest resources is not a cheap endeavor. Funds are needed for outreach efforts, forest management expenses, land conservation costs, research, fire suppression, maintaining recreational opportunities, and much more. While there are some great financial resources currently available to assist with these efforts, unfortunately these resources come far short of what is truly needed to ensure sustainability. Furthermore, the economic challenges we are currently facing have recently decreased the amount of funds available for these programs. Forest sustainability will require maintaining existing funding sources and tapping into many new funding opportunities. Future funding sources could include developing new markets for ecosystem service, climate change adaptation funding, increased state or federal funding, biofuels markets, private grants, soliciting donations and volunteerism, and more. There are no silver bullets and a variety of avenues will need to be sought.

B. Partnerships

Providing a sustainable future for Missouri's forest resources will also require a lot of people. Looking back at the first 10 Issue Themes, it is clear that no single organization could adequately address the issues identified in FRAS all on its own. Success is only possible through the effective use of collaborative and synergistic partnerships. This includes working with statewide umbrella organizations (e.g. Missouri Forest Resources Advisory Council), local partnerships (e.g. Middle Meramec Conservation Opportunity Area Stakeholder Team), individual agencies and non-governmental organizations, and Missouri citizens in general.

MDC has already enlisted a team of partners (see Appendix A) who have helped in developing FRAS, and will likely contribute to implementation of FRAS strategies. Our hope is that this list will grow much longer in the coming years. Please note that this list does not include several other partners who are actively engaged with Forestry Division, but did not formally contribute to the development of FRAS.

C. Public Awareness and Support

Perhaps the most important factor in ensuring the sustainability of Missouri's trees and forests is achieving awareness of the extent and quality of the State's resources among Missouri's citizenry. If we want Missouri citizens to support their forest resources, they need to understand and appreciate the importance of Missouri's trees and forests, the threats that these resources face and the opportunities that they offer, and the role that people play in determining the future of the forest. Needed support includes financial support of forestry agencies and NGOs, a conservation mindset in day-to-day actions and consumption habits, volunteerism and charity, environmental literacy and spreading this knowledge to future generations, and much more. The success of FRAS will depend greatly on an effective communication strategy to spread these important messages to the public.

D. Legal Framework

Compared to many states, Missouri has very few forestry laws and regulations regarding forest management. Arguably, Missouri's most imposing forestry law gives MDC the right to enter private property for the purpose of putting out wildfires. Instead of taking a heavy-handed legal approach to ensuring that Missouri's forests are well managed, Missouri relies almost entirely on the good will of private forest landowners (who own 82% of Missouri's forestland) to "do the right thing". This approach has real advantages and disadvantages and includes a large number of supporters and detractors. While laws and regulations are subject to change, FRAS strategies are structured based on our existing legal framework.

## E. Bringing it all Together

Achieving the goals laid out for FRAS will be a complex and challenging venture. Success will only be achieved through the cooperation of many different organizations, and the support of Missouri's citizens. Missouri is fortunate to have such impressive forest resources in our backyard. We have too much to lose to not fully embrace this challenge. The Eleven Issue Themes have revealed that Missouri's forest resources face many significant threats and pose equally significant opportunities. Missouri's Forest Resource Strategy provides a blueprint for best addressing these Assessment findings to ensure a sustainable future for Missouri's forest resources and the benefits we derive from them.

Assessment - Part B: Forest Opportunity Areas

The 11 Issue Themes reveal that much work is needed to ensure a sustainable future for Missouri's forest resources. In order to promote the most efficient, strategic, and effective use of limited resources for addressing forest threats and opportunities identified in Chapter 3, Missouri's Forest Resource Assessment and Strategy (FRAS) establishes Forest Opportunity Areas.

> **Forest Opportunity Areas (FOA):** Areas which offer Missouri's best geographic opportunities for sustaining forest resources and the benefits and services derived from them. The term "forest" is used here in the broadest of senses to include all forest and woodland natural communities, associated natural communities and features such as streams, caves, and urban areas.

FOAs include rural, wildland-urban interface (WUI), and urban settings. The existing distribution of all existing forest resources is shown below. For the purposes of FRAS, FOAs are lumped into two categories: "Rural/WUI", and "Urban". Chapter 4 presents our methodology for determining Rural/WUI and Urban FOAs and the results.

Existing Forest Resources

- = Existing Rural Forest
- = Existing WUI Forest
- = Urban Areas (Existing Impervious Surface)

0 25 50 100 Miles
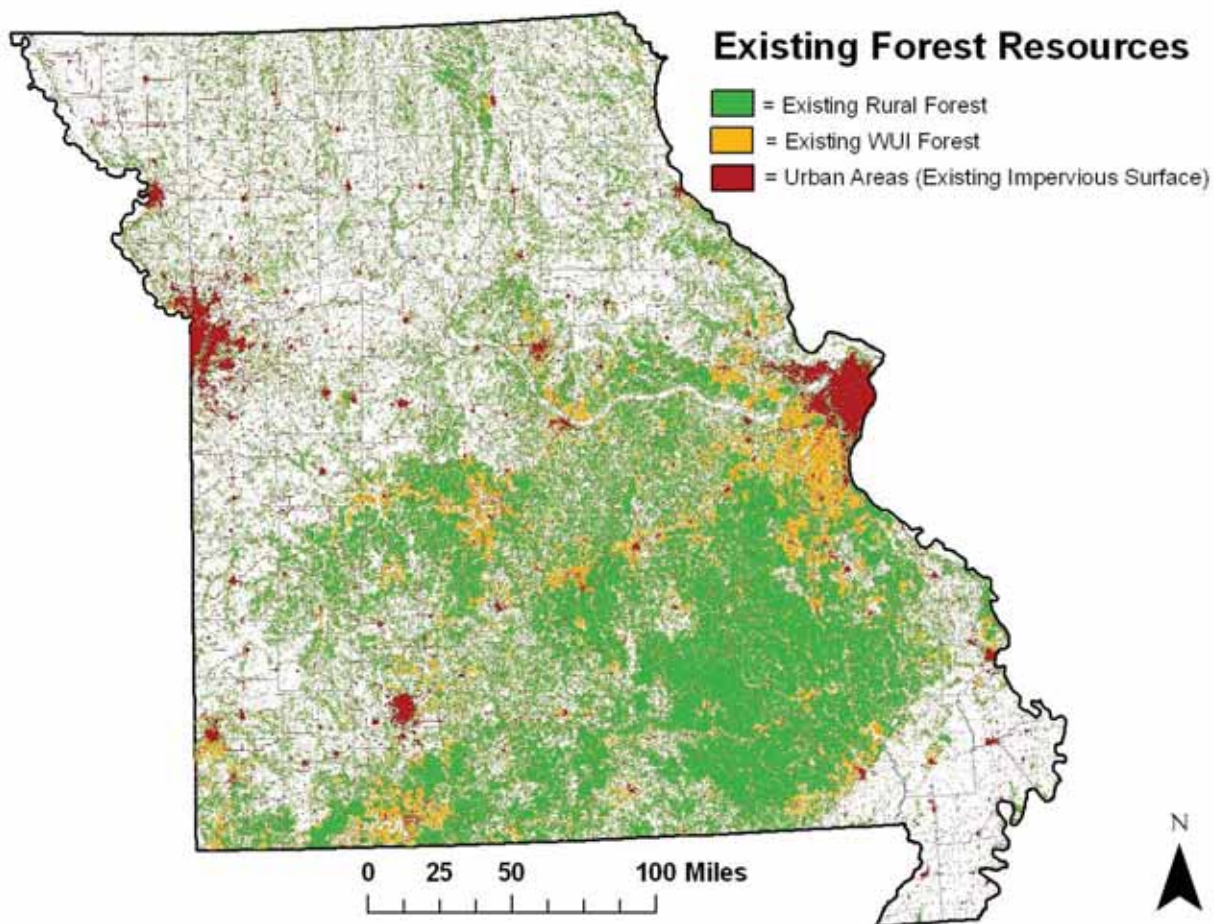
Rural/WUI Forest Opportunity Areas:

The Forest Opportunity Model

In order to identify the best geographic opportunities for sustaining Missouri's rural and WUI forest resources, a **"Forest Opportunity Model"** was developed. The Forest Opportunity Model evaluates forest opportunity on individual quarter acre cells across the state with 8 Data Sets. Each cell gets a score of up to 10 points for each Data Set, and then a composite score of up to 80 points (8 data sets times 10 points) which is used to compare the forest opportunity between cells.

Forest Opportunity Model Data Sets:

Forest Benefits and Attributes:
1. Biodiversity
2. Forest Productivity and Carbon Sequestration
3. Soil and Water Conservation
4. Recreation and Social Values
5. Forest Patch Size

Forest Vulnerabilities:
6. Current Harvest Pressure
7. Insect and Disease Vulnerability
8. Housing Density Projections

The first five Data Sets represent important "benefits and attributes" of forests. The last 3 Data Sets represent significant "vulnerabilities" to sustainability which could be minimized through implementation of our Forest Resource Strategy. Essentially, the more important a cell is, plus the more vulnerable the cell is to stressors which we can positively influence, the greater the "opportunity".

An example of how this works is Labarque Creek watershed in Jefferson County. This watershed is of especially high importance for biodiversity and public drinking water quality, but it is also under great development pressure. This development pressure could be minimized through practices such as "smart growth planning", conservation easements, and working with landowners. Therefore, this landscape is a good place to invest resources. Other areas may be just as ecologically important, but are less vulnerable to degradation. Therefore, it is less urgent to invest resources in these places. Some other places might be even more vulnerable than Labarque Creek watershed, but less able to provide important benefits. Therefore, they pose less opportunity as well.

The following pages provide a more thorough description of the Forest Opportunity Model Data Sets, and the composite model results.

Data Set One: Biodiversity

Description: This data set includes three primary components: 1) Conservation Opportunity Areas (COA) identified in Missouri's Comprehensive Wildlife Strategy which include significant forest and woodland components; 2) Forest/woodland dominated Natural Areas (NA); and 3) Forest-dependent natural heritage points and hot spots. NAs and heritage points/hotspots include a 1/4 mile-wide buffer. Points are allocated as follows:

> Cells which are within a COA <u>and</u> NA or heritage point/hotspot = 10 Points
> Cells which are within a COA only = 8 points
> Cells which are within a NA or heritage point/hotspot, but not in a COA = 8 points

Significance: This layer represents areas in which forest/woodland conservation and restoration has the greatest potential to conserve Missouri's biological diversity.

Data Sources: Comprehensive Wildlife Strategy COAs (which includes aquatic COAs), MDC's Natural Areas Database, MDC's Natural Heritage Database
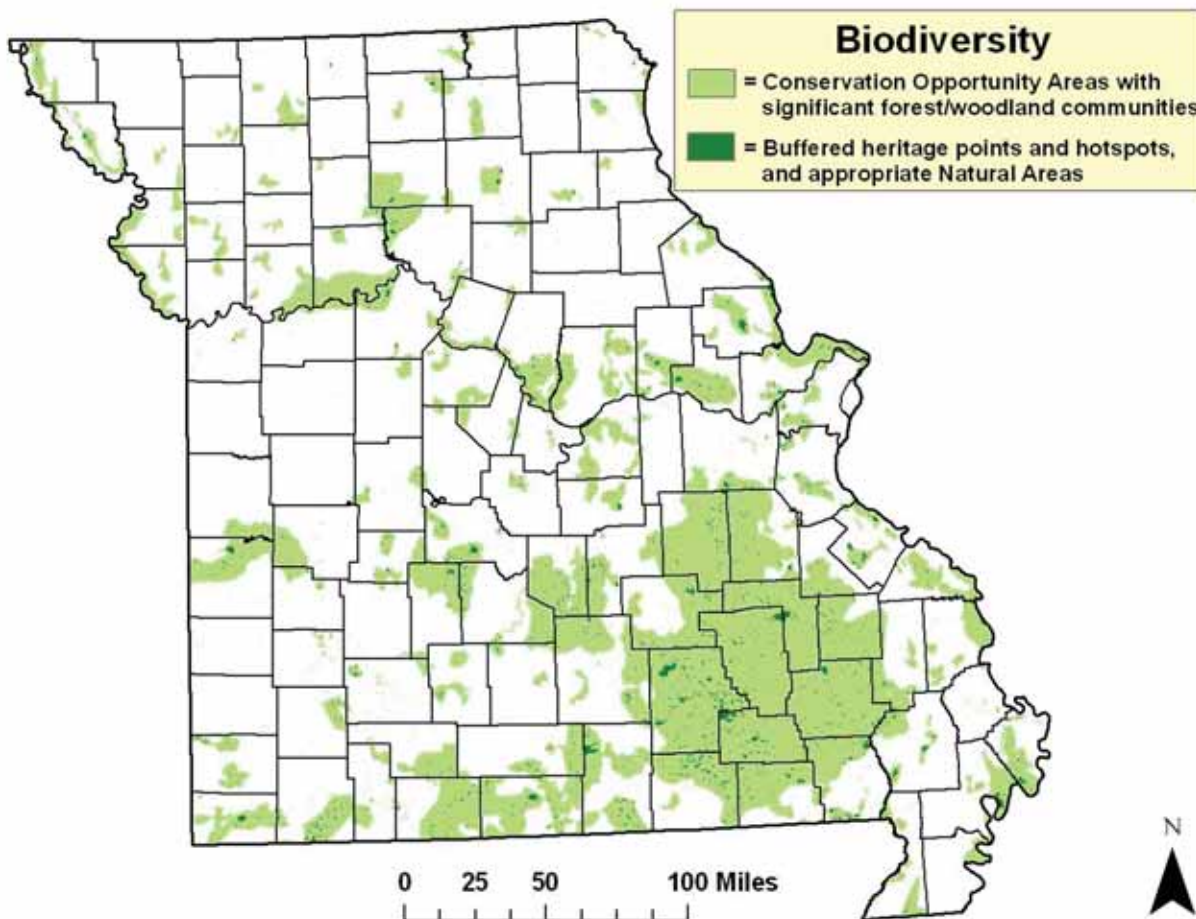
Data Set Two: Forest Productivity and Carbon Sequestration

Description: This data set includes areas well suited to forest/woodland with the greatest potential to produce quality timber and sequester carbon. Historic vegetation mapping (1795-1852) is used with the following assumptions: 1) Areas which were historically forest or closed woodland are well suited to this cover type and are generally productive; 2) Areas which were historically open woodland are generally less productive than forests and closed woodlands; 3) Areas which were historically barren/scrub are transitional sites that are variably well suited to forest/woodland, and variably productive; and 4) Areas which are currently forest/woodland, but were not historically forest/woodland may be growing on sites better suited to prairie or glade. However, these forests still contribute to production and carbon sequestration. Points are allocated as follows:

> Cells which were historically Forest or Closed Woodland = 10 points
> Cells which were historically Open Woodland = 8 points
> Cells which were historically Barren/Scrub = 6 points
> Cells which are currently forested, but were not historically = 4 points

Relevance: This layer represents: 1) areas with the greatest potential for producing high quality forest products; 2) areas which are most likely to be targeted for harvesting; 3) non-forested areas which are particularly well suited to reforestation; and 4) areas capable of sequestering and storing significant amounts of carbon (This assumes that highly productive sites can store more carbon. However, more research is needed).

Data Sources: National Land Cover Database – 2001; Historic Vegetation Map – Geographic Resources Center, Department of Geography, University of Missouri.

Forest Productivity and Carbon Sequestration

Legend:
= Historic Forest/Closed Canopy Woodland
= Historic Open Woodland
= Historic Barren/Scrub
= Existing forest/woodland which was not historically forest/woodland

0 25 50 100 Miles

# Data Set Three: Soil and Water Conservation

Description: This layer is comprised of two general criteria: 1) Areas identified as priority drinking water supply forest watersheds in the U.S. Forest Service's Forests, Water and People Assessment (Barnes 2009); and 2) Existing and potential riparian forests. Points are allocated as follows:

> 200 foot-wide stream buffers on each side of permanent "blue line" streams, and 100 foot-wide stream buffers on each side of intermittent "blue line" streams are automatically considered Forest Opportunity Area.
>
> Non-buffer areas within high priority watersheds (top FWPA tiers) = 6 points

Relevance: This layer represents: 1) forest areas in which protection of water quality is of the greatest importance for maintaining clean and affordable public drinking water supplies; 2) areas with the greatest potential for minimizing soil loss and maintaining or improving water quality (riparian buffers).

Data for this layer comes from the following sources: USFS's Forests, Water and People Assessment (Barnes 2009), National Hydrography Dataset (NHD) Data
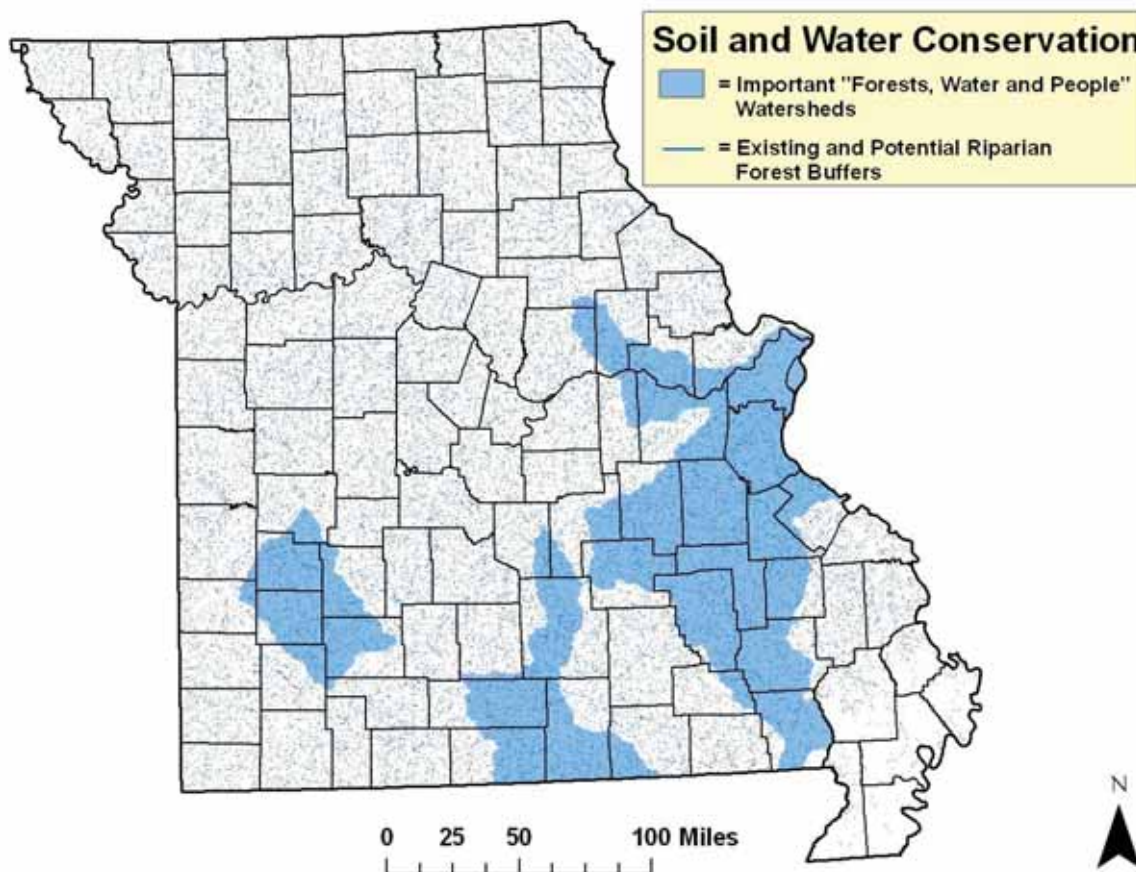
Data Set Four: Recreation and Social Values

Description: This data set includes publicly-owned land (mostly forested, but not all) plus privately-owned land under conservation easement or other legal protection to prohibit development, to the extent that this information is available. Collectively, these tracts will be referred to as "reserves". This layer also includes buffers around reserves:

  Cells on public and private forest reserves = 10 points
  Cells within ½ mile of reserves = 10 points
  Cells ½-1 mile distance of reserves = 8 points
  Cells 1-2 mile distance of reserves = 6 points

Relevance: Publicly-owned forest land provides terrific recreation opportunities, aesthetics, psychological benefits and more. Privately-owned forest reserves also provide a number of social and intrinsic values. These tracts are expected to remain forested indefinitely and generally have legal requirements for sustainable forest management practices. Buffers around forest reserves help to maintain the ecological and social integrity of these reserves. Besides the great importance of forest reserves to the public, they are also especially worthy of enhanced funding and attention because there is assurance that such investment will be sustained into the future.

Data for this layer comes from the following sources: MDC's public land data, plus data provided by the Natural Resources Conservation Service, Ozark Regional Land Trust and The Nature Conservancy on privately owned protected land.

Recreation and Social Values
- = Forest reserves plus 1/2 mile buffer
- = 1/2 to 1 mile buffer
- = 1 to 2 mile buffer

0 25 50 100 Miles

# Data Set Five: Forest Patch Size

Description: Large contiguous forest patches.

> Cells in forest patches > 1,000 acres = 10 points
> Cells in forest patches 500-1,000 acres = 8 points
> Cells in forest patches 250-500 acres = 6 points
> Cells in forest patches 100-250 acres = 4 points

Relevance: Large forest patches are better able to provide many benefits compared to smaller forest patches. Large forest patches provide unique habitat for fish and wildlife which helps to maintain Missouri's plant and animal biodiversity. Larger forest patches provide greater flexibility in forest management options – including prescribed fire, timber harvesting, and non-commercial thinning. Larger forest patches are also better able to provide environmental services such as clean water and carbon sequestration compared to more fragmented forests. An additional advantage of large forest patches is that they are less vulnerable to numerous negative "edge" effects such as exotic invasive plants, animals and diseases.

Data for this layer comes from the following sources:
MDC analysis of 2001 National Land Cover Database data
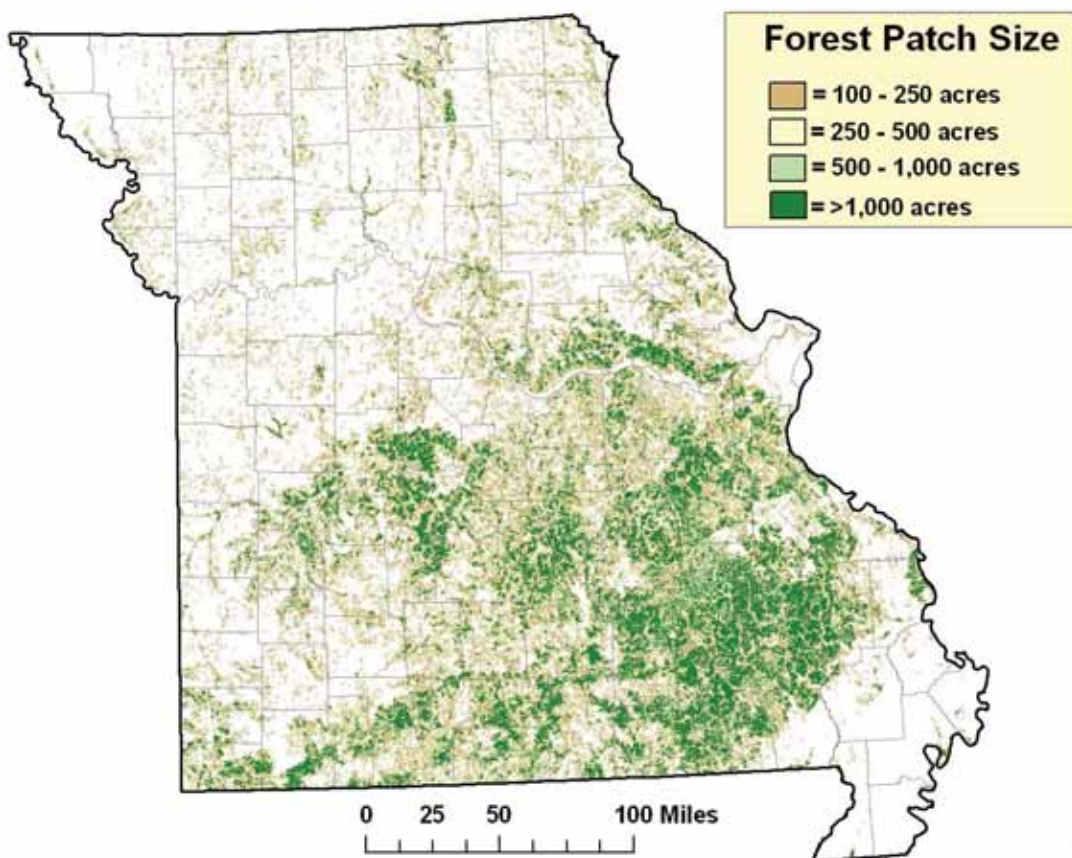
Data Set Six: Current Harvest Pressure

Description: Forestland rated by current harvest pressure per forest acre per year based on Primary Wood Processor Survey data. Sawmill output and sourcing radius is extrapolated to determine average harvest pressure per acre of existing forest per year. Areas experiencing the greatest pressure get the most points:

> Cells in the top tier (>28 board feet/forest acre/year) = 10 points
> Cells in the next tier (13-28 board feet/forest acre/year) = 8 points
> Cells in the next tier (<13 board feet/forest acre/year) = 6 points

Relevance: Areas of greater current harvest pressure have a greater need for forester availability to ensure harvesting is conducted in a sustainable manner. This also represents areas in which communities are especially economically dependent on the harvest and production of forest products.

Data for this layer comes from the following sources: MDC's Primary Wood Processor Survey information and 2001 NLCD data
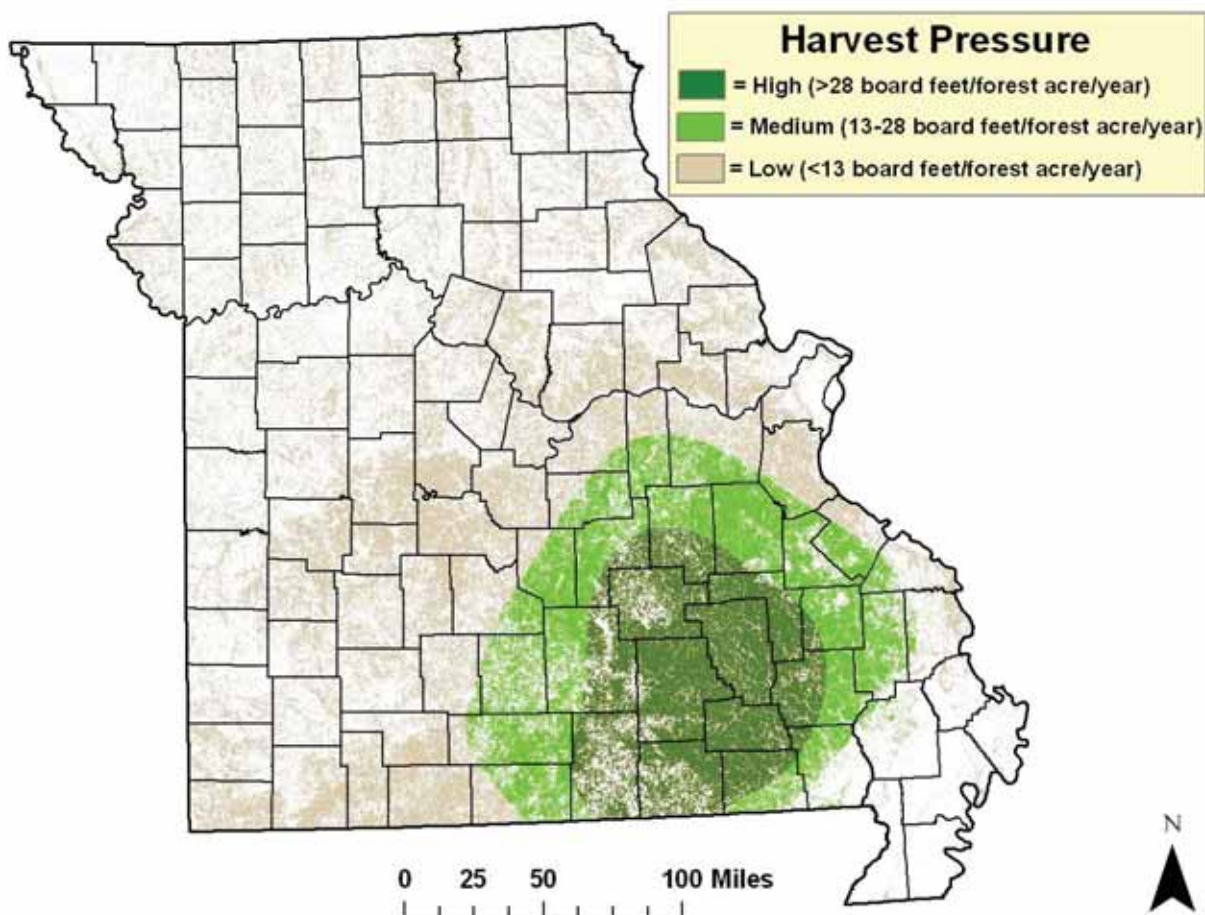
# Data Set Seven: Insect and Disease Vulnerability

Description: Areas most prone to tree mortality from insects and diseases from 2006 through 2020. Red oak group decline is the primary influencer, but ash decline, Dutch elm disease and gypsy moth are also incorporated into this assessment.

> Cells with projected tree mortality of >25% basal area = 10 points
> Cells with projected tree mortality of 16-25% basal area = 8 points
> Cells with projected tree mortality of 5-15% basal area = 6 points

Relevance: This layer represents areas most prone to tree mortality from insects and diseases from 2006 through 2020. These areas need increased attention to minimize mortality and/or economic losses, and to ensure a healthy forest emerges following mortality.

Data for this layer comes from the following sources:
U.S. Forest Service National Disease and Risk Map
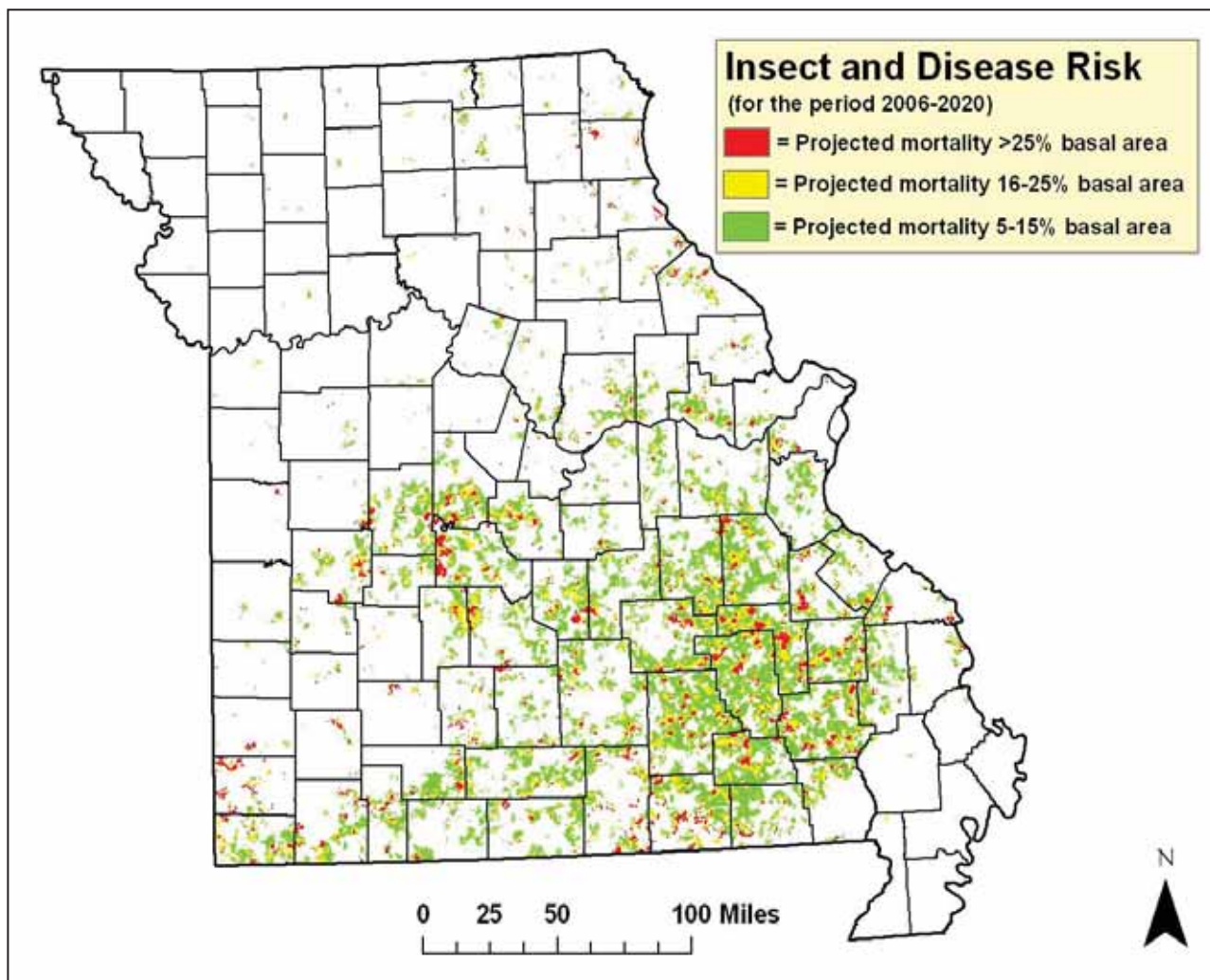
Data Set Eight: Housing Density Projections

Description: Areas identified as vulnerable to development through 2030*.

> High projected increase in housing density = 10 points
> Moderate projected increase in housing density = 8 points
> Low projected increase in housing density = 6 points

Relevance: These areas are subject to increased threat of development, fragmentation and parcelization in the next ~20 years. These threatened areas which overlap with FOAs represent high priority areas for targeting land conservation efforts (smart growth planning, conservation easements, etc.).

Data Source: Housing Density Projection Assessment (Theobald 2004a&b)

* Measured at the census block level using the projected change in acres/housing unit.
- High projected housing density increase ≥15 acre decrease in acres per housing unit.
- Moderate projected housing density increase = 10-15 acre decrease in acres per housing unit.
- Low projected housing density increase = 5-10 acre decrease in acres per housing unit.

For example, if a census block with 30 acres per housing unit is projected to change to 18 acres per housing unit (due to increased houses), there is a 12 acre projected decrease of acres per housing unit, which is considered Moderate.

Housing Density Projections Through 2030

- = High projected increase in housing density
- = Mod. projected increase in housing density
- = Low projected increase in housing density

0   25   50   100 Miles

N
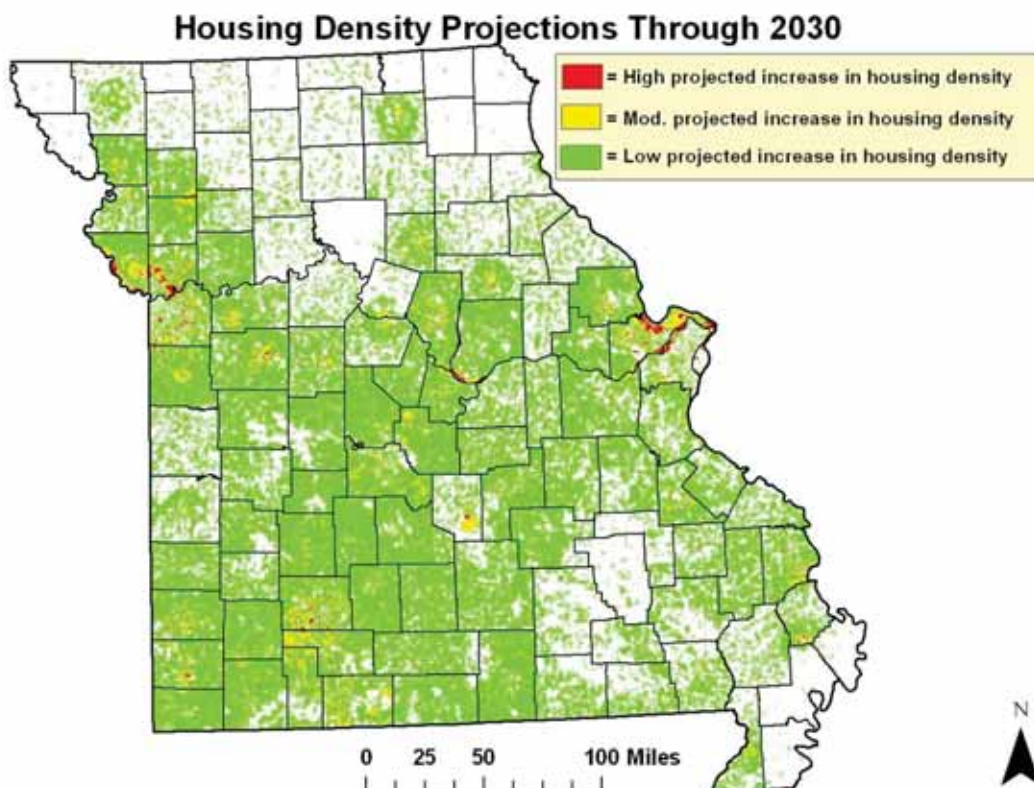
Forest Opportunity Model - Composite Score Map

As the Data Set scores for each ¼ acre cell are added up, they result in the following Composite Score Map. On the color spectrum shown below, the darkest areas represent the greatest opportunities for sustaining forests and forest benefits.

Composite Map

Legend
(points per 1/4 acre cell)

Forest Opportunity Model Values

Value

High : 76

Low : 0

0   25   50   100 Miles
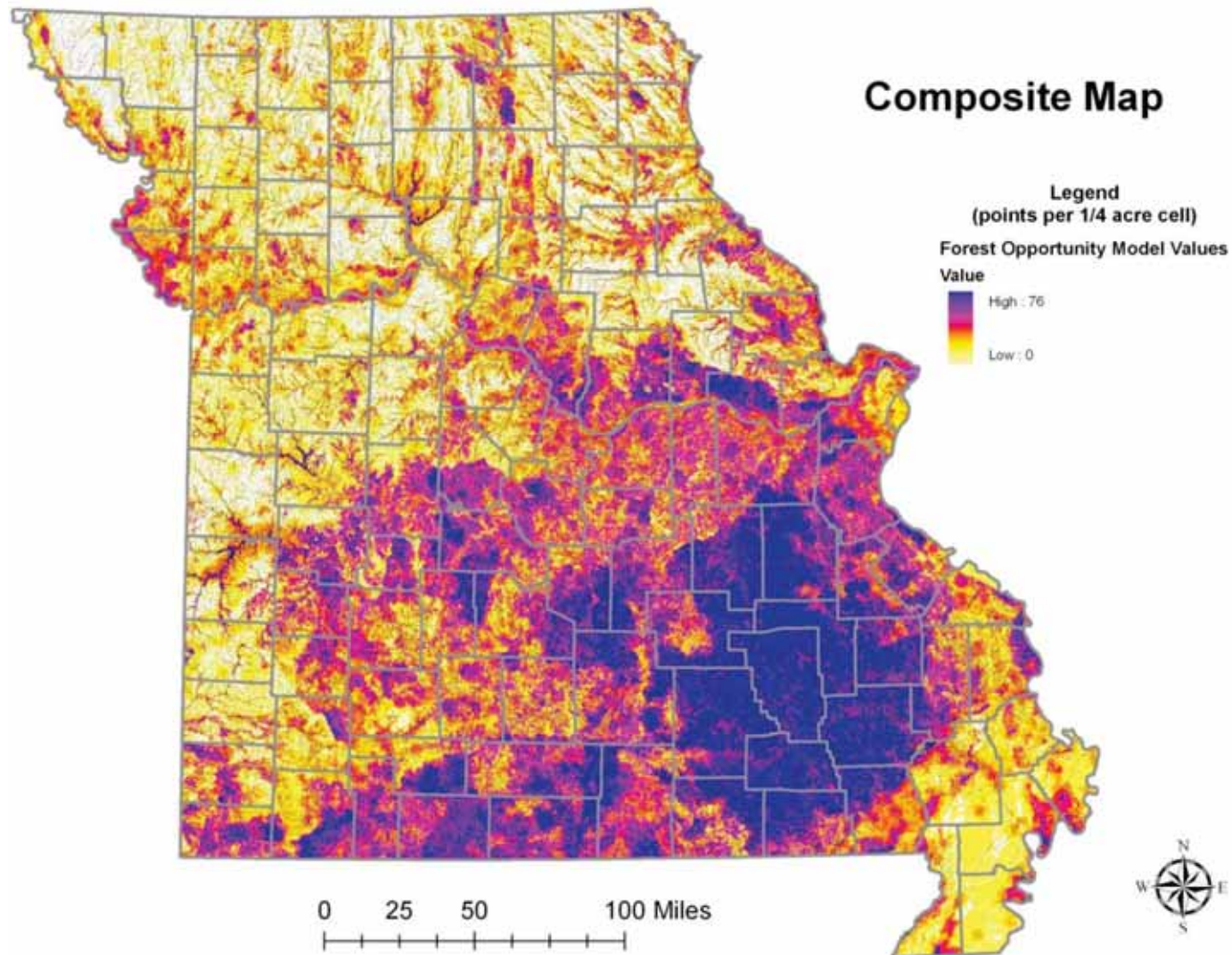
Rural/WUI Forest Opportunity Area Designation

Building upon the Forest Opportunity Model, the following places are recognized as Rural/WUI Forest Opportunity Areas:

1. The highest scoring tier of ¼ acre cells[29] from the Forest Opportunity Model.
2. All riparian areas within 200 feet of permanent "blue line" tributaries and 100 feet of intermittent "blue line" tributaries[30].
3. The highest scoring tier of watersheds using the Forest Opportunity Model[31].
4. Additional areas which uniquely promote the Seven Criterion of Forest Sustainability, upon approval of the State Forester.

Much of Missouri's Forest Opportunity Areas are also recognized as Priority Forest Landscapes. **Priority Forest Landscapes (PFL)** are large landscapes (generally >10,000 acres) of concentrated FOA. PFLs will be used for strategic planning, stakeholder collaboration, and conservation marketing. All areas within a PFL are considered FOA.

The following map shows the resulting Forest Opportunity Areas, including PFLs. On this map, approximately 50% of Missouri's existing forestland is recognized as Forest Opportunity Area.

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[29] Tiers are established by applying three natural breaks using ArcGIS. All cells scoring 0 points were dropped out prior to calculating the natural breaks.

[30] FRAS recognizes that some riparian areas may be well suited to grassland uses as well. However, delineating which riparian areas are better suited to forest vs. grassland has proven to be problematic. FRAS includes all riparian areas and leaves it to the discretion of the land manager to make this determination.

[31] For this calculation, each 12 digit HUC watershed was given an average score using the Forest Opportunity Model. Tiers were then established by applying three natural breaks using ArcGIS.

Rural/WUI Forest Opportunity Areas

= Rural Forest Opportunity Area

= WUI Forest Opportunity Area

= Priority Forest Landscape
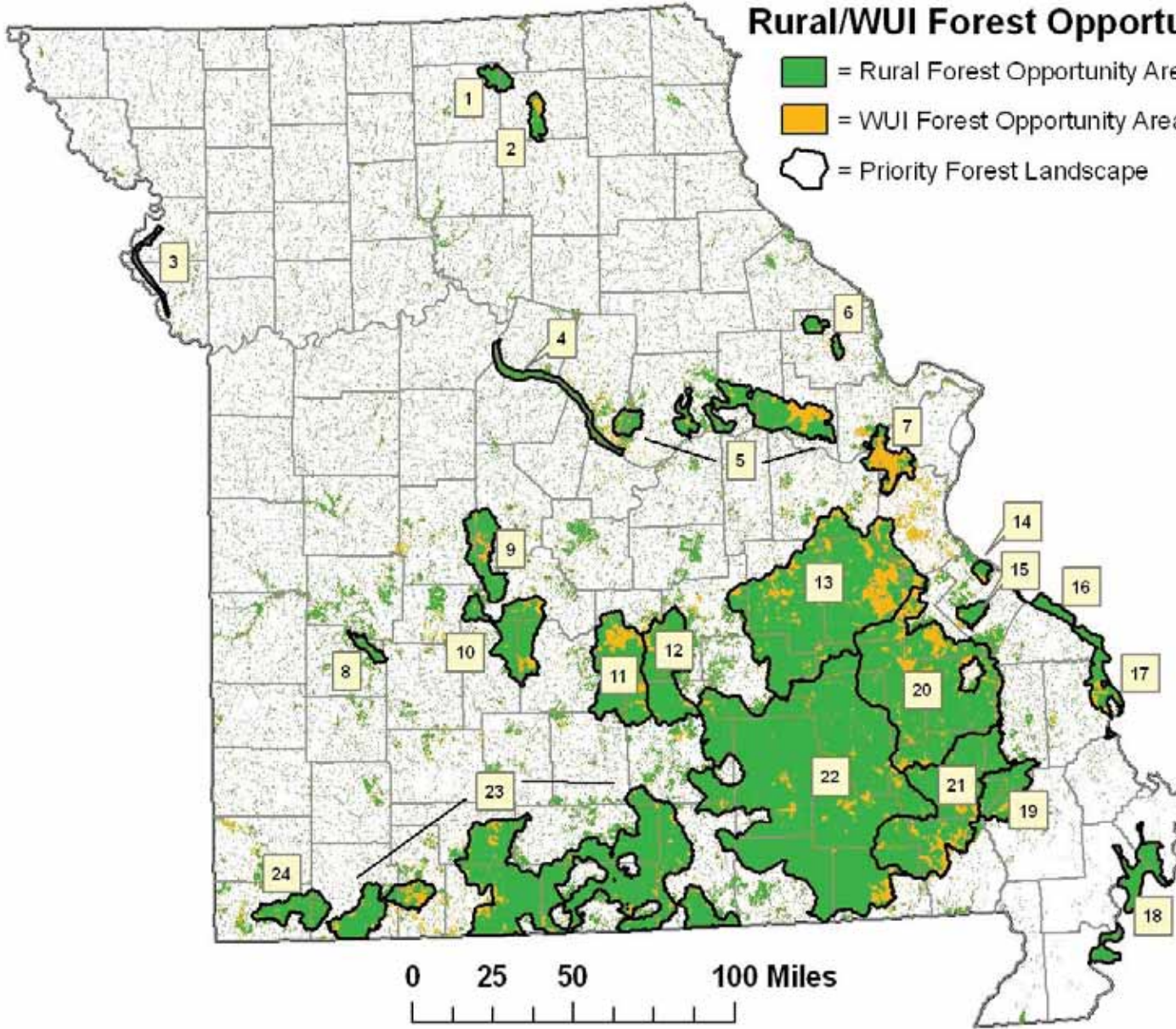
Priority Forest Landscapes:
1. Union Ridge
2. Thousand Hills Woodland
3. Iatan/Weston
4. Manitou Bluffs
5. Missouri River Hills
6. Cuivre River Hills
7. Lower Meramec/Missouri
8. Lower Sac
9. Lake of the Ozarks
10. Niangua Basin
11. Upper Gasconade
12. Big Piney
13. Meramec River Hills
14. Establishment Creek
15. Jonca Creek
16. Middle Mississippi
17. Cape Hills
18. River Bends
19. Mingo Basin
20. St. Francois Knobs
21. Black River Ozark Border
22. Current River Hills
23. White River Hills
24. Elk River Hills

0 25 50 100 Miles

N

Synergies with
Missouri's Comprehensive Wildlife Strategy (CWS)

CWS identifies 19 forest/woodland Conservation Opportunity Areas (COA) with dedicated stakeholder groups. These COAs nest almost entirely within PFLs. While the goals of FRAS and CWS vary slightly, these two initiatives have much in common. FRAS will work closely with these COA stakeholder groups for the purposes of collaborating on strategies, marketing, applying for grants, etc. Detailed profiles of each of these COAs can be found in CWS's "Directory of Conservation Opportunity".

A FRAS strategy will be to develop additional stakeholder groups tied to PFLs.

FRAS/CWS Synergistic Opportunities

= Priority Forest Landscape (PFL)

= PFL and CWS Conservation Opportunity Area (COA) with active stakeholder group

0   25   50   100 Miles
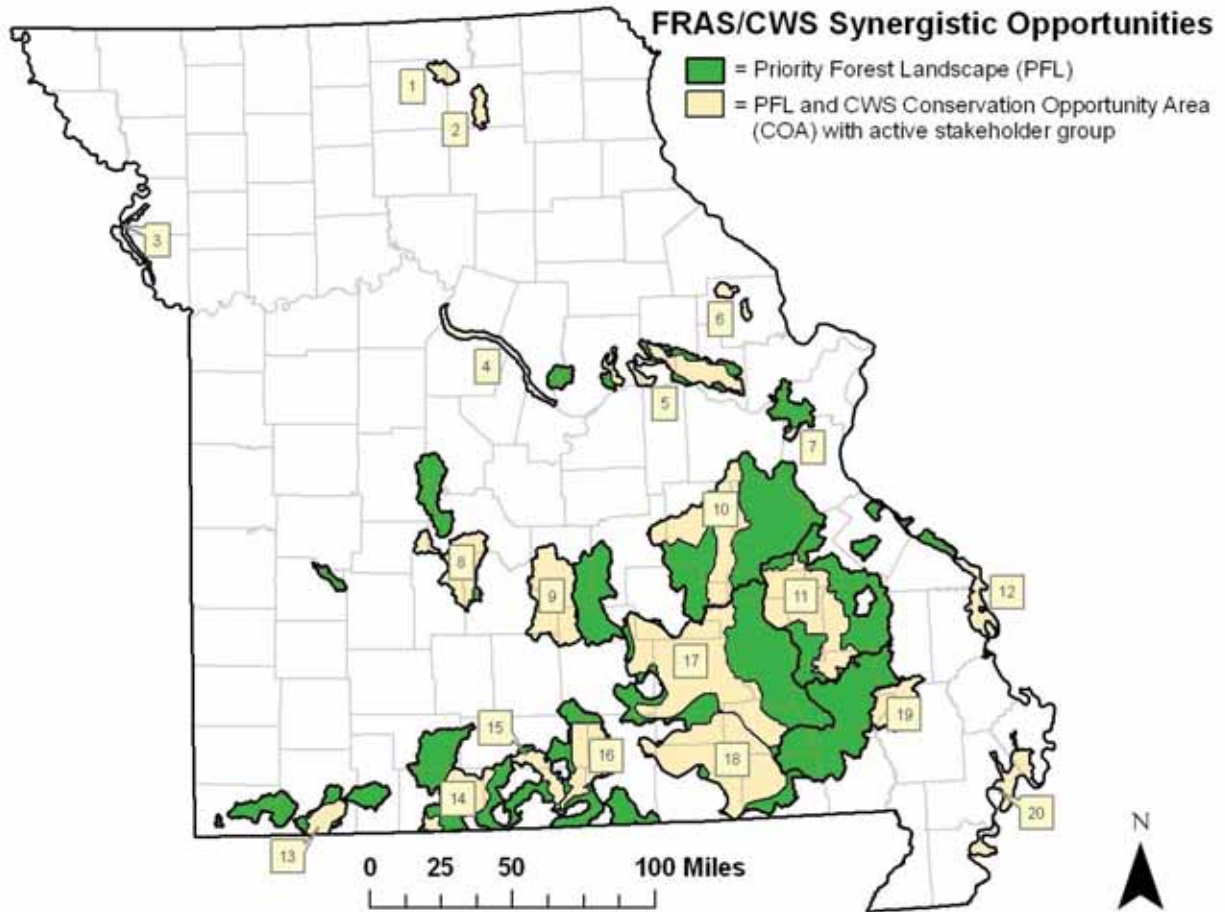
CWS Forest/Woodland Conservation Opportunity Areas with active stakeholder groups:

1.	Union Ridge	11.	St. Francois Knobs
2.	Thousand Hills Woodland	12.	Cape Hills
3.	Iatan/Weston	13.	Roaring River
4.	Manitou Bluffs	14.	White River Glades and Woodland
5.	Missouri River Hills	15.	Bryant Creek
6.	Cuivre River Hills	16.	North Fork
7.	Labarque Creek	17.	Current River Hills
8.	Niangua Basin	18.	Eleven Point Hills
9.	Upper Gasconade River Hills	19.	Mingo Basin
10.	Middle Meramec	20.	River Bends

Urban Forest Opportunity Areas

The issues, threats and opportunities facing urban forests are often different from forests in Rural/WUI areas. Therefore, a separate assessment is needed. Unfortunately, much of the data that would facilitate a high resolution urban forest assessment have not yet been developed. Therefore, FRAS approaches Urban FOAs with a two phase approach:

In Phase One, Urban FOAs are identified as Missouri's 10 largest metropolitan areas, based on population and concentration of impervious surface.   Most FRAS urban forest goals and strategies are oriented towards providing social benefits to people or improving environmental quality in the places that people live, work and play. Therefore, FRAS urban forest efforts will be focused on areas with the greatest concentrations of people.

Urban Forest Opportunity Areas

Urban FOA:	U.S. Census Bureau Population Estimate 2008	Population estimate includes these counties:
St. Louis	2,014,235	St. Louis County and City, St. Charles, Jefferson, Franklin
Kansas City	1,091,894	Jackson, Clay, Cass, Platt, Ray
Springfield	342,423	Greene, Christian
Columbia/Jefferson City	272,142	Boone, Cole, Callaway
Joplin	172,933	Jasper, Newton
St. Joseph	106,331	Andrew, Buchanan
Lake of the Ozarks	86,474	Camden, Morgan, Miller
Branson	78,574	Stone, Taney
Cape Girardeau	73,243	Cape Girardeau

Strategies pursued in Phase One will be oriented towards developing better information in Urban FOAs so that a more complete assessment of urban forest needs and opportunities can be done in the future. Potential strategies might include Urban Tree Canopy Assessments, Green Infrastructure Planning, and i-Tree Eco and i-Tree Street analyses.

Phase Two will incorporate newly generated data into a more informative, finer resolution urban forest assessment. At that time, Urban FOAs will likely be revised accordingly. Phase Two is expected to take place in five years when FRAS is scheduled for revision.

The following map shows Urban FOAs nested within concentrations of impervious surface and forested wildland/urban interface. Distinct boundaries of urban forest opportunity areas are not delineated due to the variability of urban Strategies.   For instance, the impervious surface layer might work very well for Urban Tree Canopy Assessments. However, regional council of government district boundaries might work better for Green Infrastructure Planning.

Urban Forest Opportunity Areas

■ = Urban Areas (impervious surface)
□ = Forested Wildland Urban Interface
City = Urban Forest Opportunity Area

St. Joseph

Kansas City

Columbia

Jefferson City

St. Louis

Lake of the Ozarks

Cape Giraurdeau

Springfield

Joplin

Branson
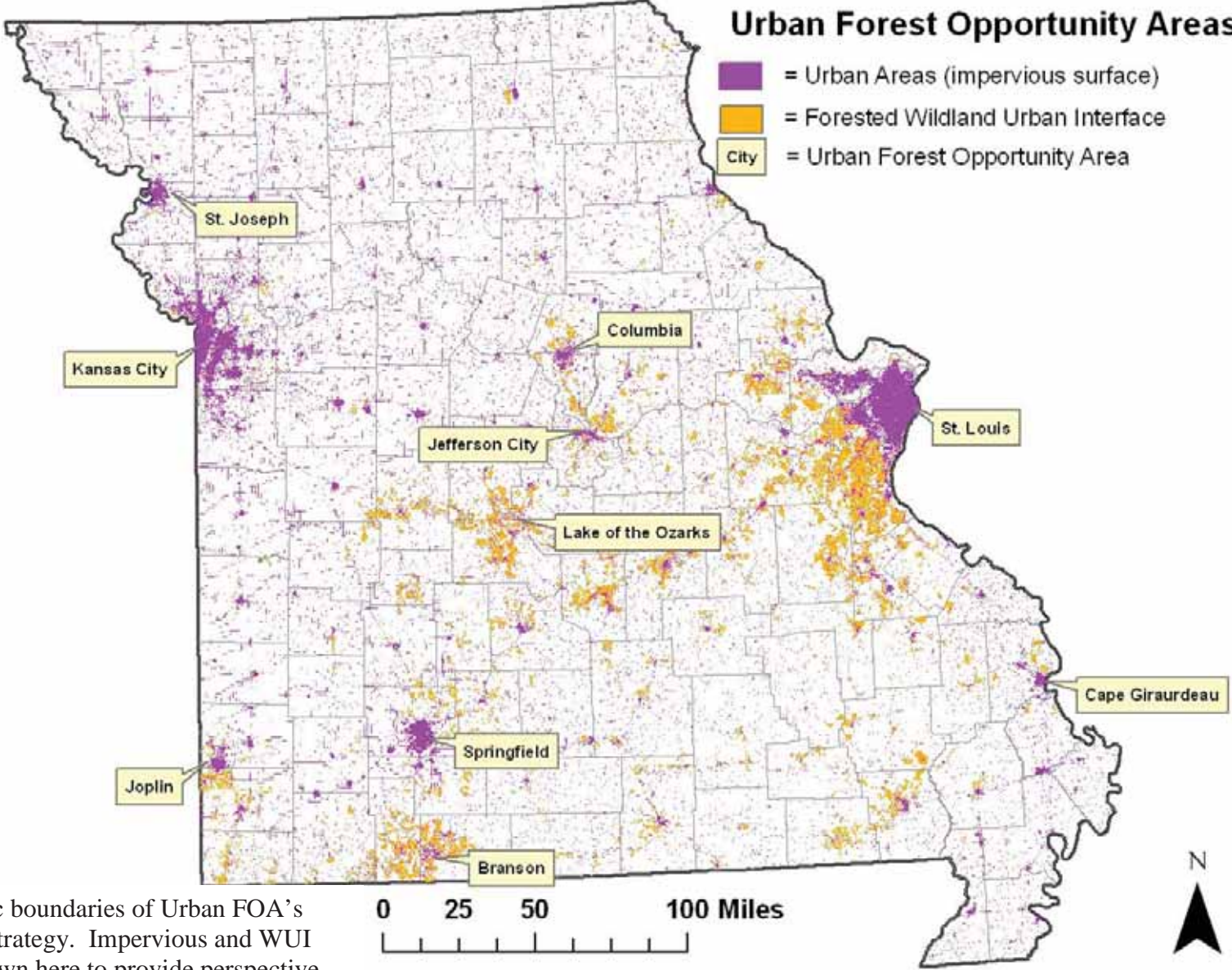
Note: Specific boundaries of Urban FOA's will vary by strategy. Impervious and WUI layers are shown here to provide perspective.

0   25   50   100 Miles

N

Combined Map of Forest Opportunity

= Rural Forest Opportunity Area
= WUI Forest Opportunity Area
= Urban Forest Opportunity Area (shown by impervious surface)
= Priority Forest Landscape
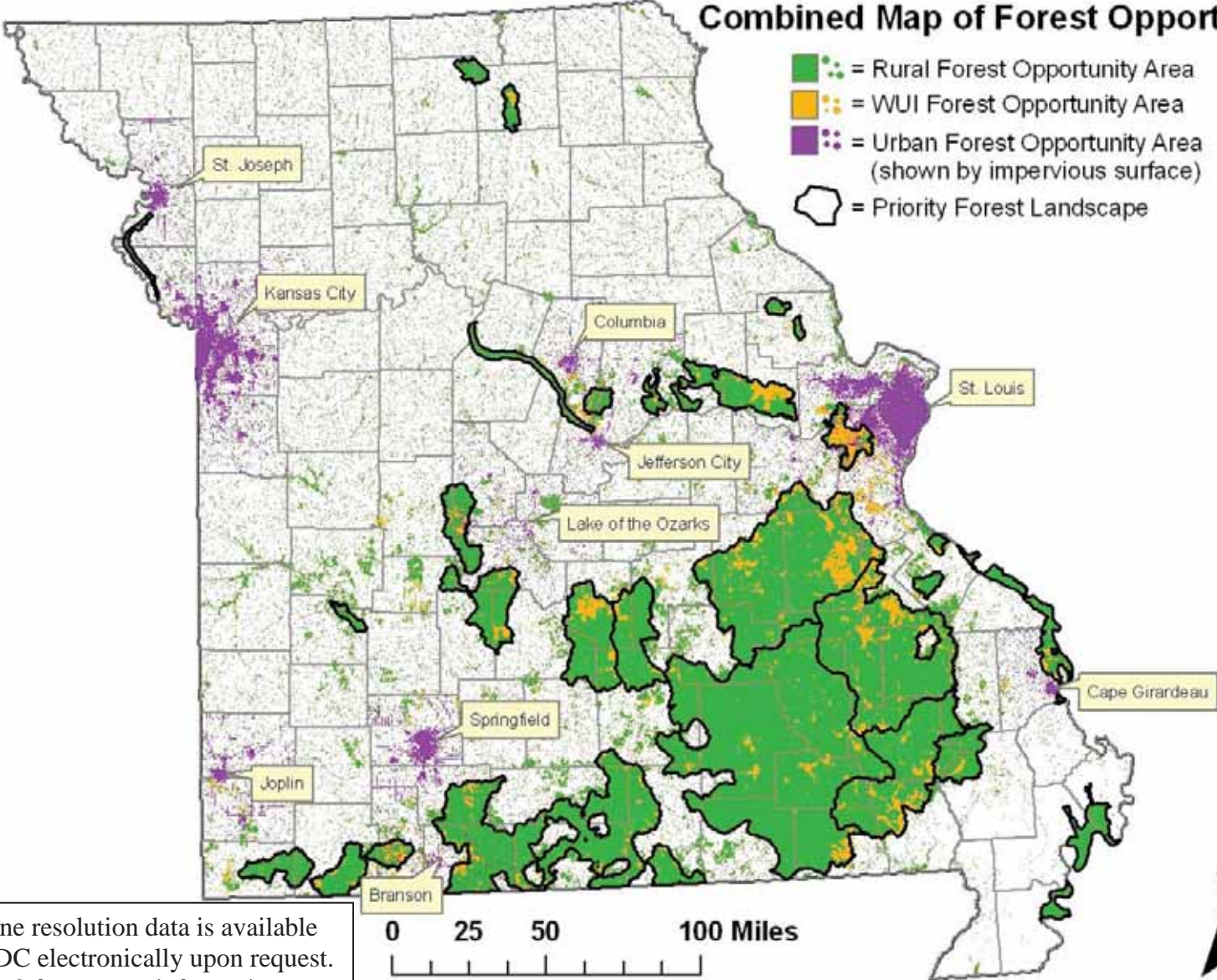
Note: Fine resolution data is available from MDC electronically upon request. See page 2 for contact information.

0   25   50   100 Miles

Missouri's Forest Resource Assessment and Strategy

Multi-State Priority Areas and Issues

Multi-State Priority Areas and Issues are geographies and/or issues which benefit significantly from multi-state collaboration. The "Areas and Issues" designations are not exclusive. Multi-State Priority Areas are typically given priority status because of one or more critical forest related issues. Multi-State Priority Issues are often bound by particular geographies – though not always. The following list of Multi-State Priority Areas and Issues includes several existing and potential priority areas and partnerships. By and large, potential multi-state priority areas and issues have not been explored with neighboring states. This is because insufficient funds are available to pursue such additional projects at this time. However, potential opportunities are listed below in case such funding would become available in the 5-year period covered by this Assessment and Strategy.

Existing and Potential Multi-State Areas and Issues

#	Existing or Potential	Name	States	Issue/Description	U.S. Forest Service Write-up Available?
1	Potential	St. Louis Metro Urban Area	MO, IL	Emphasis on urban areas that transcend state lines	No
2	Existing	Kansas City Metro Urban Area	KS, MO	Emphasis on urban areas that transcend state lines	No
3	Potential	Bentonville, AR/Joplin, MO Urban Area	MO, AR, OK	Emphasis on urban areas that transcend state lines	No
4	Existing	Upper Mississippi River Forest Watershed	MN, WI, IA, IL, IN, MO	Water pollution, loss of migratory bird habitat, forest loss and fragmentation	Yes, see Appendix E Pg 194
5	Existing	Lower Mississippi bottomland areas (i.e. River Bends COA)	MO, KY, TN, IL	Loss of bottomland forests, forest fragmentation, restoration potential	No, but COA Action Plan has been developed for MO.
6	Potential	Weston Bend COA/Fort Leavenworth	MO, KS	Forest/woodland landscape restoration opportunities, enhanced by recent COE acquisitions	No, but COA Action Plan has been developed for MO.
7	Potential	Missouri/Mississippi Rivers Confluence	MO, IL	Habitat restoration and recreational opportunities.	No, but COA Action Plan has been developed for MO.
8	Potential	Missouri River corridor and watershed	MO,KS,NE,SD, ND,CO,WY,MT	Habitat restoration, water quality and recreational opportunities.	No
9	Existing	Big Rivers Fire Compact	IA, IL, IN MO	Fire	Yes, see Appendix E Pg 197
10	Potential	Ozark Highlands forest/woodland restoration	MO, AR, OK, IL	Forest/woodland landscape restoration opportunities (i.e. shortleaf pine restoration/expansion)	No
11	Potential	Ice Storm Recovery Area	MO, AR, KY, TN	Coordinated efforts needed to improve forest health, reduce fuel loading, and improve utilization opportunities for recovery efforts.	No

12	Potential	Karst Topography Areas	IL,IN,IA, KY,MO	Water quality	Yes, see Appendix E Pg 199
13	Existing	Central Hardwoods Joint Venture (Partners in Flight)	MO,AR,KY, TN,OK,IL,IN	Maintain viability of native bird populations	No
14	Potential	Loess Hills	MO,NE,IA	Forest restoration opportunities of a rare community type	No
15	Potential	Biodiversity	Variable	Conservation of sensitive plants and animals (e.g. Indiana bats)	No
16	Potential	Climate Change	IL,IN,IA,MO, WI,MI,MN	Adaptation and mitigation.	Yes, see Appendix E Pg 201
17	Potential	Ecosystem Services	IL,IN,IA,MO, WI,MI,MN	Develop markets for the sustainability of ecosystem services.	Yes, see Appendix E Pg 203
18	Potential	Forestation/Reforestation	IL,IN,IA,MO, WI,MI,MN	Reforestation of important natural community types	Yes, see Appendix E Pg 206
19	Potential	Sustaining forest industry and markets	IL,IN,IA,MO, WI,MI,MN	Maintain markets for forest products and ecosystem services.	Yes, see Appendix E Pg 208
20	Potential	Promote Active and Sustainable Private Forest Management	IL,IN,IA,MO, WI,MI,MN	Sustainability of privately-owned forests.	Yes, see Appendix E Pg 210
21	Potential	Urban Forest Inventory and Analysis	MO, WI and possibly others	Improved urban forest data.	Yes, see Appendix E Pg 212
22	Potential	Invasive Species	IL,IN,IA,MO, WI,MI,MN	Reduce the threat of invasive forest insects, diseases and plants.	Yes, see Appendix E Pg 214

Chapter Four: The Strategy

In Chapter 3, a comprehensive Assessment was presented to describe: 1) the myriad of benefits and opportunities offered by Missouri's forests, 2) the threats affecting the ability of these forests to provide benefits and opportunities into the future, and 3) a list of Desired Future Conditions established by Missouri's diverse forest stakeholders.   Chapter 4 (the Strategy) incorporates these Assessment findings into a comprehensive list of individual strategies designed to best achieve these Desired Future Conditions (DFCs).

Missouri's Strategy includes seventy-seven individual strategies - organized by the Eleven Issue Themes established in the Assessment. In reality, each strategy addresses multiple Issue Themes. However, each strategy is listed only once under the most appropriate heading. Therefore, in order to properly achieve a specific DFC, it is necessary to consider strategies listed under all related Issue Themes.

Individual strategies are presented here in two different formats. The first format is a simple "List of Strategies" by Issue Theme. This format is intended to serve as a simple and quick overview and reference.

Following the List of Strategies is a more comprehensive "Strategy Matrix". The Strategy Matrix is a table which provides more detailed information on each strategy to help explain how strategies might be implemented, where efforts will be targeted, why the strategy is important, what people and resources are needed for implementation, and what are our benchmarks for success.

List of Strategies – Organized by Issue Theme

Issue Theme One - Private Forest Landowner Demographic Trends and Corresponding Land Use Changes: Missouri's family forest landowners are getting older. This trend, paired with other factors such as increasing land prices, real estate taxes and economic hardships are making Missouri's privately owned forestland increasingly vulnerable to threats such as forest conversion, fragmentation, parcelization and urban sprawl.

Forest Land Conservation Strategies:
1.1.1. Provide successional planning information to landowners to help facilitate the smooth and sustainable transition of property to the next generation of landowners.
1.1.2. Focus development in less ecologically important areas utilizing smart growth principles.
1.1.3. Develop and implement a strategic forest land conservation program in order to protect tracts and forests of especially high public benefit.

Small Acreage Landowner Assistance Strategies:
1.2.1. Develop effective and efficient techniques for assisting small acreage landowners.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 2-6, 8, 9 & 11.

Issue Theme Two - Challenges and Opportunities for Private Forest Landowners:
Private forest landowners face a number of challenges and opportunities which affects their ability to manage forestland sustainably. Professional foresters, loggers and contractors exist, but are not always readily available. Furthermore, taxes, ordinances and forest investment costs can impact a landowners ability to make management decisions based on long term conservation objectives. Despite these challenges, new opportunities are developing such as ecosystem service markets, biofuels markets, and conservation easement programs. These and other developments could significantly change the face of private land ownership in the future.

Technical Assistance Strategies:

2.1.1. Increase the availability and credibility of quality foresters, loggers and contractors able to help landowners set and achieve personal objectives through sustainable forest management practices.

2.1.2. Provide technical information, assistance and financial help to private landowners which enables them to make and carry out informed management decisions towards healthy and sustainable forests.

Ecosystem Service Markets, Programs and Incentives Strategies:

2.2.1. Develop and promote markets for ecosystem services, such as carbon sequestration and clean drinking water, and incentives which make sustainable forest management a more affordable option for private landowners.

Private Landowner Awareness Strategies:

2.3.1. Increase private landowner awareness of important forestry threats and opportunities, and the important role their property contributes to particular watersheds, landscapes or initiatives.

Public Awareness Strategies:

2.4.1. Increase awareness of the general public and local decision makers regarding the existing and potential ecosystem services offered by privately owned forests (i.e. clean drinking water) to the extent that they are willing to support programs which enable landowners to cost effectively manage their forests sustainably for the greater public good.

Private Landowner Recognition Strategies:

2.5.1. Recognize landowners who contribute significantly to forest conservation and sustainability.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 5, 6, 7, 10 & 11.

Issue Theme Three - Climate Change: Without taking appropriate precautions, Missouri's trees and forests could be highly vulnerable to potential changes in climate. There is much we do not know about how climate change will take form in Missouri. However, forest management practices can make our forests more resilient and adaptable regardless of how our climate changes. These same practices pose many other benefits to our forests such as improved overall forest health, productivity and wildlife habitat. The threat of climate change simply underscores the importance of these practices. Issue Three also explores the important role Missouri's forest resources could play in mitigating climate change.

Climate Change Adaptation Strategies:
3.1.1. Increase the adaptability of Missouri's forests to uncertain changes in climate.

Climate Change Mitigation Strategies:
3.2.1. Promote the role of forests and forest products in sequestering carbon and mitigating the potential effects of carbon emissions.

Climate Change Research Strategies:
3.3.1. Conduct research to increase our understanding of carbon sequestration, climate change, potential impacts and management implications.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, & 4-11.

Issue Theme Four - Maintaining High Quality Soil and Water Resources: Trees and forests, when managed properly, are highly effective at conserving soil and water resources. Forested landscapes produce much of our cleanest and most cost effective drinking water. Riparian forests help hold stream banks in place and filter out pesticides, nutrients and sediments before they can reach streams. Urban trees and forests minimize storm water runoff and associated issues. In order to maintain and enhance the soil and water benefits of trees and forests, existing forest resources must be carefully managed, and reforestation should be conducted in strategic locations. These same efforts will also help to ensure that soils will remain productive and abundant into the future.

Best Management Practices (BMPs) Strategies:
4.1.1. Increase and improve the use of forestry Best Management Practices which protect soil and water resources.

Riparian Forests and Wetlands Strategies:
4.2.1. Maintain existing riparian forests and wetlands, and re-forest priority riparian areas and wetlands which have been converted from forest to non-forest use.

Coordination with Watershed Partnerships and Plans Strategies:
4.3.1. Utilize and promote watershed basin partnerships and plans which incorporate tree and forest strategies to benefit water quality and quantity.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-3, 5-7, & 9-11.

Issue Theme Five - The Role of Fire in Missouri's Forests – Past, Present and Future: Historically, fire played a large role in shaping Missouri's forests and woodlands. Over the last century, Missouri has waged a highly successful campaign to keep wildfires to a minimum. These efforts have done tremendous good in protecting people and property. However, the exclusion of fire is significantly modifying the structure, diversity and function of many forest and woodland communities. Since wildfires can no longer be tolerated, proactive management practices (i.e. prescribed fire, TSI, harvesting) are often needed in order to restore or maintain Missouri's forest resources in a healthy, productive and wildlife friendly condition.

Wildfire Prevention Strategies:
5.1.1. Minimize the occurrence and impact of wildfire through the use of prevention efforts.

Wildfire Suppression Strategies:
5.2.1. Suppress wildfires in order to protect people, property and natural resources through effective collaboration between public agencies and fire departments.

Prescribed Fire Strategies:
5.3.1. Advance the science and understanding of Rx fire in order to better quantify its effects and improve its effectiveness.
5.3.2. Provide resources needed by private landowners to safely conduct Rx fires without the assistance of public agency personnel.

Multi-agency Collaboration and Preparedness Strategies:
5.4.1. Develop an active, multi-agency Fire Council to better foster communication and collaboration concerning wildfire and Rx fire.
5.4.2. Develop Community Wildfire Protection Plans (CWPP).
5.4.3. Monitor fire weather and fuel conditions to determine fire risk and the appropriateness of Rx fire, and communicate information to fire partners.
5.4.4. Monitor wildfires and Rx fires to determine the frequency, acreage & spatial distribution.
5.4.5. Maintain expertise in wildfire suppression and the use of prescribed fire in order to sustain proficiency and preparedness.

Public Awareness Strategies:
5.5.1. Increase public awareness of the benefits of carefully planned and executed Rx fire, the harm of wildfire, and the differentiation between the two.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-3, 6, 7 & 9-11.

Issue Theme Six - Missouri's Growth, Harvest and Consumption of Forest Products: Missouri's forest products industry is an important contributor to Missouri's economy, and supports a number of economic, social and environmental values. Ensuring that these values are maintained into the future means carefully balancing harvest and consumption rates with available growth, and making sure that harvest practices account for long term productivity and sustainability of all forest benefits and services.

Forest Product Market Strategies:

6.1.1. Promote certified forests and certified forest products as a means of encouraging sustainable forest management on private lands and also to maintain Missouri's market share in the forest products industry.

6.1.2. Encourage better utilization of forest products in a way which provides better incentive to landowners for sustainable management.

6.1.3. Promote marketing and branding of Missouri grown forest products.

6.1.4. Steer potentially emerging woody biomass markets, and other potentially emerging markets, in a sustainable direction.

Timber Price Trends Monitoring Strategies:

6.2.1. Monitor and report timber price trends in order to maintain a pulse on demand and to improve trust levels between mills, loggers and landowners.

Forester, Logger and Mill Communications Strategies:

6.4.1. Improve communications between foresters, mills and loggers to provide better understanding of each other's needs, expectations and to increase awareness of long term impacts of management decisions.

Forest Health Strategies:

6.5.1. Develop partnership between governmental agencies and private industry towards minimizing forest health risk from plant, insect and disease threats.

Consumer Strategies:

6.6.1. Encourage the wise consumption of forest products.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-5, 7 &, 9-11.

Issue Theme Seven - Forest Health Threats: Plants, Animals, Diseases and Weather: Missouri's forest resources are vulnerable to a number of current and potential forest health stressors. Exotic and invasive plants (i.e. honeysuckle, garlic mustard, ironwood), insects and diseases (i.e. emerald ash borer, gypsy moth, thousand cankers disease), large animals (i.e. feral hogs, livestock, overpopulated deer), and extreme weather events are posing increasingly detrimental impacts to our forests. Proactive measures are needed in order to avoid preventable forest health issues and minimize harm from health stressors that arise.

Insect and Disease Threat Strategies:

7.1.1. Monitor the current and potential range and extent of new and existing forest insect and disease threats. Strive for early detection of new forest health threats in order to minimize harm, and increase the affordability and effectiveness of control strategies.

7.1.2. Develop, maintain and implement strategic plans for known forest insect and disease pests which pose high current or potential threat.

7.1.3. Conduct and/or compile research on the most effective and efficient methods for addressing miscellaneous tree insect and disease pests.

Invasive Plant Threat Strategies:

7.2.1. Develop geographic information on the range, extent, and level of threat of invasive plants detrimental to forest health.

7.2.2. Develop and implement a strategic plan for protecting forests from exotic and invasive plants in the most effective and efficient manner possible.

7.2.3. Conduct and/or compile research on the most effective and efficient methods for addressing exotic plant species outbreaks.

Forest Health Communications Strategies:

7.3.1. Improve communications and awareness of forest health threats to the public to help citizens identify threats, avoid their establishment, and appropriately address detected outbreaks and occurrences.

Forest Resiliency Strategies:

7.4.1. Improve the overall health of trees and forests in order to make them as resilient as possible to miscellaneous forest health threats.

Feral Hog Strategies:

7.5.1. Reduce or eradicate feral hogs.

Livestock Exclusion Strategies:

7.6.1. Promote the benefits of excluding livestock from the woods, and provide financial resources to landowners to make this possible.

Deer Strategies:

7.7.1. Monitor deer browse impacts where this is a concern and recommend modifying hunting regulations as needed.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 5, 6, 8, 9, 10 & 11.

Issue Theme Eight - The Role of Trees and Forests in Improving Quality of Life and Sustainability in Cities: Urban/community trees and forests provide numerous social, economic and environmental benefits. Urban/community trees and forests decrease storm water runoff, improve air quality, reduce the heat island effect, provide wildlife habitat and aesthetics, decrease energy demands, and much more. Maintaining and enhancing urban forest resources will require better quantification of benefits, existing condition and maintenance needs so that local decision makers can more easily plan and justify investments in urban forest infrastructure.

Public Awareness Strategies:
8.1.1. Increase awareness of the general public and local decision makers regarding the public benefits of urban trees and forests - to the extent that they demand the maintenance and development of green infrastructure and are willing to pay for it.
8.1.2. Increase public awareness of the importance of proper tree selection, planting and maintenance practices, and provide training to municipalities, private arborists, utility workers and homeowners.

Technical Assistance Strategies:
8.2.1. Promote the use of International Society of Arborist certified arborists and Society of American Foresters certified foresters who are trained and qualified to manage urban forests.
8.2.2. Provide technical assistance to communities for developing comprehensive community forestry programs.

Data Strategies:
8.3.1. Gather data to accurately monitor and assess urban forests.

Development BMPs Strategies:
8.4.1. Demonstrate and showcase BMP's for green development with partners.

Recognition Strategies:
8.5.1. Recognize arborists, volunteers, etc. for quality work and contributions.

Urban Wood Waste Strategies:
8.6.1. Develop cost effective and resourceful methods of utilizing wood waste.

Urban Forest Diversity Strategies:
8.7.1. Diversify the urban forests by promoting the use of native species and cultivars which are not as well known, but desirable for urban landscape use.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 7 & 11.

Issue Theme Nine - Public Lands which are Managed for the Greatest Public Good:
Public lands and other protected lands are important assets which are highly valued by society. Beyond the normal benefits and services provided by forests, public forest lands are especially important because they are typically managed under agency mandates for sustainability and conservation, and are generally protected from conversion to other uses such as urban development. Furthermore, due to size, location and management objectives, public forests offer many of Missouri's best opportunities to maintain biodiversity and provide recreational opportunities. Sustaining the benefits of public forest land will require maintaining sufficient funding for management, and carefully balancing the demands of a diverse public and the needs of a diverse forest resource.

Recreation Strategies:
9.1.1. Maintain recreational facilities to provide sufficient, yet efficient public recreational opportunities.

Forest Planning Strategies:
9.2.1. Develop Area/Forest Plans to formalize and guide management objectives and strategies on specific public ownerships.

Public Trust and Awareness Strategies:
9.3.1. Develop better public trust and awareness of public land management needs and activities through enhanced communication, transparency and stakeholder input.

Conflict Avoidance Strategies:
9.4.1. Manage and maintain public lands in a way which minimizes potential conflicts and impacts between different user groups and interest groups.

Forest Land Conservation Strategies:
9.5.1. Develop and implement a strategic forest land conservation program with goals of: 1) Acquiring or otherwise protecting tracts key to maintaining or enhancing the value of existing public lands; 2) Acquiring or otherwise protecting tracts key to providing other important public benefit; and 3) Disposing of tracts which offer minimal conservation or public value (replacing them with equal acreage of greater public value).

Partner Collaboration Strategies:
9.6.1. Foster better communication and collaboration between all public forest land management agencies.

Demonstration Strategies:
9.7.1. Manage public land in a way which demonstrates sustainable forest management practices – providing examples for others to follow.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 8, 10 & 11.

Issue Theme Ten - Maintaining Biological Diversity: Missouri's forests and woodlands support a great diversity of plants and animals. Missouri's Comprehensive Wildlife Strategy (CWS) was created to maintain and enhance this diversity. Threats and opportunities facing Missouri's forest and woodland biodiversity are virtually identical to the forest sustainability issues described in great detail throughout this Assessment. Therefore, CWS and FRAS will work together very closely towards achieving overlapping visions. Issue Ten provides a brief overview of CWS, and describes three additional tools and resources MDC and various stakeholders are using to maintain and enhance diversity: Missouri's ecological classification systems, Forest Land Action Guidelines, and the Missouri Natural Areas Program.

Natural Community Restoration and Maintenance Strategies:
10.1.1 Maintain and restore forests, woodlands, glades and savannas which are well suited to their growing sites, best suited to wildlife targets, and most resilient to forest threats.

Forest Land Action Guidelines Strategies:
10.2.1. Maintain and Utilize MDC's Forest Land Action Guidelines (FLAG) to help guide forest management decision-making on MDC forestland and other forests as land managers so choose.

Comprehensive Wildlife Strategy Strategies:
10.3.1. Work with and utilize the CWS process to maintain and enhance Missouri's biodiversity.

Natural Areas Program Strategies:
10.4.1. Recognize the best examples of healthy forest and woodland community types and manage them to maintain their integrity.

Wildlife Population Data and Target Strategies:
10.5.1. Establish baseline data and targets for forest wildlife habitat initiatives.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 9, 10 & 11.

Issue Theme Eleven - Logistical Framework for Sustainability: Today's actions will largely determine the future health and sustainability of our forest resources, and the future benefits these resources will provide. Sustaining forest resources requires adequate funding, and a diversity of partnerships and people collaborating on the implementation of strategies which are as efficient, effective and synergistic as possible. Above all, sustainability of Missouri's forest resources requires that Missouri citizens understand and appreciate the value of forest resources, the issues facing them, the opportunities they present, and the role people play in determining the future of the forest.

Partner Collaboration Strategies:
11.1.1. Develop Priority Forest Landscape (PFL) and Urban Forest Opportunity Area (UFOA) stakeholder groups for the purpose of collaborating on the development and implementation of objectives and strategies specific to established priority geographies.
11.1.2. Utilize the Missouri Forest Resources Advisory Council (MOFRAC) as a means of collaboration and communication of prominent forestry issues between Missouri's forestry agencies and partner organizations.

11.1.3. Utilize the Missouri Community Forestry Council as a means of collaboration and communication of prominent urban and community forestry issues between forestry agencies and partner organizations.
11.1.4. Develop a Missouri Forest Landowner Association to improve communication of important forestry information to and from landowners, and to develop advocacy for sustainable forestry.

Data and Research Strategies:
11.2.1. Inventory and monitor forests and forest product trends to ensure harvest rates remain sustainable, to facilitate sustainable forest management decisions, and to help prioritize forestry efforts.
11.2.2. Develop and/or obtain better geographic information to enhance assessment capabilities, planning efforts, and management decision making.
11.2.3. Conduct research on important data gaps which will facilitate the advancement and improvement of forest resource planning, management and assistance.

Legislation Strategies:
11.3.1. Explore the feasibility and desirability of establishing forest-friendly legislation.

Volunteer Recruitment Strategies:
11.4.1. Recruit concerned citizens and volunteers to assist with miscellaneous activities towards sustainability of Missouri's forest resources.

Communications Strategies:
11.5.1. Develop and implement a comprehensive forestry communications and marketing strategy for building awareness of Missouri's forest resources and their associated benefits, threats and opportunities.

Engagement Strategies:
11.6.1. Increase the connection and engagement of the general public, especially kids, to the trees, forests and natural world that support their quality of life.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-10.

Strategy Matrix:

Below is a brief description of the eight column headings used in the proceeding FRAS Strategy Matrix:

1. **Example Action Items:** Examples of how a strategy might be implemented. This list is not meant to be all inclusive.

2. **Target Geographies:** Places in which action items might be focused to achieve maximum effectiveness.

3. **FRAS Issues and DFCs Supported:** Listing of Issue Themes and corresponding Desired Future Conditions (DFC's) addressed by the strategy. A complete listing of the Issue Themes and DFCs can be found in the Executive Summary starting on page 9.

4. **Criterion and Indicators Supported:** Listing of the Seven Criteria and Indicators addressed by the strategy, as adopted by the Northeastern Area Association of State Foresters and U.S. Forest Service's State and Private Forestry Program -Northeastern Area. The Seven Criteria and Indicators are listed in Appendix B.

5. **National Priorities and Objectives:** Listing of the U.S. Forest Service's State and Private Forestry Program "National Priorities, Objectives, and Performance Measures" addressed by the strategy. National Priorities and Objectives are listed in the Introduction on page 7.

6. **Key Potential Stakeholders:** Listing of potential stakeholders who may wish to participate in implementation of a strategy. This list is not all inclusive and serves as merely an "educated guess" to help guide implementation. A key to acronyms can be found in Appendix C of the Strategy.

7. **Resources Needed for Implementation: Current Resources:** A rough list of resources currently available to help implement the strategy. **Additional Resources Needed:** A rough list of new resources needed in order to implement the strategy. This list is not all inclusive and serves to inform Annual Work Plan implementation.

8. **Measures of Success:** These are measures of success in addition to the National Performance Measures listed in Column 5, including both Current Resources and Optimal Resources. **Current Resources:** A listing of what could be accomplished by this strategy using existing resources only. Whenever possible, time-bound measurable targets are listed. Otherwise, more general objectives are listed. **Optimal Resources:** A listing what can realistically be achieved in the next five years (or less) provided the "Additional Resources Needed" identified in Column 7. In many cases, loftier goals would be preferred, but are not listed because they are not deemed realistic in the five year time-span of FRAS.

Issue Theme One - Private Forest Landowner Demographic Trends and Corresponding Land Use Changes:

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
Strategy 1.1.1 - Forest Land Conservation. Provide successional planning information to landowners to help facilitate the smooth and sustainable transition of property to the next generation of landowners.							
-Offer training and information to private landowners on successional planning tools and considerations. -Offer similar training to foresters, financial advisors and attorneys. -Develop information packets for real estate agents to distribute. -MDC, NRCS and consultant forester advisory services.	All FOA/PFL.	1.1-6 2.4 3.1&2 4.1-4&6 5.5 6.1-4&6 7.1-4 8.1-3 10.1-4 11.1,2,4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USFS-S&PF USFWS Extension RCGs MCFA/consultants Financial advisors Attorneys NIPFL's Land Trusts NGOs MFPA/industry Real estate agents Water Districts	**Current Resources:** -Key Stakeholders -MDC, NRCS and consultant forester advisory services. **Additional Resources Needed:** -Funding and people dedicated to developing successional planning informational resources, providing training, and for disseminating information to landowners.	**Current Resources:** -Not applicable. **Optimal resources:** -Develop and utilize successional planning training program and informational resources within 2 years.
Strategy 1.1.2 - Forest Land Conservation. Focus development in less ecologically important areas utilizing smart growth principles.							
-Develop Green Infrastructure Plans to delineate areas well suited for smart growth and areas which should be protected as important green infrastructure. -Work with Regional Councils of Gov't., counties, cities and developers to promote conservation principles in planning and zoning regulations and development efforts.	All FOA/PFL, but especially in Urban and WUI areas where development pressure is the greatest.	1.1-6 2.4 3.1&2 4.1-3,5&6 5.2 6.1&6 7.1,3&4 8.1-3 10.1,3&4 11.1,2,4&6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 2.2 3.1 3.2 3.3 3.4 3.5 3.7	MDC/DNR/MDA NRCS/FSA/COE Public land agencies USFS-S&PF USFWS MORAP RCGs/Local Gov't. MCFA/consultants Developers NIPFL's Land Trusts NGOs MFPA/industry Water Districts	**Current Resources:** -Key Stakeholders -Existing geographic data. **Additional Resources Needed:** -Funding and people dedicated to developing and implementing Green Infrastructure Plans for Urban FOA's. -Collaborative stakeholder teams in Urban FOA's. -People dedicated to working with local governments and developers on incorporation of smart growth principals.	**Current Resources:** -Not applicable. **Optimal Resources:** -Develop Green Infrastructure Plans in St. Louis, Kansas City and Springfield Urban FOAs within 5 years. -Incorporate conservation principals into planning and zoning regulations in 10 cities or counties within 5 years.

Strategy 1.1.3 - Forest Land Conservation. Develop and implement a strategic forest land conservation program in order to protect tracts and forests of especially high public benefit.

-Targeted land acquisition from willing sellers and donors. -Promote conservation easements in targeted areas. -Explore the concept of Transferable Development Rights (TDR's) -Offer state-funded Payment in Lieu of Taxes to cities and counties for setting aside more green areas.	All FOA, but especially areas adjacent to existing protected ownerships and areas which provide unique forest benefits.	1.1-6 2.2-4 3.1&2 4.1-4&6 5.5 6.1,2,5&6 7.1,2,3&4 8.1-3 9.1&2 10.1-4 11.1-4&6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA/COE Public land agencies USFS-S&PF USFS-MTNF USFWS RCG's/Local gov't. MCFA/consultants Developers NIPFLs Land Trusts NGOs MFPA/industry Water Districts Attorneys Financial advisors	**Current Resources:** -Key Stakeholders -Forest Legacy Program -Wetland Reserve Program -Public agency budgets. -Landowner donations. -NGO fundraising efforts. -S&PF Competitive Grant **Additional Resources Needed:** -Significant funding increase for acquiring public land and/or establishing conservation easements; and sufficient logistical support for administering re-vamped land conservation programs. -Enhanced enabling legislation for conservation easements. -Communications strategy.	**Current Resources:** -Permanently protect 15,000 acres of PFL/FOA in the next 5 years. **Optimal Resources:** -Permanently protect 100,000 acres of PFL/FOA in the next 5 years.

Strategy 1.2.1 - Small Acreage Landowners. Develop effective and efficient techniques for assisting small acreage landowners.

-Develop and promote Missouri Heritage Woods program. -Offer small acreage landowner workshops. -Promote the establishment of forest landowner coops.	Privately-owned tracts of FOA with less than 10 acres of forest.	1.1-5 2.1&4 3.1&2 4.1-6 5.2 6.1-7 7.1-4&6 8.1-3 10.1-4 11.1,2 &4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC USFS-S&PF NRCS Extension Small acreage NIPFL MCFA/consultants MFPA/industry Fire Departments NGOs	**Current Resources:** -Outreach materials -Missouri Heritage Woods program (in development). -MDC, NRCS and Consulting foresters. **Additional Resources Needed:** -Funding and people dedicated to advancing Missouri Heritage Woods Program, developing forestry coops, and providing information and services to small acreage landowners.	**Current Resources:** -Develop Missouri Heritage Woods program and recruit 1,000 members in the next 5 years. -Provide at least 5 small acreage landowner workshops per year. **Optimal Resources:** -Develop 5 pilot forestry coops in the next 5 years.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 2, 3, 4, 5, 6, 8, 9 & 11

Issue Theme Two: Challenges and Opportunities for Private Forest Landowners

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
2.1.1 Technical Assistance - Increase the availability and credibility of quality foresters, loggers and contractors able to help landowners set and achieve personal objectives through sustainable forest management practices.							
-Promote Missouri's Master Logger Certification and Professional Timber Harvester Training programs. -Promote MDC's Logger of the Year Awards. -Develop internships for training potential consulting foresters. -Provide continuing education opportunities for foresters. -Make potential college students aware of Forestry as a career choice. -Develop and utilize two year Forestry Associates Degree programs to make available trained technicians. -Explore opportunities to improve and expand Forester Certification programs.	All FOA/PFL.	1.1-6 2.1,3&4 3.1&2 4.1-6 5.1-6 6.1-7 7.1-4&6 8.1-3 9.6 10.1-4 11.1,2 & 4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/NRCS USFS-S&PF Universities NGOs Extension MFPA/ Industry MCFA/ Consultants Contractors	**Current Resources:** -MDC, NRCS and Consulting foresters. -Current contractors and loggers. -Master Logger Certification Program -Professional Timber Harvester Training program -Logger of the Year Award. -SAF Forester Certification Program. **Additional Resources Needed:** -Funding and qualified people to make 10 additional foresters and 10 additional contractors available to help landowners. -Funding to expand Missouri's Master Logger Certification Program.	**Current Resources:** -Maintain current number of foresters and contractors available to help landowners over the next 5 years. -Maintain current number of Trained Professional Timber Harvesters, and slowly expand the number of certified loggers over the next 5 years. -Provide recognition of top performing loggers each year. **Optimal Resources:** -Increase the number of foresters and contractors available to help landowners by 10 each in the next five years. -Recruit 50 new Certified Master Loggers in the next 5 yrs.
2.1.2 Technical Assistance - Provide technical information, assistance and financial help to private landowners which enables them to make and carry out informed management decisions towards healthy and sustainable forests.							
-Provide on-site consultation visits for landowners. -Make available publications, web materials and information packets. - Provide technical assistance with forest inventorying and planning, timber harvests, TSI, tree planting, etc. - Provide increased cost share for forest improvement practices.	All FOA /PFL, focusing on landowners with >10 acres of forest.	1.1-6 2.1-4 3.1&2 4.1-6 5.1-6 6.1-7 7.1-4&6 8.1-3 9.6 10.1-4 11.1,2 & 4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.21 3.4 3.5 3.6 3.7	MDC NRCS/FSA USFS-S&PF USFWS NGOs MFPA/ Industry MCFA/ Consultants Extension	**Current Resources:** -MDC, NRCS and Consulting foresters. -EQIP, WHIP, CRP, WRP, CSP, state and private cost share resources. **Additional Resources Needed:** -10 additional foresters. -Significantly increased funding for landowner cost share programs.	**Current resources:** -On-site visits covering 50,000+ acres per year in Target Geographies – including follow-up work as needed. **Optimal resources:** -On-site visits covering 100,000+ acres per year in Target Geographies – including follow-up work as needed.

2.2.1 Markets, Programs and Incentives - Develop and promote markets for ecosystem services, such as carbon sequestration and clean drinking water, and incentives which make sustainable forest management a more affordable option for private landowners.   (Note: wood product markets are covered separately under Issue Theme Six)

-Develop and promote markets for carbon sequestration and clean drinking water. -Develop favorable tax structure (inheritance, real estate, income) which encourages sustainability of privately-owned forests. -Offer bundled service packages to landowners (i.e. certification, ecosystem service payments, forester assistance, cost share, tax abatements) in exchange for legally committing to sustainable forestry.	All FOA /PFL - focusing on landowners with >10 acres of forest.	1.1-6 2.2-4 3.1&2 4.1-6 5.5 6.1-7 7.1-3 8.1-3 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA USFS-S&PF USFWS NRCS/FSA/EPA Universities Extension RC&D's NGOs MFPA/Industry MCFA/ Consultants Water Districts Entrepreneurs Land trusts Financial advisors Attorneys NIPFLs	**Current Resources:** -Key Stakeholders -Limited markets for carbon sequestration **Additional Resources Needed:** -Expanded ecosystem service markets. -Improved tax law for sustainable forest management. -Bundled service packages (see action items). -Sufficient foresters, other professionals and funding to administer these programs.	**Current resources:** -Not applicable. **Optimal Resources:** -Sustainable forest management ensured on 200,000 acres over the next 5 years through ecosystem service markets, tax incentives, and bundled service packages.

2.3.1 Landowner Awareness - Increase private landowner awareness of important forestry threats and opportunities, and the important role their property contributes to particular watersheds, landscapes or initiatives.

-Develop landscape based stewardship plans in accordance with the USFS's revised stewardship program. -Promote the Call Before you Cut Campaign -Provide forestry information to realtors who can pass it on to new landowners. -Enhance internet resources for private landowners. -Initiate a "Forests for the Future" outreach campaign. -Develop a Missouri Forest Landowner Association	All FOA/PFL.	1.1-6 2.4 3.1&2 4.1-6 5.1-6 6.1-7 7.1-6 8.1-3 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USFS-S&PF USFS-NRS USFWS Universities Extension RCGs RC&Ds Land Trusts NGOs Volunteer organizations MCFA/ Consultants MFPA/industry Water Districts	**Current Resources:** -Key Stakeholders -MDC, NRCS and Consulting foresters. -Call Before You Cut Campaign -MDC outreach programs. -Revised Stewardship program (in progress). **Additional Resources Needed:** -10 additional foresters. -Funding and people dedicated to developing and providing outreach resources to private landowners. -Missouri Forest Landowner Association	**Current Resources:** -National Woodland Owners Survey results showing that landowners are generally well informed about forestry issues and opportunities in five years. **Optimal Resources:** -National Woodland Owners Survey results showing that landowners are highly informed about forestry issues and opportunities in five years.

2.4.1 Public Awareness - Increase awareness of the general public and local decision makers regarding the existing and potential ecosystem services offered by privately owned forests (i.e. clean drinking water) to the extent that they are willing to support programs which enable landowners to cost effectively manage their forests sustainably for the greater public good.

-Develop and implement a communication strategy (i.e. a "Forests for the Future" outreach campaign) which promotes ecosystem service markets for clean water, carbon sequestration, wildlife habitat, etc., and public funding and support for conservation easements. -Demonstrate an economic justification for keeping forests as forests. -Industry promotion of sustainability.	Statewide.	1.1-6 2.2-4 3.1&2 4.1-6 5.1,3-6 6.1-8 7.1-6 8.1-3 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USFS-S&PF USFS-NRS USFWS Universities Extension RCG's Land Trusts NGOs Volunteer organizations MCFA Consultants MFPA/industry Water Districts	**Current Resources:** -Key Stakeholders. -MDC outreach programs. **Additional Resources Needed:** -Funding and people dedicated to developing and implementing a forestry communication strategy.	**Current Resources:** -MDC's Conservation Opinion Survey results showing that the general public is generally well informed about the benefits and opportunities provided by private forests and the threats they face and is somewhat engaged in activities towards sustainability. **Optimal Resources:** -MDC's Conservation Opinion Survey results showing that the general public is highly informed about the benefits and opportunities provided by private forests and the threats they face, and is highly engaged in activities towards sustainability.

2.5.1 Landowner Recognition - Recognize landowners who contribute greatly to forest conservation and sustainability.

-Utilize the Missouri Tree Farm Certification program, and expand the program through the use of "bundled service packages" as described under Strategy 2.2.1. -Develop and promote the Missouri Heritage Woods program. -Encourage Missouri Forestry Association to develop a landowner recognition program.	Statewide.	1.1-6 2.2-4 3.1&2 4.1-6 5.1-6 6.1-7 7.1-6 8.1-3 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USFS-S&PF Extension USFWS Land Trusts NGOs MFPA/industry MCFA/ Consultants	**Current Resources:** -Tree Farm Certification program -Missouri Heritage Woods program **Additional Resources Needed:** -Funding and people dedicated to utilizing the Missouri Tree Farm Program to its full potential, and to offering "bundled service packages" for Certified Tree Farmers.	**Current Resources:** -Maintain existing number of Certified Tree Farms and acreage during the next 5 years. -Develop Missouri Heritage Woods program and recruit 1,000 members in the next 5 years. **Additional Resources:** -Development of the Tree Farm Certification program as part of a bundled service package as described under Strategy 2.2.1 with expanded enrolment as landowner interest dictates.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 5, 6, 7, 10 & 11.

Issue Theme Three: Climate Change

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
3.1.1 Adaptation - Increase the adaptability of Missouri's forests to uncertain changes in climate.							
-Manage healthy forests using Missouri's Forest Land Action Guidelines. -Thin forests to improve overall health. -Promote broad tree species diversity, taking potential tree species shifts into management consideration. -Promote forest habitat connectivity through conservation easements, reforestation, etc.	All FOA/PFL.	1.1-6 3.1-3 4.1-6 5.3&5 6.1-7 7.1-4 8.1-3 9.1,2,5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USDA-APHIS USFS-S&PF USFS-MTNF USFS-NRS USFWS Public land agencies Universities Extension RCGs/Local Gov't. RC&D's MORAP Land Trusts NGOs & Volunteers MFPA/industry MCFA/consultants NIPFL's	**Current Resources:** -EQIP, WHIP, CRP, WRP, CSP, state and private cost share for non-commercial thinning and reforestation on private land. -State, federal and private funding for non-commercial thinning on public land. -Limited forest product markets for commercial thinning. -Limited funding for conservation easements. **Additional Resources Needed:** -Increased funding for non-commercial thinning and reforestation. -Increased forest product markets for small diameter and low quality trees. -Increased funding and logistical framework for conservation easements.	**Current Resources:** -Improve forest health, vigor and adaptability on 40,000 acres per year. **Optimal Resources:** -Improve forest health, vigor and adaptability on 100,000 acres per year.
3.2.1 Mitigation - Promote the role of forests and forest products in sequestering carbon and mitigating the potential effects of carbon emissions.							
-Increase landowner accessibility to carbon sequestration markets. -Promote sustainable, conservation friendly biofuels markets as a substitute for non-renewable fossil fuels. -Facilitate landowner enrollment into conservation easements. -Reforestation in FOAs.	All FOA /PFL.	1.1-6 2.2-4 3.1-3 4.1-6 5.5 6.1-7 7.1-3 8.1-3 9.1,3,&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA/EPA USFS-S&PF USFS-MTNF USFS-NRS USFWS USDA-APHIS Public land agencies Universities Extension RCGs/Local Gov't. RC&D's NGOs, Land Trusts MCFA/consultants MFPA/industry NIPFLs Entrepreneurs	**Current Resources:** -Limited accessibility and incentive for carbon sequestration markets, forest certification programs, and conservation easements. -Limited sustainable biofuels markets. -Limited cost share funds for re-forestation. -Limited active and passive re-forestation. **Additional Resources Needed:** -Enhanced accessibility and incentive for carbon sequestration markets, certification programs, and conservation easements. -Increased sustainable biofuels markets. -Enhance cost share availability for re-forestation in FOAs.	**Current Resources:** -Maintain existing levels of stored carbon in Missouri's forests, or increase slightly over the next 5 years. **Optimal Resources:** -Increase carbon storage in Missouri's forests by 10% (84 million tons) in the next 5 years.

3.3.1 Research - Conduct research to increase our understanding of carbon sequestration, climate change, potential impacts and management implications.

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
-Research the effects of forest management practices on carbon sequestration rates. -Improve data on carbon sequestration rates for different forest types. -Improve data on how adaptable various tree species are to potential climate scenarios.	All FOA/PFL.	1.1&6 2.2-4 3.1-3 4.1-3,5&6 5.3 6.1-6 7.1-6 8.1&2 9.1-3&5-7 10.1-4 11.1,2&4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	2.2 3.1 3.2 3.4 3.5 3.7	MDC/DNR/MDA USFS-NRS USFWS/EPA Universities	**Current Resources:** Key Stakeholders which are already engaged in various levels of research pertaining to climate change adaptation and mitigation. **Additional Resources Needed:** Increased funding for new and sustained research on climate change adaptation and mitigation.	**Current Resources:** -Limited data is available to make better informed forest management decisions regarding climate change mitigation and adaptation in the next 5 years. **Optimal Resources:** -Sufficient data is available to make well informed forest management decisions regarding climate change mitigation and adaptation in the next 5 years.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 4, 5, 6, 7, 8, 9, 10 & 11.

Issue Theme Four: Maintaining High Quality Soil and Water Resources

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
4.1.1 Best Management Practices (BMPs) - Increase and improve the use of forestry Best Management Practices which protect soil and water resources.							
-Require use of BMPs on public land and on private land when government funding is involved. -Improve landowner awareness of BMPs. -Explore the feasibility of establishing forest practice regulations. -Increase industry awareness and incentive to use BMPs. -Monitor the use of BMPs on public and private land to determine usage rates and effectiveness. -Refine BMPs to accommodate new technologies and science.	Statewide, but especially in FOA/PFL.	1.1&6 2.3&4 3.1&2 4.1-6 5.6 6.1-6 7.1-3 8.1-3 9.1,2,&4-7 10.1-4 11.1,2,&4-6	1.4 2.6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.2 3.1 3.4 3.5 3.6	MDC/DNR/MDA USFS-S&PF USFS-NRS USFS-MTNF Public land agencies NRCS/FSA/EPA COE RCGs/Local Gov't. RC&Ds Universities Extension Land Trusts NGOs MPFA/industry MCFA/consultants Water Districts NIPFLs	**Current Resources:** -BMP guidelines. -BMP monitoring program. -MO Master Logger Program. -MO Professional Timber Harvester Training program **Additional Resources Needed:** -Increased funding for BMP monitoring. -Funding to expand Missouri's Master Logger Certification Program., or, enactment of forest practice regulations.	**Current Resources:** -Continue existing BMP monitoring program with results showing sustained levels of BMP usage and success during the next five years. **Optimal Resources:** -Expand existing BMP monitoring program to include 10% of private land timber sales with results showing significant increase in BMP usage and success on private lands over the next five years.

4.2.1 Riparian Forests and Wetlands - Maintain existing riparian forests and wetlands, and re-forest priority riparian areas and wetlands which have been converted from forest to non-forest use.

-Offer incentives for re-forestation of riparian areas (i.e. CRP).	PFLs and other FOA which lies within Priority Surface Drinking Water Supply Watersheds.	1.1-4,6 2.4 3.1,2 4.1-6 6.1-3&6 7.1-3 8.1-3 9.1-3,&5-7 10.1-4 11.1,2,&4-6	1.1-4 2.5&6 3.7 4.8,9,10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA USFS-S&PF USFS-NRS USFS-MTNF Public land agencies NRCS/FSA/EPA COE RCGs/Local Gov't. Extension Land trusts NGOs MPFA/industry MCFA/consultants Water Districts NIPFLs Volunteer orgs.	**Current Resources:** -EQIP, WHIP, CRP, WRP, CSP, state and private cost share for reforestation on private land. -Limited active and passive reforestation without cost share. **Additional Resources Needed:** Sufficient funding to reforest 50,000 acres of riparian areas and wetlands in the next 5 years	**Current Resources:** -Reforest 10,000 acres of riparian areas and wetlands in next five years. **Optimal Resources:** -Reforest 50,000 acres of riparian areas and wetlands in next 5 years.

4.3.1 Coordination with Watershed Partnerships and Plans - Utilize and promote watershed basin partnerships and plans which incorporate tree and forest strategies to benefit water quality and quantity.

-Work with the James River Partnership and promote tree and forest strategies. -Upper Mississippi Forest Watershed Partnership. - Work with the Mid American Regional Council to promote the adoption of stream buffers in urban areas.	Areas in which FOA/PFL's overlap with watershed partnerships and plans.	1.1-6 2.2&4 3.1&2 4.1-6 6.1-6&8 7.1-6 8.1-3 9.7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3,5 3.6 3.7	Watershed Partnership Teams	**Current Resources:** -Existing watershed partnerships. **Additional Resources Needed:** -Funding and people to develop or improve collaborative watershed partnerships and to increase their forestry accomplishments.	**Current Resources:** Maintain existing level of forestry involvement and accomplishments in watershed partnerships over the next 5 years. **Optimal Resources:** Increase forestry involvement and accomplishments in 5 watershed partnerships over the next 5 years.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 5, 6, 7, 9, 10 & 11.

Issue Theme Five: The Role of Fire in Missouri's Forests – Past, Present and Future

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
5.1.1 Prevention - Minimize the occurrence and impact of wildfire through the use of prevention efforts.							
-Promote Firewise program and principals to both communities and individuals. -Promote public awareness of fire safety and wildfire hazards.	Wildfire Priority Areas and other areas of concentrated Wildland-Urban Interface.	2.3 3.1&2 4.1&2 5.1-4 6.1-3, & 5-7 7.1-4 9.1-3,5&6 10.1-4 11.1-4&6	1.2&4 2.6 3.7 4.8,10 5.11 6.12-16 7.18	2.1 3.3	MDC USFS-S&PF USFS-MTNF Public land agencies Fire Departments Local Gov't. NGOs MFPA-Industry NIPFLs	**Current Resources:** -MDC/USFS/Fire Department fire prevention efforts. **Additional Resources Needed:** -Funding and people dedicated to promoting Firewise homes and communities.	**Current Resources:** -Annual number and acreage of wildfires remains at or below the previous 10 year average during the next 5 yrs. **Optimal Resources:** -Reduction in the annual number of structure fires resulting from wildfires compared to the last 10 years during the next 5 yrs.
5.2.1 Suppression - Suppress wildfires in order to protect people, property and natural resources through effective collaboration between public agencies and fire departments.							
-Suppress wildfires. -Make sufficient equipment available to fire departments through matching grant program, FEPP, FFPP and dry hydrant program.	Statewide, though resources should be concentrated in Wildfire Priority Areas.	2.3 3.1&2 4.1,2,4&6 5.1,3&4 6.1-3, & 5-7 7.1-3 9.1,2,5&6 10.1-4 11.1-3	1.2&4 2.6 3.7 4.8,10 5.11 6.12-16 7.18	2.1 3.3	MDC/NRCS USFS-S&PF USFS-MTNF Public land agencies Fire Departments Local Gov't. NGOs	**Current Resources:** -MDC/USFS/Fire Department fire suppression efforts. -MDC/USFS fire equipment programs for fire departments. **Additional Resources Needed:** -Funding and people which enable expansion of areas covered by fire departments.	**Current Resources:** -Maintain current wildfire suppression capacity and preparedness. **Optimal Resources:** -Fire Departments cover all Wildfire Priority Areas, or preferably statewide.
5.3.1 Prescribed Fire - Advance the science and understanding of Rx fire in order to better quantify its effects and improve its effectiveness.							
-Research implications of Rx fire such as carbon, water quality, timber quality and tree regeneration. -Research on timing and intensity of Rx fire for obtaining desired results.	FOA/PFL's.	3.1-3 4.1,2,4&6 5.5&6 6.1-3,&5-7 7.1-4&6 9.1-3,&5-7 10.1-4 11.1,2,4&5	1.2&4 2.6 3.7 4.8&10 5.11 6.12-16 7.17&18	2.1 2.2 3.5 3.7	MDC/NRCS Public land agencies USFS-S&PF USFS-MTNF USFS-NRS Universities NGOs Contractors MCFA/Consultants	**Current Resources:** -Key stakeholders which are already engaged in various levels of research pertaining to Rx fire effects and techniques. **Additional Resources Needed:** -Increased funding for new and sustained research on Rx fire effects and techniques.	**Current Resources:** -Limited data is available to make better informed forest management decisions regarding Rx fire effects and techniques in the next 5 yrs. **Optimal Resources:** -Sufficient data is available to make well informed forest management decisions regarding Rx fire effects and techniques in the next 5 yrs.

5.3.2 Prescribed Fire - Provide resources needed by private landowners to safely conduct Rx fires without the assistance of public agency personnel.

-Provide training to private landowners on the safe and effective use of Rx fire. -Make burn kits available to private landowners. -Develop a cadre of Rx fire contractors capable of servicing private land requests.	Statewide, but especially in PFL's and other focus areas (i.e. grassland COA's) with a focus on prescribed fire.	1.1 3.1 4.1,2,4&6 5.1,&3-5 6.1-3,&5-7 7.1-4&6 10.1-4 11.1,2&4-6	1.2&4 2.6 3.7 4.8&10 5.11 6.12-16 7.17&18	2.1 2.2 3.4 3.5 3.6 3.7	MDC/NRCS USFS-S&PF Extension USFWS Fire Departments NGOs Contractors MCFA/Consultants	**Current Resources:** -Rx fire workshops. -Limited Rx fire kits. -Limited Rx fire contractors. **Additional Resources Needed:** -Funding and people dedicated to providing training, tools and contractors available to private landowners for Rx fire.	**Current Resources:** -Maintain current acreage of private land Rx fire conducted each year. **Optimal Resources:** -Increase acreage of private land Rx fire conducted annually by 100% within five years and increase the overall safety and effectiveness of these burns.

5.4.1 Multi-agency Collaboration and Preparedness - Develop an active, multi-agency Fire Council to better foster communication and collaboration concerning wildfire and Rx fire.

-Develop a State Fire Council. -Develop Statewide Smoke Management Plan.	Statewide.	3.1-3 4.1,2,4&6 5.1-6 6.1-3&5-7 7.1-4&6 9.1,3,&5-7 10.1-4 11.1-6	1.2&4 2.6 3.7 4.8&10 5.11 6.12-16 7.17&18	2.1 2.2 3.3 3.4 3.5 3.6 3.7	MDC/DNR/NRCS USFS-S&PF USFS-MTNF Public land agencies Universities Extension, NGOs Fire Departments MCFA/Consultants Contractors	**Current Resources:** -MO Fire Council is under development. **Additional Resources Needed:** -Funding and people dedicated to coordinating Fire Council efforts, such as developing a Smoke Management Plan.	**Current Resources:** -MO Fire Council is initiated fully established and functioning within one year. **Optimal Resources:** -MO Fire Council is fully established and functioning within one year. -A Statewide Smoke Management Plan is developed within five years.

5.4.2 Multi-agency Collaboration and Preparedness - Develop Community Wildfire Protection Plans (CWPPs).

-Offer grants for developing CWPPs	Wildfire Priority Areas.	2.3 4.1,2&6 5.1-4 6.1-3, & 5-7 7.1-3 9.1-3,5&6 10.1-4 11.1-4&6	1.2&4 2.6 3.7 4.8,10 5.11 6.12-16 7.18	2.1 3.3	MDC, USFS-MTNF USFS-S&PF Public land agencies RCGs, RC&Ds Fire Departments Local Gov't. MCFA/Consultants Contractors	**Current Resources:** -Minimal grant money for developing CWPP's. **Additional Resources Needed:** -Funding and people for developing CWPP's.	**Current Resources:** -10 CWPP's developed in the next 5 years. **Optimal Resources:** -CWPP's developed for all Wildfire Priority Areas in the next 5 years.

5.4.3 Multi-agency Collaboration and Preparedness - Monitor fire weather and fuel conditions to determine fire risk and the appropriateness of Rx fire, and communicate information to fire partners.

-Maintain and monitor fire weather stations. -Provide high quality communications of fire weather and fuels information to partners.	Statewide, but especially in Wildfire Priority Areas.	4.1,2,4&6 5.1-6 6.1-3, &5-7 7.1-3 9.1,2,5&6 10.1-4 11.1&2	1.2&4 2.6 3.7 4.8&10 5.11 6.12-16 7.17&18	2.1 2.2 3.3 3.5 3.7	MDC/NRCS USFS-MTNF & S&PF Public land agencies Fire Departments NGOs, Contractors MCFA/Consultants NIPFLs	**Current Resources:** -16 monitored and maintained fire weather stations statewide. -NOAA Fire Weather Reports. **Additional Resources Needed:** -Funding and people dedicated to improving communications of fire weather and fuels information to partners.	**Current Resources:** -Maintain existing fire weather stations and NOAA Fire Weather Report services over the next five years. **Optimal Resources:** -Partners are well informed of fire weather conditions affecting wildfire risks and the appropriateness of Rx fire.

5.4.4 Multi-agency Collaboration and Preparedness - Monitor wildfires and Rx fires to determine the frequency, acreage, spatial distribution, etc.

-Maintain MDC Wildfire Reporting System. -Collect and compile agency data on Rx fire activity.	Statewide.	3.3 5.1-6 6.1-3, & 5-7 7.1-3&6 9.1-3, 5 & 6 10.1-4 11.1-6	1.2&4 2.6 3.7 4.8&10 5.11 6.12-16 7.17&18	2.1 3.3	MDC/NRCS USFS-MTNF USFS-S&PF Public land agencies Fire Departments NGOs MCFA/Consultants Contractors NIPFLs	**Current Resources:** -MDC Fire Reporting System. -State Fire Marshal Fire Reporting System. **Additional Resources Needed:** -Increased incentive for fire departments to submit fire reports.	**Current Resources:** -Annual report on yearly number and acreage of wildfires and prescribed fires. **Optimal Resources:** -Increased accuracy of the annual report on yearly number and acreage of wildfires and prescribed fires.

5.4.5 Multi-agency Collaboration and Preparedness - Maintain expertise in wildfire suppression and the use of prescribed fire in order to sustain proficiency and preparedness.

-Provide fire simulation training to RFD's. -Utilize the Midwest Wildfire Training Academy to train firefighters and Rx Fire technicians from multiple agencies. -Supply crews to the USFS for out-of-state fire assignments to build preparedness for potential large scale disasters in Missouri.	Statewide, but especially in Wildfire Priority Areas.	2.3 3.1,2 4.1,2,4&6 5.1-6 6.1-3&5-7 7.1-4&6 9.1,2,5&6 10.1-4 11.1&2	1.2&4 2.6 3.7 4.8,10 5.11 6.12-16 7.17&18	2.1 2.2 3.3 3.5 3.7	MDC/NRCS USFS-MTNF USFS-S&PF Public land agencies Fire Departments NGOs MCFA/Consultants Contractors NIPFLs	**Current Resources:** -Midwest Wildfire Training Academy -In-state wildfire and Rx fire experience. -Out-of-state wildfire experience. -MDC Fire Training. **Additional Resources Needed:** -None at this time.	**Current Resources:** -Maintain current wildfire suppression capacity and preparedness and expertise in conducting Rx fires. **Optimal Resources:** -Not applicable.

5.5.1 Public Awareness - Increase public awareness of the benefits of carefully planned and executed Rx fire, the harm of wildfire, and the differentiation between the two.

-Increase publicity of high profile Rx fires and why they are being conducted. -Revamp existing informational materials. -Provide public notice during times of extended red flag weather.	FOA/PFL's and Wildfire Priority Areas.	2.3 3.1&2 4.1,2,4&6 5.1-6 6.1-3&5-7 7.1-4&6 9.1,2&5-7	1.2&4 2.6 3.7 4.8,10 5.11 6.12-16 7.17&18	2.1 2.2 3.3 3.5 3.7	MDC/NRCS/USFWS USFS-MTNF USFS-S&PF Public land agencies Fire Departments Extension NGOs MCFA/Consultants Contractors NIPFLs	**Current Resources:** -MDC/USFS/Fire Department outreach efforts. **Additional Resources Needed:** -Funding and people dedicated to increasing public awareness of wildfire and RX fire.	**Current Resources:** -Maintain current level of public understanding of Rx fire as a forest management tool, as documented in future Conservation Opinion Surveys. **Optimal Resources:** -Sustain ability to utilize carefully planned and executed Rx fire. -Increase current level of public understanding of Rx fire as a forest management tool, as documented in future Conservation Opinion Surveys.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 6, 7, 9, 10 & 11.

Issue Theme Six: Missouri's Growth, Harvest and Consumption of Forest Products

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
6.1.1 Markets - Promote certified forests and certified forest products as a means of encouraging sustainable forest management on private lands and also to maintain Missouri's market share in the forest products industry.							
-Certify public lands to provide a critical mass for a sustainable source of certified Missouri-grown forest products and to help advance this market. -Utilize the Tree Farm Certification Program with appropriate private landowners.	PFL's.	1.1-5 2.2-4 3.1&2 4.1-4&6 6.1-8 7.1-6 9.1-3,5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.7	MDC/MDA/NRCS USFS-MTNF USFS-S&PF Public land agencies NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -SFI, FSC and Tree Farm Certification programs. **Additional Resources Needed:** -Funding or market incentives to entice landowners to certify their forests. -Sufficient people and logistical framework to handle workloads caused by certification.	**Current Resources:** Maintain existing acreage of certified forestland over the next five years. **Optimal Resources:** Significantly increase acreage of certified forestland over the next five years.

6.1.2 Markets - Encourage better utilization of forest products in a way which provides better incentive to landowners for sustainable management.

						Current Resources:	Current Resources:
-Develop sustainable biomass markets. -Promote and develop forest product markets in parts of the state where they are lacking.	PFL's.	1.1-5 2.2&3 3.1&2 5.3&5 6.1-7 7.1-3 9.1,5&6 10.1-4 11.1-3	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.2 2.1 2.2 3.4 3.5 3.7	MDC/MDA/NRCS USFS-MTNF USFS-S&PF Public land agencies NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Limited markets for biomass and small diameter/low quality logs. **Additional Resources Needed:** -Expanded markets for biomass and small diameter/low quality logs.	**Current Resources:** Improve forest health and vigor on 35,000 acres per year via commercial harvesting. **Optimal Resources:** Improve forest health and vigor on 70,000 acres per year via commercial harvesting.

6.1.3 Markets - Promote marketing and branding of Missouri grown forest products.

-Promote marketing and branding of forest products grown in Missouri.	Statewide.	1.1-5 2.2-4 3.1&2 5.3&5 6.1-8 7.1-3 9.1,5&6 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16	1.2 2.1 2.2 3.4 3.5 3.7	MDC/MDA/NRCS USFS-MTNF USFS-S&PF Public land agencies NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Key Stakeholders **Additional Resources Needed:** -Funding and people dedicated to branding and marketing Missouri-grown forest products.	**Current Resources:** -Not applicable. **Optimal Resources:** -Marketing and branding campaign initiated and implemented in the next 3 years. -Increased financial value for Missouri grown forest products within 3 years of initiating campaign.

6.1.4 Markets - Steer potentially emerging woody biomass markets, and other potentially emerging markets, in a sustainable direction.

-Promote the utilization of BMPs for Woody Biomass Harvesting. -Coordinate the location of emerging markets to avoid unsustainable harvest rates at local and regional scales.	Statewide, but especially in PFL's.	1.1-5 2.2-4 3.1&2 4.1-4&6 5.3&5 6.1-8 7.1-4&6 9.1,2,5&6 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.4 3.5 3.7	MDC/DNR/MDA USFS-MTNF USFS-S&PF USFS-NRS NRCS Public land agencies Universities RC&Ds Extension Land Trusts NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -BMP's for Woody Biomass Harvesting. -Forest Inventory and Analysis and Timber Product Output data. -Master Logger Certification program. -Foresters available to help private landowners. **Additional Resources Needed:** -Funding or market incentives for utilizing BMPs and sustainable harvest rates, or enactment of forest practice legislation. -Improved coordination between industry and public agencies on sourcing areas and harvest rates.	**Current Resources:** Maintain data on harvest rate sustainability at local and regional scales. **Optimal Resources:** Missouri's forest growth rate exceeds harvest rates into the future at local, regional and statewide scales.

6.2.1 Monitoring - Monitor and report timber price trends in order to maintain a pulse on demand and to improve trust levels between mills, loggers and landowners.

-Maintain Missouri's quarterly Timber Price Trends Report.	Statewide.	2.2&3 6.1,6&7 11.1-4	2.6 6.12,14&16 7.18	3.4	MDC/NRCS USFS-MTNF USFS-S&PF Extension NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Missouri's Timber Price Trends Report. **Additional Resources Needed:** -Increased number of timber price reports submitted to improve accuracy.	**Current Resources:** Maintain quarterly Timber Price Trends Report. **Optimal Resources:** Increase statistical accuracy of Timber Price Trends Report.

6.4.1 Communication - Improve communications between foresters, mills and loggers to provide better understanding of each other's needs, expectations and to increase awareness of long term impacts of management decisions.

-Forester and logger training on Utilization and Marketing. -MDC technical assistance provided to industry as needed. -Professional Timber Harvester training. -Cross training between foresters and loggers.	Statewide.	1.3 2.1&3 3.1&2 4.1-4&6 5,5 6.1-7 7.1-6 9.1,2,5&6 10.1-4 11.1-3	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/NRCS USFS-MTNF USFS-S&PF Public land agencies Extension NGOs MFPA/Industry MCFA/Consultants	**Current Resources:** -MDC's Utilization Program Supervisor position. -Professional Timber Harvester Training Program. **Additional Resources Needed:** -People dedicated to increasing communication between foresters, loggers and mills.	**Current Resources:** -Maintain current level of understanding between foresters, loggers and mills. **Optimal Resources:** -Increased use of BMPs over the next five years. -Increased logger interest in forester marked harvests over the next five years. -Decrease acreage of high grade harvesting conducted on private land over the next five years.

6.5.1 Forest Health - Develop partnership between governmental agencies and private industry towards minimizing forest health risk from plant, insect and disease threats.

-Coordination of response to Emerald Ash Borer infestation between public agencies and MFPA.. -Take necessary safeguards against 1,000 cankers walnut disease -Minimize the distance of travel of firewood.	Statewide, but especially in areas under forest product quarantines.	2.3 3.1&2 4.1-3&6 5.1&3 6.1-6 7.1-6 8.1&2 9.1,2,5&6 10.1-4 11.1-4&6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/NRCS/MDA USDA-APHIS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies Universities Extension NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Key Stakeholders **Additional Resources Needed:** -Enhanced communication and collaboration on forest health threats and related strategies.	**Current Resources:** -Not applicable. **Optimal Resources:** -Slow the spread of invasive plants, insects and diseases resulting from the movement of forest products and logging equipment.

6.6.1 Consumption – Encourage conservation-minded consumption practices.

Example Action Items	Target Geographies	FRAS Issues & DFCs Supported	Criterion & Indicators Supported	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
-Promote the use of locally grown sustainability certified forest products as they become available. -Promote the use of sustainably grown forest products over non-renewable, energy intensive alternatives. -Encourage consumers to reduce, reuse and recycle all consumer goods, including wood products.	-Statewide	1.1-6 2.2-4 3.1&2 4.1-4&6 5.5 6.1-8 7.1-4 9.5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12&14-16 7.17&18	1.1 1.2 2.1 2.2 3.2 3.4 3.5 3.6 3.7	MDC/DNR/MDA USFS-S&PF USFS-NRS USFS-MTNF NRCS Universities Extension RCGs and local gov't. RC&Ds NGOs MFPA/Industry MCFA/Consultants	Current Resources: -Limited. Additional Resources Needed: -Funding and people dedicated to promoting conservation-minded consumption practices, including the use of locally grown and sustainability certified forest products.	Current Resources: -Not applicable. Optimal Resources: -Raised consumer awareness of consumption habits. -Improved markets for Missouri grown and/or certified forest products.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 7, 9, 10 & 11.

Issue Theme Seven: Forest Health Threats: Plants, Animals, Diseases and Weather

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
7.1.1 Insect and Disease Threats - Monitor the current and potential range and extent of new and existing forest insect and disease threats. Strive for early detection of new forest health threats in order to minimize harm, and increase the affordability and effectiveness of control strategies.							
-EAB monitoring. -Gypsy Moth trapping. -1,000 cankers disease monitoring. -Maintain insect and disease diagnosis lab. -Maintain insect and disease reporting system	Statewide, or in reduced areas as determined by insect and disease strategic plans.	2.3 3.1-3 4.1-3,5&6 5.1&3 6.1-7 7.1-6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.7	MDC/MDA/NRCS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies USDA-APHIS Universities Extension NGOs Volunteer orgs. MFPA/Industry MCFA/Consultants NIPFLs	Current Resources: -Existing monitoring programs. Additional Resources Needed: -Funding and people dedicated to monitoring newly emerging insect and disease threats.	Current Resources: -Accurate mapping and knowledge of the existing and potential range and extent of significant known forest insect and disease threats. Optimal Resources: -Accurate mapping and knowledge of the existing and potential range and extent of significant newly emerging forest insect and disease threats.

7.1.2 Insect and Disease Threats - Develop, maintain and implement strategic plans for known forest insect and disease pests which pose high current or potential threat.

-Maintain and implement EAB Plan. -Develop task force to address firewood issues. -Develop and implement 1,000 Cankers Disease Plan. -Maintain and implement Gypsy moth plan.	Statewide, or in reduced areas as determined by insect and disease strategic plans.	2.3 3.1&2 4.1-3,5&6 5.1&3 6.1-7 7.1-6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/MDA/NRCS USFS-S&PF&NRS USFS-MTNF Public land agencies USDA-APHIS Universities Extension NGOs, Volunteer orgs. MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Existing strategic plans (i.e. Gypsy Moth Plan) **Additional Resources Needed:** -Funding and people dedicated to developing and implementing strategic plans concerning significant insect and disease threats.	**Current Resources:** -Reactively reduce the spread and impact of significant forest insect and disease threats. **Optimal Resources:** -Proactively reduce the spread and impact of significant forest insect and disease threats.

7.1.3 Insect and Disease Threats - Conduct and/or compile research on the most effective and efficient methods for addressing miscellaneous tree insect and disease pests.

-Conduct research on current and projected impacts of tree insect and disease pests. -Conduct research on the most effective and efficient methods for addressing tree insect and disease pests.	PFL's and Urban FOA's.	3.1&2 4.1-3,5&6 5.1,3&4 6.1-7 7.1-4&6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.7	MDC/NRCS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies Universities NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Existing research efforts. **Additional Resources Needed:** -Funding and people dedicated to researching newly emerging insect and disease threats.	**Current Resources:** -Available research is used to promote effective and efficient handling of miscellaneous tree insect and disease pests. **Optimal Resources:** -The most effective and efficient methods for handling miscellaneous tree insect and disease pests developed, publicized, well known and practiced.

7.2.1 Invasive Plant Threats - Develop geographic information on the range, extent, and level of threat of invasive plants detrimental to forest health.

-Develop geographic information on the range, extent, and level of threat of invasive plants detrimental to forest health.	Statewide, but especially in PFL's.	2.3 3.1-3 4.1-3&6 5.1,3&4 6.1-7 7.1-6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.7	MDC/MDA/NRCS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies USDA-APHIS Universities Extension NGOs, Volunteer organizations MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Key Stakeholder. -Limited data on range, extent and level of threat of invasive plants. **Additional Resources Needed:** -Funding and people dedicated to developing new and improved data on range, extent and level of threat of invasive plants.	**Current Resources:** -Limited data on range, extent and level of threat of invasive plants. **Optimal Resources:** -Accurate mapping and knowledge of the existing and potential range, extent and threat of significant known invasive plant forest threats.

7.2.2 Invasive Plant Threats - Develop and implement a strategic plan for protecting forests from exotic and invasive plants in the most effective and efficient manner possible.

-Establish a "Detail Assignment" within MDC to collaboratively develop and promote an invasive plant strategic plan. -Develop and utilize Cooperative Weed Management Programs and Plans.	Statewide, or in reduced areas as determined by exotic and invasive plant strategic plans.	2.3 3.1&2 4.1-3&6 5.1,3&4 6.1-7 7.1-6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/MDA/NRCS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies USDA-APHIS Universities Extension NGOs, Volunteer organizations MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Key Stakeholders **Additional Resources Needed:** -Funding and people dedicated to developing and implementing strategic plans concerning significant invasive plant threats.	**Current Resources:** -Reactively reduce the spread and impact of significant invasive plant threats. **Optimal Resources:** -Proactively reduce the spread and impact of significant invasive plant threats.

7.2.3 Invasive Plant Threats - Conduct and/or compile research on the most effective and efficient methods for addressing exotic plant species outbreaks.

-Conduct research on current and projected impacts of exotic invasive plant species. -Conduct research on the most effective and efficient methods for addressing exotic invasive plant species.	PFL's and Urban FOA's.	3.1&2 4.1-3,5&6 5.1,3&4 6.1-7 7.1-4&6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.7	MDC/NRCS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies Universities NGOs MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Existing research efforts. **Additional Resources Needed:** -Funding and people dedicated to researching control methods for addressing invasive plant threats. -Coordination between partners on existing research available and Adaptive Management successes and failures.	**Current Resources:** Available research is used to promote effective and efficient control of invasive plants. **Optimal Resources:** The most effective and efficient methods for controlling invasive plants are developed, publicized, well known and practiced.

7.3.1 Communications - Improve communications and awareness of forest health threats to the public to help citizens identify threats, avoid their establishment, and appropriately address detected outbreaks and occurrences.

-Develop web tools for I&D diagnosis. -"Don't Move Firewood" campaign. -Develop and implement a communications strategy for exotic plants. -Promote "Grow Native!" program. -Develop and utilize a Forestry Communications Specialist within MDC.	PFL's and Urban FOA's.	3.1&2 4.1-3,5&6 5.1,3&4 6.1-7 7.1-6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/MDA/NRCS USFS-S&PF USFS-NRS Public land agencies USDA-APHIS Universities Extension NGOs, Volunteer organizations MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Existing outreach efforts of Key Stakeholders. **Additional Resources Needed:** -Funding and people dedicated to developing and delivering communications of forest health threats to the public.	**Current Resources:** Reactively reduce or avoid spread and impact of significant forest health threats. reactive **Optimal Resources:** Proactively reduce or avoid spread and impact of significant forest health threats.

7.4.1 Resiliency - Improve the overall health of trees and forests in order to make them as resilient as possible to miscellaneous forest health threats.

-Maintain healthy tree stocking levels. -Maintain high tree species diversity. -Conduct natural community restoration in accordance with MDC's Forest Land Action Guidelines (FLAG).	All FOA/PFL's.	3.1&2 4.1-3,5&6 5.1,3&4 6.1-7 7.1-4 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 3.1 3.2 3.4 3.5 3.7	MDC/NRCS/USFWS USFS-S&PF USFS-NRS USFS-MTNF Public land agencies Universities Extension Land trusts NGOs, Volunteer organizations MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Limited public and private funding for forest restoration and improvement on public and private lands. -Limited markets for small diameter and poor quality trees. **Additional Resources Needed:** -Significantly enhanced funding for forest improvement on public and private lands. -Enhanced markets for small diameter and poor quality trees.	**Current Resources:** Improve forest health, vigor and resiliency on 40,000 acres per year. **Optimal Resources:** Improve forest health, vigor and resiliency on 100,000 acres per year.

7.5.1 Feral Hogs – Reduce or eradicate feral hogs.

-Utilize an inter-agency feral hog task force for coordinating eradication efforts.	As determined by feral hog strategic plans.	1.1 3.1&2 4.1-3&6 6.1-7 7.1-6 9.1-3&5-7 10.1-4 11.1-6	1.3&4 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.4 3.5 3.6 3.7	MDC/DNR/MDA USFS-MTNF USFWS USDA-APHIS Public land agencies NGOs Volunteer organizations NIPFLs	**Current Resources:** -Inter-agency eradication efforts on public lands. -Hunter eradication efforts on public and private lands. **Additional Resources Needed:** -Increased funding and people dedicated to feral hog eradication efforts, public awareness and enforcement.	**Current Resources:** Slow the spread of feral hogs. **Optimal Resources:** Reduce or eradicate feral hogs.

7.6.1 Livestock - Promote the benefits of excluding livestock from the woods, and provide financial resources to landowners to make this possible.

-Provide enhanced cost share to landowners for fencing livestock out of the woods. -Outreach efforts concerning the harmful effects of allowing livestock access to woods.	All FOA/PFL's.	1.1&3 2.2&3 3.1 4.1-4&6 6.1-7 7.1-6 9.1,2,5&6 10.1-4 11.1-6	1.2&4 2.6 3.7 4.8&10 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.4 3.5 3.6 3.7	MDC/DNR/MDA NRCS/FSA USFS-S&PF Extension Land Trusts NGO MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Public and private forestry advisory services and cost share funding. **Additional Resources Needed:** -Increased funding for cost share programs. -People dedicated to public awareness campaigning.	**Current Resources:** -Maintain or reduce acreage of forest exposed to livestock. **Optimal Resources:** -Significantly reduce acreage of forest exposed to livestock.

7.7.1 Deer - Monitor deer browse impacts where this is a concern and recommend modifying hunting regulations as needed.

| -Monitor deer population and browse impacts in areas of concern, and suggest changes to deer hunting regulations as needed. | All FOA/PFL's | 1.3
3.1
6.1-5
7.1-6
8.1-3
9.1-3&5-7
10.1-4
11.1-6 | 1.2&4
3.7
6.12-14
7.17&18 | 1.1
1.2
2.1
2.2
3.5
3.6
3.7 | MDC
USFWS
USFS-NRS
USFS-MTNF
Public land agencies
NIPFLs | **Current Resources:**
-MDC and other public land agency monitoring of deer population and browse impacts.
-Deer hunters.

Additional Resources Needed:
-None at this time. | **Current Resources:**
-Modify deer hunting regulations as needed.

Optimal Resources:
-Not applicable. |

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 5, 6, 8, 9, 10 & 11.

Issue Theme Eight: The Role of Trees and Forests in Improving Quality of Life and Sustainability in Cities

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success

8.1.1 Public Awareness - Increase awareness of the general public and local decision makers regarding the benefits of urban trees and forests - to the extent that they demand maintenance and development of green infrastructure and are willing to pay for it.

| - Perform i-Tree Eco and i-Tree Street analyses.
- Utilize tree benefit data resulting from these analyses as an outreach tool (i.e. tree price tags showing total benefit value).
-Develop and utilize a Forestry Communications Specialist within MDC.
-Articulate the value of trees to stormwater mitigation.
-Work with communities to promote healthy watersheds and encourage smart development. | Urban FOA's. | 3.1&2
4.1-3,5&6
7.1-6
8.1-3
9.1-3&5-7
10.1-4
11.1-6 | 1.1,3&4
2.5
3.1
4.9&10
5.11
6.13-16
7.17&18 | 2.2
3.1
3.2
3.3
3.4
3.4
3.6
3.7 | MDC/DNR
USFS-S&PF
USFS-NRS
Extension
RCGs/Local gov't.
NGOs
Volunteer organizations
MCFA/Consultants
Arborists
Water districts
Developers | **Current Resources:**
-Existing outreach efforts.

Additional Resources Needed:
-Funding and people dedicated to developing tree benefits data.
-Funding and people dedicated to developing and implementing a collaborative urban forestry communications strategy. | **Current Resources:**
-Maintain public funding and policy that supports urban forests/green infrastructure.

Optimal Resources:
-Increased public funding and policy that supports urban forests/green infrastructure. |

8.1.2 Public Awareness - Increase public awareness of the importance of proper tree selection, planting and maintenance practices, and provide training to municipalities, private arborists, utility workers and homeowners.

-Promote "Right Tree in the Right Place". - Develop list of recommended trees with consideration given to potential forest health stressors (I&D, climate change, etc.). -Anti-topping campaign. -Provide training to municipalities, private arborists, utility workers and homeowners.	Urban FOA's.	3.1&2 4.5 7.1-4&6 8.1-3 10.4 11.1-6	Not Applicable	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC USFS-S&PF USFS-NRS Extension RCGs/Local Gov't. NGOs, Volunteer organizations MCFA/consultants Arborists Developers	**Current Resources:** -Existing outreach efforts. **Additional Resources Needed:** -Funding to increase the number and availability of urban foresters and arborists. -Funding for urban forestry communications efforts.	**Current Resources:** -Urban forest health and diversity are maintained, as documented by MDC's 44 City Street Tree Inventory. **Optimal Resources:** -Urban forest health and diversity are improved, as documented by MDC's 44 City Street Tree Inventory.

8.2.1 Technical Assistance - Promote the use of International Society of Arborist certified arborists and Society of American Foresters certified foresters who are trained and qualified to manage urban trees and forests.

-Support MDC foresters to serve as Proctors administering the ISA certification exams. -Provide incentives to arborists for getting certified. - Provide incentives to cities for utilizing certified individuals to provide tree care and training. -Increase public awareness of certified foresters and certified arborists and services they provide.	Urban FOA's.	3.1&2 4.5 7.1-4&6 8.1-3 10.4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC USFS-S&PF Extension RCGs/Local Gov't. NGO's MCFA/consultants Arborists Developers	**Current Resources:** -ISA and SAF certification programs, and currently certified arborists and foresters. **Additional Resources Needed:** -Funding and people dedicated to marketing certified forester and certified arborist services. -Funding to provide incentives for becoming a certified foresters or arborists and for increasing their use.	**Current Resources:** -Urban forest health and diversity are maintained, as documented by MDC's 44 City Street Tree Inventory. **Optimal Resources:** -Urban forest health and diversity are improved, as documented by MDC's 44 City Street Tree Inventory.

8.2.2 Technical Assistance - Provide technical assistance to communities for developing comprehensive community forestry programs.

-Help communities develop and adopt city tree ordinances. -Continue support for MDC's Tree Resource Improvement and Maintenance (TRIM) grant program. -Support Tree City USA, grow to 100 Tree Cities in next five years. -Support Tree Line USA, grow to 15 providers in next five years. -Promote Tree Campus USA, grow to 5 participating schools in next 5 years.	Urban FOA's.	3.1&2 4.5 7.1-4&6 8.1-3 10.4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC USFS-S&PF Extension RCGs/Local Gov't. NGO's MCFA/consultants Arborists Developers	**Current Resources:** -Existing community forestry assistance programs. **Additional Resources Needed:** -Funding and people dedicated to providing community forestry assistance to communities.	**Current Resources:** -Urban forest health and diversity are maintained, as documented by MDC's 44 City Street Tree Inventory. **Optimal Resources:** -Urban forest health and diversity are improved, as documented by MDC's 44 City Street Tree Inventory.

8.3.1 Data - Gather data to accurately monitor and assess urban forests.

-i-Tree Eco and i-Tree Street analyses. -Tree Canopy Assessments. -44 City street tree survey. -Improved land cover data. -City street tree inventories. -Develop Urban Forest Inventory and Analysis.	Urban FOA's.	3.1&2 4.5 7.1-4&6 8.1-3 10.4 11.1-6	1.1-4 2.5&6 3.7 4.9&10 5.11 6.13-16 7.17&18	2.2 3.1 3.2 3.3 3.4 3.7	MDC USFS-S&PF USFS-NRS Universities RCGs/Local Gov't. MORAP NGOs, Volunteer organizations MCFA/Consultants Arborists	**Current Resources:** -1989 and 1999 44 City Street Tree Inventory Data. -Municipal tree inventories **Additional Resources Needed:** -Funding and people dedicated to developing and/or updating urban forest assessment data.	**Current Resources:** -Maintain existing urban forest data. **Optimal Resources:** -High quality data is available to facilitate informed assessment and planning of Missouri's urban forests within the next five years.

8.4.1 Development BMPs - Demonstrate and showcase BMP's for urban development with partners.

-Develop grant program for green development BMPs. -Conduct green development training which highlights BMP demonstration sites.	Urban FOA's, including associated WUI.	1.6 3.1&2 4.1-3,5&6 7.1-4&6 8.1-3 10.1-4 11.1-6	1.1,3&4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC/DNR/NRCS USFS-S&PF RCGs/Local Gov't. NGOs Developers Real Estate Agents MCFA/Consultants Arborists Water districts	**Current Resources:** -Limited. **Additional Resources Needed:** -Funding to develop demonstrations sites for urban development BMP's, and outreach for promoting their use.	**Current Resources:** -Not applicable. **Optimal Resources:** -Increased use of BMP's for green development.

8.5.1 Recognition - Recognize arborists, volunteers, etc. for quality work and contributions.

-Support the Missouri Arbor Award of Excellence program in partnership with the Missouri Community Forestry Council.	Statewide.	3.1&2 4.1-3,5&6 7.1-4&6 8.1-3 9.1-7 10.1-4 11.2-6	1.2&4 3.7 4.9 5.11 6.13,14,16 7.18	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC/DNR/NRCS USFS-S&PF RCGs/Local Gov't. NGOs, Volunteer organizations MCFA/Consultants Arborists	**Current Resources:** -Maintain Missouri Arbor Award of Excellence program. **Additional Resources Needed:** -None at this time.	**Current Resources:** -Annual recognition of arborists, volunteers and communities. **Optimal Resources:** -Not applicable.

8.6.1 Urban Wood Waste - Develop cost effective and resourceful methods of utilizing wood waste.

-Develop biofuels markets for urban wood waste. -Promote the utilization of urban tree wood waste for lumber production.	Urban FOA's.	3.2 6.1,2,&6-8 8.1-3 11.1-4&6	2.6 6.12,14,16	3.4	MDC/DNR USFS-S&PF & NRS RCGs/Local Gov't. RC&D's Universities Extension MFPA/Industry MCFA/Consultants Arborists	**Current Resources:** -Limited infrastructure for disposing of urban "waste wood". **Additional Resources Needed:** -Increased private investment into utilization of urban "waste wood".	**Current Resources:** -Not applicable. **Optimal Resources:** -Enhanced utilization of urban "waste wood" and improved cost effectiveness of urban forest maintenance.

8.7.1 Urban Forest Diversity - Diversify the urban forests by promoting the use of native species and cultivars which are not as well known, but desirable for urban landscape use.

-Research the utility of native species and cultivars which are not as well known, but offer good potential for urban landscape use, and promote species which demonstrate desirable characteristics. -Provide guidelines to communities and landowners on appropriate tree species and the importance of diversity.	Urban FOA's.	3.1&2 4.5 7.1-4&6 8.1-3 10.4 11.1,2,&4-6	1.2&4 3.7	2.2 3.1 3.2 3.3 3.4 3.6 3.7	MDC/NRCS/MDA USFS-S&PF & NRS Universities Extension Local Gov't. NGOs, Volunteer organizations Developers MCFA/Consultants Arborists Homeowners	**Current Resources:** -Existing nursery inventories. -Urban forester and arborist advisory services. **Additional Resources Needed:** -Funding and people to conduct research on the utility of potential native tree species for urban landscapes, and to promote findings.	**Current Resources:** Maintain urban forest diversity, as documented by MDC's 44 City Street Tree Inventory. **Optimal Resources:** Increase urban forest diversity, as documented by MDC's 44 City Street Tree Inventory.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 3, 4, 7 & 11.

Issue Theme Nine: Public Lands which are Managed for the Greatest Public Good

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Criterion & Indicators Supported (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
9.1.1 Recreation - Maintain recreational facilities to provide sufficient, yet efficient public recreational opportunities.							
-Adjust recreation infrastructure to balance available maintenance funding with public demand. -Seek volunteer organization assistance with maintenance activities.	Public land statewide.	8.1&3 9.1-4 11.1-6	6.13	3.4 3.6	Public land agencies RCGs/ local gov't. NGOs Volunteer orgs.	**Current Resources:** -Existing recreation infrastructure. **Additional Resources Needed:** -Sufficient funding to provide recreation infrastructure demanded by the public. -Adjust recreation infrastructure to balance available maintenance funding with public demand. -Volunteer assistance with maintenance activities.	**Current Resources:** Maintain existing recreation infrastructure, or reduce to accommodate public demand and/or available funding. **Optimal Resources:** Sufficient recreational opportunities exist to meet most public demand.

9.2.1 Forest Planning - Develop Area/Forest Plans to formalize and guide management objectives and strategies on specific public ownerships.

-Maintain and implement MTNF's Forest Plan -Maintain and implement Area Plans for MDC Conservation Areas	Public land statewide as deemed necessary.	3.1&2 4.1-6 5.3-6 6.1-8 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies Land Trusts NGOs MFPA/ Industry MCFA/ Consultants	**Current Resources:** -Existing area/forest plans. **Additional Resources Needed:** -Funding and people dedicated to preparing and updating plans as needed to guide management decisions.	**Current Resources:** Utilize existing Area/Forest plans which are still current. **Optimal Resources:** Develop and utilize Area/Forest Plans to guide management on all priority public ownerships within ten years.

9.3.1 Public Trust and Awareness - Develop better public trust and awareness of public land management needs and activities through enhanced communication, transparency and stakeholder input.

-Conduct stakeholder meetings to provide opportunity for feedback on Area/Forest Plans. -Provide notification and information about forest management activities being implemented – what, why and when.	Statewide.	3.1&2 4.1-6 5.1&3-6 6.1-8 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies USFS-S&PF USFS-NRS NGOs	**Current Resources:** -Widely varying input opportunities and outreach efforts. **Additional Resources Needed:** -Funding and people dedicated to providing opportunities for public feedback.	**Current Resources:** Maintain current level of public trust and awareness of public land management activities over the next 5 yrs. **Optimal Resources:** Increase level of public trust and awareness of public land management activities over the next five years.

9.4.1 Conflict Avoidance - Manage and maintain public lands in a way which minimizes potential conflicts and impacts between different user groups and interest groups.

-Incorporate conflict avoidance concepts into Area/Forest Plans and implementation. -Engage stakeholders in developing Area/Forest Plans. -Provide opportunities for public feedback. -Enforce area regulations.	Public land statewide.	4.1-6 5.5&6 6.1-8 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies NGOs RCGs/ local gov't. MFPA/ Industry	**Current Resources:** -Existing Area/Forest Plans. -Existing public feedback opportunities. **Additional Resources Needed:** -Funding and people dedicated to providing opportunities for public feedback. --Funding and people dedicated to preparing and updating area plans as needed to address evolving concerns and information.	**Current Resources:** Maintain current level of conflict avoidance over the next five years. **Optimal Resources:** Improve conflict avoidance over the next five years.

9.5.1 Forest Land Conservation - Develop and implement a strategic forest land conservation program with goals of: 1) Acquiring or otherwise protecting tracts key to maintaining or enhancing the value of existing public lands; 2) Acquiring or otherwise protecting tracts key to providing other important public benefits; and 3) Disposing of tracts which offer minimal conservation or public value (replacing them with equal acreage of greater public value).

-Targeted land acquisition and disposal. -Conservation easements.	Land conservation efforts targeted in FOA/PFL. Land disposal efforts targeted statewide as deemed appropriate.	1.1-6 2.2-4 3.1&2 4.1-6 5.2&4-6 6.1-7 7.1-4&6 8.1-3 9.1-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies USFS-S&PF USFWS NGOs RCGs/ local gov't.	**Current Resources:** -Limited public agency funding for acquisition and easements. -Limited private funding and donations of land and/or development rights. -Forest Legacy program. **Additional Resources Needed:** -Significantly enhanced public funding for strategic forest land conservation. -Private donations of money, land or land development rights.	**Current Resources:** Permanently protect 15,000 acres of PFL/FOA in the next 5 years. **Optimal Resources:** Permanently protect 100,000 acres of PFL/FOA in the next 5 years.

9.6.1 Partner Collaboration - Foster better communication and collaboration between all public forest land management agencies.

-Utilize Missouri Forest Resource Advisory Council. -Utilize COA/PFL Teams. -Conduct a Forest Summit of public land agencies on implementation of FRAS. -Agencies with foresters on staff offer inter-agency support to agencies without foresters(or assist with contracting out consultant forester services).	PFL's.	3.1-3 4.1-6 5.1-6 6.1-8 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies	**Current Resources:** -Missouri Forest Resources Advisory Council. -Existing COA Stakeholder Teams. -Varying levels of other public land agency collaboration. **Additional Resources Needed:** -Additional COA/PFL Stakeholder Teams -Enhanced coordination between public land agencies – locally, regionally and statewide.	**Current Resources:** Maintain current level of communication and collaboration between public land agencies. **Optimal Resources:** Enhanced communication and collaboration between public land agencies.

9.7.1 Demonstration - Manage public land in a way which demonstrates sustainable forest management practices – providing examples for other landowners to follow.

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported	Pertinent Criterion & Indicators	National Priorities & Objectives	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
-Utilize public land management projects as demonstration sites for other landowners to follow. -Offer public workshops and interpretive information to explain forest management practices.	Public land statewide, but especially in PFLs.	1.1 2.4 3.1&2 4.1-6 5.1-6 6.1-8 7.1-6 8.1-3 9.6&7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies NGOs Volunteer organizations MCFA/ Consultants	**Current Resources:** -Past and current land management activities. -Limited public workshops and interpretive information explaining practices. **Additional Resources Needed:** -People dedicated to promoting sustainable forest management practices through public workshops and interpretive information which showcase public land projects.	**Current Resources:** -Maintain current level of public understanding and awareness of forest management needs and practices. -Recruit limited private landowners to implement similar practices on their property. **Optimal Resources:** -Increase public understanding and awareness of forest management needs and practices. -Recruit private landowners to implement similar practices on their property.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 8, 10 & 11.

Issue Theme Ten: Maintaining Biological Diversity

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Pertinent Criterion & Indicators (Criterion.Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
10.1.1 Natural Community Restoration and Maintenance - Maintain and restore forests, woodlands, glades and savannas which are well suited to their growing sites, best suited to wildlife targets, and most resilient to forest threats.							
-Utilize ECS/FLAG and adaptive natural community management. -Timber harvests -Forest Stand Improvement -Prescribed fire -Reforestation -Forest compartment inventories -Prioritize restoration activities to ensure limited resources produce maximum good.	FOA/PFL's which duplicate as Conservation Opportunity Areas.	1.1-4 2.4 3.1&2 4.1-6 5.5&6 6.1-6 7.1-4&6 8.1-3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies, USFWS USFS-S&PF USFS-MTNF NRCS/FSA Extension Land trusts NGOs, MORAP Volunteer orgs. MFPA/industry MCFA/ Consultants Contractors NIPFLs	**Current Resources:** -ECS/FLAG guidelines. -Forest product markets. -Public and private funding for restoration activities. **Additional Resources Needed:** -Significant increase in funding for non-commercial forest restoration activities. -Improved markets for small diameter and low quality trees. -Increased availability of foresters, contractors and loggers.	**Current Resources:** -Maintain or restore 40,000 acres of forest, woodland, glade and savanna natural communities per year through forest management practices. **Optimal Resources:** -Maintain or restore 100,000 acres of forest, woodland, glade and savanna natural communities per year through forest management practices.

10.2.1 Forest Land Action Guidelines - Maintain and Utilize MDC's Forest Land Action Guidelines (FLAG) to help guide forest management decision-making on MDC forestland and other forests as land managers so choose.

-Update FLAG with new information and forester experience write-ups to provide collaborative adaptive management opportunities. -Inform all forest managers about FLAG and provide training as needed.	Statewide.	1.1&3 3.1-3 4.1-6 5.5&6 6.1-6 7.1-6 8.1&2 9.1-3&5-7 10.1-4 11.1,2&4-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.7	Public land agencies USFS-S&PF & NRS USFWS NRCS/FSA MORAP Extension NGOs, Land trusts Volunteer orgs. MFPA/industry MCFA/consultants Contractors, NIPFLs	**Current Resources:** -FLAG. **Additional Resources Needed:** -Funding and people dedicated to updating FLAG as needed and providing training to potential users.	**Current Resources:** -FLAG is maintained and used widely. **Optimal Resources:** -FLAG is maintained and used to full potential.

10.3.1 Comprehensive Wildlife Strategy - Utilize Missouri's Comprehensive Wildlife Strategy (CWS) to maintain and enhance biodiversity.

-Initiate and/or expand CWS Conservation Opportunity Area (COA) Stakeholder Teams to dually serve as PFL Stakeholder Teams for collaborating on FRAS and CWS strategies. -Incorporate CWS priority landscapes into the FRAS Forest Opportunity Model for determining PFLs. -Develop crosswalk between CWS and FRAS.	FOA/PFL's which duplicate at Conservation Opportunity Areas.	1.1-6 2.2&4 3.1 4.1-4&6 5.5&6 6.1&3-5 7.1-6 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.1 2.2 3.1 3.2 3.4 3.5 3.6 3.7	Public land agencies USFWS USFS-S&PF & NRS Universities Extension Land trusts NGOs, Volunteer organizations MFPA/Industry MCFA/consultants Contractors, NIPFLs	**Current Resources:** -COA Stakeholder Teams **Additional Resources Needed:** -New and/or expanded CWS Conservation Opportunity Area (COA) Stakeholder Teams which dually serve as PFL Stakeholder Teams.	**Current Resources:** -19 COA stakeholder teams which are active to varying extents. **Optimal Resources:** -24 active COA/PFL stakeholder teams which effectively collaborate on achieving common conservation visions.

10.4.1 Natural Areas - Recognize the best examples of healthy forest and woodland community types and manage them to maintain their integrity.

-Restore and/or maintain forest communities recognized as Missouri Natural Areas.	Existing and future designated Natural Areas.	3.1 4.1-4&6 5.5&6 6.4 7.1-6 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.13-16 7.17&18	1.1 2.1 2.2 3.1 3.4 3.5 3.6 3.7	Public land agencies USFWS Land trusts NGOs NIPFL's	**Current Resources:** -180 designated Natural Areas with limited funding for management needs. -People dedicated to updating the Natural Areas System to ensure that it represents the best examples of Missouri's diverse natural communities. **Additional Resources Needed:** -Sufficient funding for management needs on designated Natural Areas and program expansion as needed.	**Current Resources:** -Maintenance of a quality Natural Area program over the next five years. **Optimal Resources:** -Improvement and/or expansion of a quality Natural Area program over the next five years.

10.5.1 Wildlife Targets - Establish baseline data and targets for forest wildlife habitat initiatives.

-Partners in Flight bird population estimates and targets. -Ruffed grouse survey in Missouri River Hills PFL.	FOA/PFL's which duplicate at Conservation Opportunity Areas.	2.4 3.1&3 4.2 5.6 6.4 7.1,3&6 8.3 9.1-3&5-7 10.1-4 11.1-6	1.1-4 2.5&6 3.7 4.8-10 5.11 6.12-16 7.17&18	1.1 1.2 2.1 2.2 3.1 3.4 3.5 3.5 3.6 3.7	MDC/USFWS USFS-NRS NGOs Volunteer organizations	**Current Resources:** -Existing baseline data and targets. **Additional Resources Needed:** -Funding and people dedicated to establishing or improving baseline data and targets for forest wildlife habitat initiatives.	**Current Resources:** -Existing baseline data and targets. **Optimal Resources:** -New and improved baseline data and targets for forest wildlife habitat initiatives.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1, 2, 3, 4, 5, 6, 7, 9, 10 & 11.

Issue Theme Eleven: Logistical Framework for Sustainability

Example Action Items	Target Geographies	FRAS Issues & DFC's Supported (Issue.DFCs)	Pertinent Criterion & Indicators (Criterion. Indicators)	National Priorities & Objectives Supported	Key Potential Stakeholders	Resources Needed to Implement	Measures of Success
11.1.1 Partner Collaboration - Develop Priority Forest Landscape (PFL) and Urban Forest Opportunity Area (UFOA) stakeholder groups for the purpose of collaborating on the development and implementation of objectives and strategies specific to established priority geographies.							
- Identify, enable and hold accountable a project leader in each PFL and UFOA. -Develop stakeholder teams for each PFL and UFOA. -Task one person with the assignment of helping to develop and promote these teams.	PFL's and Urban FOA's.	All	All	All	Public land agencies USFS-S&PF USFWS/NRCS/FSA RCGs/Local gov't. RC&Ds, Extension NGOs, Land trusts Volunteer orgs. MFPA/industry MCFA/consultants Contractors, NIPFLs Water Districts	**Current Resources:** -COA Stakeholder Teams. **Additional Resources Needed:** -Expanded COA Teams that meet the needs of PFLs. -Additional PFL and UFOA Stakeholder Teams where they are lacking.	**Current Resources:** -Maintain or improve collaboration in PFLs which have existing COA stakeholder teams over the next five years. **Optimal Resources:** -Enhance collaboration and accomplishments in all PFLs and UFOAs over the next five years.
11.1.2 Partner Collaboration - Utilize the Missouri Forest Resources Advisory Council (MOFRAC) as a means of collaboration and communication of prominent forestry issues between Missouri's forestry agencies and partner organizations.							
-Continue quarterly meetings which facilitate collaboration between forestry partner organizations. -Expand MOFRAC to include additional partner organizations as needed.	Statewide.	All	All	All	All	**Current Resources:** -MOFRAC organization. **Additional Resources Needed:** -Expanded MOFRAC membership to include additional partner organizations as needed.	**Current Resources:** -MOFRAC membership numbers and meeting attendance is maintained over the next 5 years. **Optimal Resources:** -MOFRAC membership and meeting attendance increases over the next five years.
11.1.3 Partner Collaboration - Utilize the Missouri Community Forestry Council as a means of collaboration and communication of prominent urban and community forestry issues between forestry agencies and partner organizations.							
-Continue State Council and Regional meetings which facilitate collaboration between community forestry partner organizations. -Encourage MCFC to expand to include additional partner organizations as needed. -Continue financial support of organizations – encouraging them to become self-sufficient.	Urban FOA's.	All, but with special emphasis on Urban FOA's.	All, but with special emphasis on Urban FOA's.	All, but with special emphasis on Urban FOA's.	MDC/DNR USFS-S&PF Universities RCGs/Local Gov't. NGOs, Extension Volunteer orgs. MCFA/ consultants Arborists	**Current Resources:** -MCFC and local chapters. **Additional Resources Needed:** -Expanded MCFC membership to include additional partners. -A Regional MCFC chapter established in each UFOA.	**Current Resources:** -MCFC membership and meeting attendance is maintained over the next five years. **Optimal Resources:** -MCFC membership and meeting attendance is increased over the next five years.

11.1.4 Partner Collaboration - Develop a Missouri Forest Landowner Association to improve communication of important forestry information to and from landowners, and to develop advocacy for sustainable forestry.

-Initiate a Missouri Forest Landowner Association.	Statewide.	All	All	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	MDC/NRCS USFS-S&PF Extension Land Trusts NGOs Volunteer organizations MFPA/Industry MCFA/Consultants NIPFLs	**Current Resources:** -Interested landowners and partner organizations. **Additional Resources Needed:** -Funding and people dedicated to establishing and leading a Missouri Forest Landowner Association.	**Current Resources:** -Not applicable. **Optimal Resources:** -The establishment of a self sufficient Forest Landowner Association with a membership of 1,000+ landowners within five years.

11.2.1 Data and Research – Inventory and monitor forests and forest product trends to ensure harvest rates remain sustainable, to facilitate sustainable forest management decisions, and to help prioritize forestry efforts.

-Timber Product Output survey. -Conduct Forest Inventory and Analysis to monitor forest trends statewide, regionally, and on select public ownerships. -Compartment inventories on public land. -Private land inventories.	Statewide.	1.1,3&6 2.2-4 3.1-3 4.1-4&6 6.1-8 7.1-6 9.1-3,&5-7 10.1-4 11.1-6	All	1.1 1.2 2.2 3.1 3.2 3.4 3.5 3.6 3.7	MDC/NRCS USFS-NRS USFS-S&PF Public land agencies	**Current Resources:** -USFS Forest Inventory and Analysis program. -MDC Timber Product Output survey. -Compartment inventories on public land. -Private land inventories. **Additional Resources Needed:** -Funding and people dedicated to conducting Continuous Forest Inventory on MDC land.	**Current Resources:** -Development of statistically accurate and useful data on forest/forest product trends - made available at least once every 5 years statewide and regionally, and as needed at local scales. **Optimal Resources:** -More accurate, useful and timely development of data on forests and forest product trends - made available at least once every 5 years at statewide and regionally, and as needed at local scales.

11.2.2 Data and Research - Develop and/or obtain better geographic information to enhance assessment capabilities, planning efforts, and management decision making.

-Obtain LIDAR data on priority geographies. -Obtain updated National Land Cover Database data, and/or pursue finer scale data as proposed by MORAP. -Utilize 2010 census data to develop updated WUI data, housing density projections data, etc.	PFL's and Urban FOA's	1.2-6 2.4 3.3 4.1-6 5.1-6 6.3&6 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	All	1.1 1.2 2.1 2.2 3.1 3.2 3.4 3.5 3.7	USFS/DNR/MDA USFS-S&PF USFS-NRS NRCS/USFWS Public land agencies MORAP RCGs/Local Gov't. USGS NGOs, Land trusts MFPA/industry MCFA/consultants	**Current Resources:** -Existing geographic information (i.e. 2001 NLCD, 2009 NAIP imagery, models based on 2000 census data) **Additional Resources Needed:** -Funding and people dedicated to developing geographic information enhancements.	**Current Resources:** -Existing geographic information which facilitates moderate assessment and planning capabilities during the next 5 yrs. **Optimal Resources:** -Enhanced and updated geographic information which facilitates high quality assessment and planning capabilities during the next 5 yrs.

11.2.3 Data and Research - Conduct research on important data gaps which will facilitate the advancement and improvement of forest resource planning, management and assistance.

-MO Forest Ecosystem Project. -Conduct public attitude surveys to determine opinion towards forest threats, opportunities and management alternatives. -Conduct private-landowner surveys to enhance understanding of landowner interests, needs and challenges.	Statewide.	All	All	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	USFS/DNR/MDA USFS-S&PF USFS-NRS NRCS USFWS Public land agencies Land trusts NGOs MFPA/industry MCFA/consultants	**Current Resources:** -Existing research efforts (MOFEP, NRS research, etc.) **Additional Resources Needed:** -Funding and people dedicated to conducting research of existing and future data gaps.	**Current Resources:** -Data is available to facilitate informed forest resource planning, management and assistance during the next 5 yrs. **Optimal Resources:** -Enhanced data is available to facilitate informed forest resource planning, management and assistance during the next 5 yrs.

11.3.1 Legislation - Explore the feasibility and desirability of establishing forest-friendly legislation.

-Explore the feasibility and desirability of: 1) a "Right to Practice Forestry Act", 2) "Smart Growth" legislation, 3) enhanced legislation for conservation easements, 4) legislation banning the sale of exotic invasive plants, 5) legislation restricting movement of materials which can spread harmful plants, animals and diseases, and 6) legislation improving tax code for private landowners and industry.	Statewide.	1.1-6 2.1-4 3.1&2 4.1-6 5.1-6 6.1-7 7.1-6 8.1-3 9.1-7 10.1-4 11.1-6	All	1.1 1.2 2.1 2.2 3.1 3.2 3.3 3.4 3.5 3.6 3.7	MDC/DNR/MDA Extension RCGs/Local gov't. Land Trusts NGO's Volunteer organizations MFPA/industry MCFA/consultants NIPFLs Water Districts	**Current Resources:** -Existing forestry legislation (minimal). **Additional Resources Needed:** -Funding and people dedicated to exploratory work to potentially propose new legislation, and to review draft legislation proposed by other entities.	**Current Resources:** -Not applicable. **Optimal Resources:** -Complete a comprehensive review and summary of legislative options for maintaining or enhancing the health, productivity and sustainability of Missouri's forests over the next two years.

11.4.1 Volunteer Recruitment - Recruit concerned citizens and volunteers to assist with miscellaneous activities towards sustainability of Missouri's forest resources**.**

-Adopt an Acre program for controlling exotic plant species. -Adopt a Trail program for trail maintenance. -Missouri Forestkeepers Network. -Missouri Heritage Woods program. -Missouri Master Naturalists program. -Kansas City Wildlands program.	PFL's and Urban FOA's.	All	All	All	Public land agencies Land Trusts NGOs Volunteer organizations	**Current Resources:** -Existing volunteer organizations (i.e. Forestkeepers, Master Naturalists, etc.) **Additional Resources Needed:** -Funding and people dedicated to expanding recruitment and use of volunteer organizations.	**Current Resources:** -Sustain current service hours contributed towards activities which maintain or enhance Missouri's tree and forest resources during the next five years. **Optimal Resources:** -Significantly increase service hours contributed towards activities which maintain or enhance Missouri's tree and forest resources during the next 5 years.

11.5.1 Communications - Develop and implement a comprehensive forestry communications and marketing strategy for building awareness of Missouri's forest resources and their associated benefits, threats and opportunities, and for advancing Missouri's Forest Resource Assessment and Strategy.

-Develop a comprehensive forestry communications and marketing strategy. -Conduct communications and marketing according to this strategy.	Statewide, but refined according to communications strategy.	All	All	All	MDC USFS-S&PF USFS-MTNF USFS-NRS MOFRAC	**Current Resources:** -Minimal MDC/NASF funding and resources. **Additional Resources Needed:** -Funding and people dedicated to developing and implementing a comprehensive communications and marketing strategy.	**Current Resources:** -Not applicable. **Optimal Resources:** -Development and implementation of a comprehensive communications and marketing strategy for advancing Missouri's Forest Resource Assessment and Strategy during the next five years.

11.6.1 Engagement - Increase the connection and engagement of the general public, especially kids, to the trees, forests and natural world that support their quality of life.

-Launch a "Get Into the Forest" campaign, or increase forestry role in Discover Nature Program. -Promote outdoor recreation activities. -Promote volunteerism towards improving Missouri's forest resources and services. -Improve public awareness of Missouri's forest resources, and their issues and opportunities through communications and marketing.	Statewide.	All	All	All	MDC/DNR/MDA NRCS USFS-S&PF USFS-MTNF Public land agencies Universities Extension RCGs/Local Gov't. Land trusts NGOs Volunteer organizations MFPA/industry Developers MCFA/ Consultants	**Current Resources:** -Public and private forestland recreation opportunities. -Existing volunteer organizations. -Existing outreach and education efforts. **Additional Resources Needed:** -Funding and people dedicated to developing and implementing a comprehensive communications and marketing strategy. -Funding to improve public forestland recreation opportunities. -Funding and people dedicated to expanding recruitment and involvement of citizens into volunteer organizations.	**Current Resources:** -Maintain current level of participation in recreation activities and volunteer organizations during the next five years. -Maintain current level of public knowledge regarding forest benefits, threats and opportunities during the next five years. **Optimal Resources:** -Increase level of participation in recreation activities and volunteer organizations within the next five years. -Increase level of public knowledge regarding forest benefits, threats and opportunities within five years.

Note: This list of strategies is not all inclusive. Additional strategies contributing towards this Issue Theme can be found listed under Issue Themes 1-10.

Appendix A - List of Participating Organizations

The following organizations participated in the development of FRAS. Our hope is that this list will grow much longer in the coming years. Please note that this list does not include several other partners who are actively engaged with MDC's Forestry Division, but did not formally contribute to the development of FRAS.

Umbrella Organizations:
MO Forest Resources Advisory Council
      (Forest Stewardship Coordinating
      Committee)
MO Community Forestry Council
Conservation Federation of Missouri
State Technical Committee
Missouri Forest Products Association

Government Agencies:
Missouri Department of Conservation
      Fisheries Division
      Outreach and Education Division
      Private Lands Division
      Resource Science Division
      Wildlife Division
US Forest Service
      NA State and Private Forestry
      Mark Twain National Forest
      Northern Research Station
Natural Resources Conservation Service
Mid America Regional Council
Missouri Dept of Natural Resources
City of Kansas City
MO Resource Assessment Partnership
University of Missouri – Columbia
Missouri Department of Agriculture
Missouri National Guard
MU Forestry Extension
DNR Soil and Water Conservation
      Program
Top of the Ozarks RC&D
Southwestern IL RC&D
City of Springfield

Non-Governmental Organizations:
Burroughs Audubon Chpt. of Kansas City
Audubon Society of Missouri
Missouri Chapter of The Wildlife Society
National Wild Turkey Federation
The Nature Conservancy
Midwest Forest Consultants LLC
Far More Consulting, LLC
Ruffed Grouse Society
Missouri Walnut Council
Eastern Ozarks Forestry Council
Clearwater Forestry Consultants
Webster Groves Nature Study Society
Walmar Investment Company
St. Louis Audubon Society
Gateway Off-Road Cyclists
Missouri Native Plant Society
Independent Stave Company
Ozark Regional Land Trust
Missouri Nut Growers
Kansas City Wildlands/Bridging the Gap
Missouri Society of American Foresters

Appendix B - Seven Criteria of Forest Sustainability and Indicators

**Northeastern Area Association of State Foresters/
U.S. Forest Service - Northeastern Area
Criteria and Indicators of Forest Sustainability**

Criterion 1: Conservation of Biological Diversity

Indicator 1. Area of total land, forest land, and reserved forest land

Indicator 2. Forest type, size class, age class, and successional stage

Indicator 3. Extent of forest land conversion, fragmentation, and parcelization

Indicator 4. Status of forest/woodland communities and associated species of concern

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

Indicator 5. Area of timberland

Indicator 6. Annual removal of merchantable wood volume compared with net growth

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

Indicator 7. Area of forest land affected by potentially damaging agents

Criterion 4: Conservation and Maintenance of Soil and Water Resources

Indicator 8. Soil quality on forest land

Indicator 9. Area of forest land adjacent to surface water, and forest land by watershed

Indicator 10. Water quality in forested areas

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

Indicator 11. Forest ecosystem biomass and forest carbon pools

Criterion 6: Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Indicator 12. Wood and wood products production, consumption, and trade

Indicator 13. Outdoor recreational participation and facilities

Indicator 14. Investments in forest health, management, research, and wood processing

Indicator 15. Forest ownership, land use, and specially designated areas

Indicator 16. Employment and wages in forest-related sectors

Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Indicator 17. Forest management standards/guidelines

Indicator 18. Forest-related planning, assessment, policy, and law

Appendix C – List of Potential Stakeholders and Acronyms used in Strategy Matrix

State Agencies:
  Missouri Department of Conservation (MDC)
  Missouri Department of Natural Resources/ Soil and Water Conservation Districts (DNR)
  Missouri Department of Agriculture (MDA)
  Universities and University Extension (Extension)

Federal Agencies:
  U.S.D.A. Forest Service – Mark Twain National Forest (USFS-MTNF)
  U.S.D.A. Forest Service – State and Private Forestry Program (USFS-S&PF)
  U.S.D.A Forest Service – Northern Research Station (USFS-NRS)
  U.S.D.A. Natural Resources Conservation Service (NRCS)
  U.S.D.A. Farm Service Agency (FSA)
  U.S.D.I. National Park Service (NPS)
  U.S. Army Corps of Engineers (COE)
  U.S.D.I. Fish and Wildlife Service (USFWS)
  U.S. Department of Defense (DOD)
  U.S.D.A. Animal and Plant Health Inspection Service (USDA-APHIS)

Local Government:
  Regional Councils of Government (RCG's)
  Resource Conservation and Development Units (RC&D's)
  County and Municipal Government (local gov't.)
  Fire Departments

Other Government and Quasi-Government:
  All public land management agencies (public land agencies)
  Missouri Resource Assessment Partnership (MORAP)
  Water supply companies and sewer districts (Water Districts)

Not-For-Profit Organizations:
  Land trusts
  Non-Governmental Organizations (e.g. Audubon Missouri) (NGOs)
  Volunteer Organizations (i.e. Forestkeepers, Master Naturalists) (Volunteer orgs.)

Private Industry:
  Missouri Forest Products Association (MFPA)
  Forest Industry (Industry)
  Missouri Consulting Foresters Association (MCFA)
  Consulting Foresters (Consultants)
  Arborists
  Real Estate Developers (Developers)
  Real estate agents, Attorneys, Financial advisors, Entrepreneurs

Other:
  Private donors and investors
  Non-industrial Private Forest Landowners (NIPFL's)

The following umbrella organizations will play a key role in implementing FRAS, but are not listed as key stakeholder in the Strategy Matrix:
  Missouri Forest Resource Advisory Council (MOFRAC)
  Missouri Community Forestry Council (MCFC)
  State Technical Committee (STC)
  Conservation Federation of Missouri (CFM)

Appendix D – List of Other Commonly Used Acronyms

AON   Forest Legacy Program "Assessment of Need"
BMP   Best Management Practices
COA   "Conservation Opportunity Area" designated by Missouri's Comprehensive Wildlife
        Strategy
CRP   Conservation Reserve Program
CWPP Community Wildfire Protection Plan
CWS   Comprehensive Wildlife Strategy
DFC   Desired Future Condition
EAB   Emerald Ash Borer
ECS   Ecological Classification System
EQIP   Environmental Quality Incentive Program
FLAG   Forest Land Action Guidelines
FLP   Forest Legacy Program
FOA   Forest Opportunity Area
FRAS   Forest Resource Assessment and Strategy
FSC   Forest Stewardship Council
GHG   Greenhouse Gas - Carbon
LTA   Land Type Association
NA   Natural Area
NGO   Non Governmental Organization
NLCD   National Land Cover Data
PFL   Priority Forest Landscape
SFI   Sustainable Forestry Initiative
TSI   Timber/Forest Stand Improvement
UFOA   Urban Forest Opportunity Area
WHIP   Wildlife Habitat Incentive Program
WPA   Wildfire Priority Area
WRP   Wetland Reserve Program
WUI   Wildland-Urban Interface

Appendix E – Multi-State Priority Area and Issue Write-Ups

Multi-state priority area: Upper Mississippi Watershed

States: Illinois, Indiana, Iowa, Minnesota, Missouri, Wisconsin

Issues associated with the area:

Water Pollution--Sediment, nitrogen and phosphorus are the main pollutants in the Upper Mississippi watershed. A significant portion of sediment, nitrogen and phosphorus loads to the Mississippi River comes from human activities: runoff and groundwater from farming, discharges from sewage treatment and industrial wastewater plants, and stormwater runoff from city streets. The delivery of high amounts of nitrogen to the Gulf of Mexico causes a hypoxia zone (abnormally low levels of dissolved oxygen in bottom waters) to expand each summer. About 90% of the nitrate load to the Gulf of Mexico comes from nonpoint sources, and over 31% of that load comes from the Upper Mississippi River.

Loss of Migratory Bird Habitat--The north-to-south orientation of the Upper Mississippi River and its contiguous habitat make it critical to the life cycles of many migratory birds. It is a globally important migratory flyway for 40 percent of all North American waterfowl and 60 percent of all the bird species in North America. The loss of more than 50% of historic floodplain and valley hardwood forests creates a problem for many waterfowl, raptors, songbirds, and shorebirds.

Forest Loss and Fragmentation--Forests and prairies are the most beneficial land use in the Upper Mississippi River Basin in terms of protecting watersheds and water quality. Nearly all of the prairies and about 70 percent of the forest land have been converted to agriculture and urban land uses. The remaining forest land is critical to watershed health and clean water. The ability of forests to produce abundant clean water declines as they are broken up (fragmented) and eventually lost. Fragmentation is a process where large, contiguous forest landscapes are broken into smaller, more isolated pieces, often surrounded by human-dominated uses. The loss and continued break up of forest land increasingly impairs water flow and quality, forest health and diversity, and other economic and recreational benefits.

Opportunities for partnership, cooperation, and projects:

 There are many overlapping initiatives in the Upper Mississippi Basin. Recently the Northeastern Area and the Upper Mississippi Forest Partnership participants analyzed where several major initiatives have set priorities, trying to find areas of overlap where efficiencies may exist. The initiatives included in this analysis are:
- Upper Mississippi Forest Partners GIS analysis,

- Northeastern Area, Stewardship Analysis Project,
- Northeastern Area, Forest-Water-and People,
- NRCS, Mississippi River Basin Initiative,
- State Wildlife Plan-conservation opportunity areas,
- Audubon Society-Important Bird Areas.

Through this analysis and talking to local partners a list of priority watersheds for the Upper Mississippi Forest Partnership was completed. A map of these selected watersheds attached.

Also the National Fish and Wildlife Foundation manage an Upper Mississippi Watershed Fund for the Upper Mississippi Forest Partnership. An annual RFP is a sent out to about 250 potential partners.

Existing efforts:

The current Upper Mississippi Forest Partnership (UMFP) Action Plan (2009-2013) includes the following priorities. However, it should be noted that the UMFP steering committee in March of 2010 decided to focus partnership priorities on bottomland forest restoration through 2013.
Sustainable Forests--Demonstrate through partnership conservation efforts the application of sustainable forestry to protect, maintain, and restore healthy forests.

OBJECTIVE #1—Identify several forest watershed demonstration sites within the Upper Mississippi watershed to highlight sustainable forestry.
OBJECTIVE #2—Develop an Action Plan for each forest watershed demonstration site.
OBJECTIVE #3—Develop a tool kit for forest watershed demonstration sites consisting of similar projects done elsewhere and financial and technical resources.
OBJECTIVE #4—Develop guidelines on how to identify forest fragmentation, how to monitor change over time, and look for opportunities to address negative impacts.

Water Quality --Improve water quality to support healthy and productive aquatic ecosystems with forest-based strategies at the site, watershed, and basin scale.

OBJECTIVE #1—By 2013, we have resources available to assist in the restoration and management of bottomland forests.
OBJECTIVE #2—Restore and actively manage at least 25,000 acres of bottomland forests by 2013 to meet multiple objectives—flood control, sediment and nutrient capture, carbon sequestration and more.
OBJECTIVE #3—Strengthen partnership and coordination between local, state, and federal agencies, NGO's, and other partners to work together on common water quality and forestry concerns.
OBJECTIVE #4—We have boots on the ground working with landowners on forestry and water quality problems.

Migratory Bird Habitat--Increase migratory bird habitat quality and quantity to support stable or increasing forest bird populations.

OBJECTIVE #1—Develop a forest bird conservation toolbox tailored for the different ecosystems and forest types found within the Upper Mississippi River (UMR) basin.

OBJECTIVE #2—Create a network of BIRDs (Bird-Intensive Restoration Demonstrations) strategic demonstration/restoration landscapes representing the major forest types in the UMR. For example: upland forest (Cerulean Warbler), bottomland hardwood forest (Prothonatory Warbler), and transitional/successional forest (Golden-winged Warbler or Woodcock.) OBJECTIVE #3—Develop a framework for monitoring bird response to forest management activities.

Key contact persons, resources, organizations for the area:

Upper Mississippi Forest Partnership
http://www.na.fs.fed.us/watershed/upper_mississippi_partnership/
Richard Peterson, Chairperson, steering committee
507-333-2012 ext. 222
Richard.peterson@state.mn.us

Teri Heyer, coordinator
651-649-5239
theyer@fs.fed.us

Upper Mississippi Watershed Fund
National Fish and Wildlife Foundation
www.nfwf.org/uppermiss
John Curry
612-713-5176
John.curry@nfwf.org

Multi-state priority issue: Wildfire risk

In state priority areas where wildfire risk is identified as a critical issue, planning and management are likely to reduce a relatively high risk of wildfire. Wildland fire management programs use planning, hazard mitigation and prescribed fire practices targeted toward high risk areas as well as suppression and preparedness actions. Fire management practices may be integrated into the overall forest management strategy to be employed while also addressing wildfire risk areas.

States:

Minnesota, Michigan, Wisconsin, Iowa, Missouri, Indiana, Illinois, Canadian Provinces of Ontario and Manitoba

St. Paul Field Office Service Area

Issues:

- Fire regime condition class change which has been occurring over the decades. Vegetative cover and fuel loading has changed due to change in the land management practices and settlement patterns.
- Prescribed burning and its use as a multi-purpose land management tool. There are common issues in the states regarding training, qualifications and the number of people available for burning as well as the environmental issues associated with prescribed fire.
- Significant weather events which have damaged the forest and change fuel composition: Ice Storm (in the southern tier of the mid-west states) and wind events.
- Grassland Management and prairie restoration: Mid west and parts of southern MN. The use of fire is needed to maintain or restore these systems.
- Insect damage - northern tier of the Lake States - Beetle killed spruce and jack pine stands contribute to increased fuel loading.
- Community Wildfire Protection Planning – Successful community planning efforts can mitigate losses and the impacts of wildfire to the ecosystems. Planning to reduce fire risk can be incorporated into overall land management planning or specifically identified for communities at risk of wildfire.
- Aging of personnel - an overall problem for all the states as the workforce ages which will result in a decrease in the fire management program's capacity.

Opportunities for partnership, cooperation, and projects:

Hazard mitigation—activities focus on hazard fuels reduction, development and implementation of Community Wildfire Protection Plans (CWPPs), prevention and mitigation education, Firewise programming, and community hazard mitigation.

Prescribed burning—hazard mitigation; ecosystem maintenance/restoration; control of invasives and wildlife habitat improvement; silvicultural practices including site preparation and oak regeneration; management activities for rare, threatened, and endangered species; watershed management and forest health practices all can be achieved with prescribed burns.

Cooperating Agreements - State Strategies should also identify the existence of any cooperating agreements for suppression activities on Federal lands.

Key contact persons, resources, organizations for the issue:
Federal Land Management Agencies: USFS National Forest System, National Park Service, US Fish and Wildlife Service
Tribal Lands Programs
Great Lakes Forest Fire Compact - http://www.glffc.com/content/
Big Rivers Forest Fire Compact - http://www.brffmc.org/
The Nature Conservancy – local chapters
Chicago Wilderness - http://www.chicagowilderness.org/

Priority Area: Karst Topography

Area with a geology of limestone or other soluble rock that is characterized by caves, sinkholes, and sinking streams.

States:

Illinois, Indiana, Iowa, Kentucky, and Missouri

Issues associated with the area:

- Water Quality. The porous landscape prevents adequate filtering that usually takes place through soil layers. Therefore, groundwater quality is greatly threatened by overland activity. Herbicide treatment for forest management is limited, and the practice by landowners to fill sinkholes with garbage and other materials degrades the water quality.

Karst Topography

- Sensitive and Protected Species. Karst areas contain a great number of protected or sensitive species, usually associated with caves. Forest management and recreational activities are limited in these areas.

- Cave Vandalism.

Opportunities for partnership, cooperation, and projects:

- Partner with non-profit organizations and state and federal fish and wildlife agencies to provide environmental education on sinkhole management and how humans impact the spread of deadly disease for sensitive species through cave exploration.

- Since limitations for management in areas with sensitive species often result in small project areas, coordinating with adjacent states for forest management projects may increase cost-effectiveness and make it possible to manage lands that otherwise would not be big enough to conduct necessary management activities.

Existing efforts:

- Region 9 of the U.S. Forest Service closed all of its caves to the public due to the threat of white-nose syndrome and its impact on the endangered Indiana bat. The vectors for transmitting the fungus are not currently known.

- A video completed by the Hoosier National Forest has been distributed internationally and may be valuable to states seeking to improve education about white-nose syndrome of bats. www.cavebiota.org

Key contact persons, resources, organizations for the area:

- The National Karst Map Project,
  http://www.nature.nps.gov/nckri/map/project/index.html

- The Karst Conservancy, http://www.karstconservancy.org

- Indiana Karst Conservancy, http://ikc.caves.org/index.shtml

- Karst Conservancy of Illinois, http://karstconservancyofillinois.org/

- Missouri Caves and Karst Conservancy, http://www.mocavesandkarst.org/main.htm

Multi-state priority issue: Climate Change

Important questions exist over the impact that potential changes in climate will have on forest resources in the future. How will a rise in global temperature affect the continued viability of the existing forest ecosystems? How will these changes affect the existing forest industry? Will both ecosystems and industry be able to respond quickly enough to changing conditions to prevent the collapse of either? The uncertainty of the many issues impacting forests and forests resources in the face of a changing climate severely impacts our ability to plan for future forest conditions.

St. Paul Field Office Service Area

States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Wisconsin

Issues:

- Great uncertainty exists over the extent temperatures might raise in the future. This uncertainty makes long-term planning difficult because future climatic conditions are not known.
- Carbon sequestration and carbon storage facilitated by forest management activities has great potential for increasing interest in forest management. However, uncertainties with the current carbon market and a recent plunge in the value of carbon have hampered an expansion of forest-related carbon activity.
- Tourism is a major industry in much of the region and the forested landscapes of the north make this area a prime destination for tourist and vacationers. Changes in the forested condition of this region would greatly impact its appeal as a tourist destination.
- Forestry and the forest products industry are also import contributors to the economy of the region. Climatic change would likely alter the tree species that make up the various forested regimes in the region or threaten the very existence of forests in forest-prairie transitional areas. The forest products industry would likely suffer as it struggles to adapt to a changing forest composition.
- Reforestation efforts would likely need to increase and new species would likely need to be introduced to maintain viable forest cover in many cases.
- Hunting and fishing are also important contributors to the economy in parts of this region. Changes in forests and forest composition would alter wildlife populations with potential for negatively affecting those populations and industries dependent upon them.
- Trees under stress due to a changing climate would be increasingly vulnerable to insect and disease infestation.
- Invasive plant problem would increase as climate induced disturbances would create increased opportunities for invasion.

Issues identified by the US Global Climate Change Research Program for the Midwest: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/midwest

1. During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing insect and waterborne diseases. In the winter, warming will have mixed impacts.
    a. Heat waves that are more frequent, more severe, and longer-lasting are projected. The frequency of hot days and the length of the heat-wave season will both be more than twice as great under a higher emissions scenario than a lower one (see full report for information on emission scenarios). Insects such as ticks and mosquitoes that carry disease will survive winters more easily and produce larger populations in a warmer Midwest.
    b. Significant reductions in Great Lakes water levels, which are projected under higher emissions scenarios, lead to impacts on shipping, infrastructure, beaches, and ecosystems.
    c. Higher temperatures will mean more evaporation and hence a likely reduction in Great Lakes water levels. Reduced lake ice increases evaporation in winter, contributing to the decline. This will affect shipping, ecosystems, recreation, infrastructure, and dredging requirements. Costs will include lost recreation and tourism dollars and increased repair and maintenance costs.
2. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.
    a. The projected pattern of increasing precipitation in winter and spring and heavy downpours is expected to lead to more frequent flooding, increasing infrastructure damage, and impacts on human health. Heavy downpours can overload drainage systems and water treatment facilities, increasing the risk of waterborne diseases. In summer, with increasing evaporation and longer periods between rainfalls, the likelihood of drought will increase and water levels in rivers and wetlands are likely to decline.
3. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to managing crops, livestock, and forests.
    a. Spring flooding is likely to delay planting. An increase in disease-causing pathogens, insect pests, and weeds cause additional challenges for agriculture. Livestock production is expected to become more costly as higher temperatures stress livestock, decreasing productivity and increasing costs associated with the needed ventilation and cooling equipment.
4. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.
    a. All major groups of animals including birds, mammals, amphibians, reptiles, and insects will be affected by climate change impacts on local populations and by competition from species moving into the Midwest. The potential for animals to shift their ranges to keep pace with the changing climate will be inhibited by major urban areas and the presence of the Great Lakes.

Key contact persons, resources, organizations for the issue:

http://epa.gov/climatechange/index.html
http://www.pewclimate.org/global-warming-in-depth/all_reports/forests_and_climate_change
http://www.climatehotmap.org/impacts/greatlakes.html
http://www.fs.fed.us/climatechange/
http://www.ipcc.ch/

Multi-state priority issue:
Ecosystem Services

Healthy forest ecosystems are ecological life-support systems. Forests provide a full suite of goods and services that are vital to human health and livelihood, natural assets we call **ecosystem services.**

Many of these goods and services are traditionally viewed as free benefits to society, or "public goods" - wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes, for example. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate, and individual decision-making.

St. Paul Field Office Service Area

When our forests are undervalued they are increasingly susceptible to development pressures and conversion. Recognizing forest ecosystems as natural assets with economic and social value can help promote conservation and more responsible decision-making.

The Forest Service is exploring national opportunities to advance markets and payments for ecosystem services. With help from our partners and others, we will encourage broader thinking and collaboration that stimulates market-based conservation and stewardship.

Note: Text & content taken from: http://www.fs.fed.us/ecosystemservices/

States: Minnesota, Wisconsin, Michigan, Iowa Missouri, Illinois, Indiana

Issues:

As population, income, and consumption levels increase, humans put more and more pressure on the natural environment to deliver these benefits. The 2005 Millennium Ecosystem Assessment, prepared by a group of over 1300 international experts, found that 60 percent of ecosystem services assessed globally are either degraded or being used unsustainably. Seventy percent of the regulating and cultural services evaluated in the assessment are in decline. Millennium Ecosystem Assessment scientists predicted that ecosystem degradation could grow significantly worse in the first half of the 21st century, with important consequences to human well-being.

Climate change, pollution, over-exploitation, and land-use change are some of the drivers of ecosystem loss, as well as resource challenges associated with globalization and urbanization. Land use change is an immediate issue in the United States. Today, the Nation is experiencing a loss of open space and a decline in forest health and biodiversity, particularly on private lands. Approximately 57% of all forestland in the United States, or 429 million acres, is privately owned. Non-industrial interests – families, organizations, and communities that own the land for the aesthetics and uses that forests provide or for income generated from the sale of forest products and services - own 85% of our private lands. Recent trends in parcelization and

divestiture of private lands in the United States suggest that private landowners are commonly under economic pressures to sell their forest holdings. Rising property values, tax burdens, and global market competition are some of the factors that motivate landowners to sell their lands, often for development uses. The loss of healthy forests directly affects forest landowners, rural communities, and the economy. As private lands are developed, we also lose the life-supporting ecosystem services that forests provide.

Opportunities for partnership, cooperation, and projects:

Cross agency (federal and state) cooperation in partnership with land trusts, private landowners and communities can identify important landscapes to protect and manage. Community officials who are educated on forest conservation and have good planning tools to use can decide zoning ordinances and practices that benefit forests and watersheds. Working with urban communities to promote and implement healthy trees and urban forests can contribute to improved air and water quality, watershed function, energy conservation and social well-being.

Regulations, land acquisitions, conservation easements, and tax incentives are some of the conservation approaches that aim to protect and conserve the Nation's forests and grasslands. Over the past decade, advances in sustainable forest management and forest certification have complemented conservation objectives. Traditional conservation programs, however, may not be enough to safeguard natural landscapes and biodiversity, and traditional markets may not provide landowners with a sufficient economic incentive to own and sustainably manage forestland. To reverse the loss and degradation of ecosystem services, economic and financial motivations must include a conservation objective, and the value of ecosystem services needs to be incorporated into any decision-making.

How can we make good stewardship profitable?

Mechanisms are needed by which private forest landowners can seek returns on their forestland *in addition* to those commonly associated with commercial forest products. The ability to capture the financial value of ecosystem services may help landowners who currently do not benefit from the true value of their land and all of the goods and services forests provide. Because ecosystem services are not traded and do not have a "price," landowners are not typically compensated for the critical benefits forests naturally deliver to the public. New natural revenue streams might help forest owners cover the costs of owning forestland and provide them with incentives to hold onto their land and practice sustainable forest management. Valuing ecosystem services will encourage forest restoration and may provide a new means to finance reforestation and afforestation activities. Valuing forests as natural assets will increase society's appreciation and support of lands that are already protected and healthy.

Existing efforts:

New approaches to conservation are emerging that may financially compensate landowners for providing ecosystem services. Markets and payments for carbon sequestration, watershed management, ecotourism, and a host of other services may supplement traditional forest revenues and promote good stewardship, especially when used together with other conservation tools.

Key contact persons, resources, organizations for the issue:

- USDA Forest Service, Valuing Ecosystem Services - http://www.fs.fed.us/ecosystemservices/

- EPA Ecosystem Services Research Program - http://www.epa.gov/ord/esrp/quick-finder/mid-west.htm
- Conservation Marketplace of Minnesota - http://www.conservationmarketsofmn.org/
- Integrated Valuation of Ecosystem Services Tool (INVEST) - http://www.invest.wri.gvsu.edu/

Multi-state priority issue: Forestation-Reforestation

Healthy diverse forests are essential for providing a broad range of goods and services from our forested ecosystems. Maintaining a balance of the many forest-types within the landscape is increasingly difficult due to the many and diverging interests of various forestland owners/managers. Further, many forest-types are becoming increasingly harder to maintain and/or regenerate due to a variety of factors including climate, disease, insect activity, deer herbivory, and invasive plants to name a few.

States: Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, and Indiana

St. Paul Field Office Service Area

Issues:

- Invasive plants such as garlic mustard, Japanese stilt grass and reed canary grass have literally taken over the understory on many locations out-competing the native vegetation, including tree seedling, reducing or eliminating natural regeneration on these sites.
- Extremely high deer populations reduce natural regeneration or shift species composition by favoring some tree species as browse over another. This has contributed to a trend towards increasing amounts of red maple (less favorable browse) in some areas and a complete lack of white cedar (highly preferred browse) regeneration in other areas.
- The low-land hardwood forest type has been severely impacted by the loss of American elm due to Dutch elm disease. Now the Emerald Ash Borer threatens to eliminate ash species, especially black ash that is another important low-land hardwood species.
- Oak regeneration has proven to be extremely difficult to achieve on many sites that have historically been oak dominated systems.
- Historically, large-scale forest disturbance patterns initiated forest regeneration, these include fire, tornadoes/wind. Fire suppression has virtually eliminated large-scale fire as a disturbance agent. Large scale-wind events are still with us; however their impact on the landscape is often tempered by forest fragmentation and land-use patterns.
- Climate change is forcing us to rethink our notion of species range. As temperatures rise, many tree species may no longer be able to thrive in locations where they existed historically.
- Forest fragmentation has created many smaller blocks of forest and greatly increased the amount of forest "edge" that has existed historically. Edges tend to favor sun-loving species where shade tolerant species may have once dominated.
- Management practices have altered natural species and age distribution patterns. Pine plantations and other even-age practices reduce biodiversity and age-class variability.
- Many forest tree nurseries in the region have closed or are producing at greatly reduced capacities. Adequate stocks of planting material may be an issue with reduced capacity.

Opportunities for partnership, cooperation, and projects:

- Wildlife habitat considerations drive many reforestation efforts. By partnering with wildlife agencies and non-governmental wildlife interests, forest managers might increase opportunities for mutually beneficial tree planting efforts.
- Water quality issues provide opportunities for non-traditional partnerships. Establishment and expansion of riparian forest buffers provide opportunities to increase tree cover while providing the benefit of clean drinking water.
- The current interest in carbon markets and carbon sequestration creates an opportunity to increase tree cover and provide other ecosystem benefits while achieving the goal of increasing carbon storage and sequestration.
- NRCS offers a variety of programs to off-set the costs of forest establishment for a variety of purposes including enhancing wildlife habitat and active forest management

Existing efforts:

- **US Forest Service "Plant a Tree Program"** – An effort to get the public involved in reforestation efforts while providing a mechanism to fund reforestation efforts. http://www.fs.fed.us/forestmanagement/infocenter/reforestationpartnership/documents/History_of_PAT.pdf
- **National Seed Laboratory** - Most native plants used for ecosystem conservation and restoration are propagated exclusively from seeds. Sufficient quantities of seeds are, therefore, needed to restore and sustain native plant communities that are increasingly affected by invasive species, pest infestations, wildfire, and climate change. Successful seed production requires knowledge of seed development, cleaning, germination, and storage procedures, known collectively as seed science and technology. The National Seed Laboratory (NSL) is currently addressing these complex challenges and is serving as the primary national strategic resource for forest ecosystem seed science and technology. http://www.nsl.fs.fed.us/

Key contact persons, resources, organizations for the issue:

- US Forest Service, Reforestation, Nurseries, & Genetics Research - http://www.rngr.net/
- Natural Resources Conservation Service – http://www.nrcs.usda.gov/

Multi-state priority issue: Sustaining Forest Industry and Markets

The loss of forest products industries and markets constrains opportunities to manage forests and diminishes options for the production and enhancement of an array of ecosystem services

States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Wisconsin

Issues:

St. Paul Field Office Service Area

- Competition for forest resources amongst various industrial users of low quality wood likely to increase as biomass markets (eg pellet production) grow rapidly
- New state and federal energy/climate policies will increasingly stimulate demand for forest resources. For instance, proposed federal Renewable Energy Standards are already catalyzing coal fired power plants to co-fire with wood. Large scale fuel switching could cause an enormous drain on resources
- Requests for resource information (inventory and timber product outputs) will increase as resource use patterns change.
- Which forest products industries and commercial users of wood create the most jobs per volume of wood utilized will become a frequent area for debate
- Pulp and paper. Though still a very large part of US demand for wood , pulp production has declined for more than 10 years. US still the global leader in wood pulp production, although percentage of total continues to decline. Switch from newsprint to electronic media, declining demand for packaging grade papers as US industries continue to move offshore. Growth in demand and production is focused now in Europe and Asia. Losses in paper output range from -54% for newsprint to -10% for containerboard. [32]
- Acute shortage of loggers as boomers retire and industry fails to recruit new entrants
- Discussion and information needs regarding forest products production and bioenergy application impacts on carbon lifecycles will increase
- Housing. Softwood lumber demand associated with homebuilding has been off dramatically. As the economy collapsed and home foreclosure rates accelerated resale values of homes plummeted and new starts turned down as well. Predictions are a return to normal housing starts of 1.5-1.7 million starts by 2012.[33]   Homeowner improvements and remodeling are expected to begin a gradual rebound in 2010. [34] Some suggest a trend towards smaller homes with less use of hardwoods for flooring and millwork as homebuyers try to economize on housing costs.

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[32] Peter Ince. USDA Forest Products Lab. Forests in Transition. New England Society of American Foresters Winter Meeting
[33] National Association of Homebuilders. March 24, 2010. Urs Buehlman, Virginia Tech personal communication
[34] Harvard Joint Center for Housing Research. Urs Buehlman, Virginia Tech personal communication

- Hardwood, solid wood products. Recent years outsourcing of furniture, kitchen cabinets, millwork and flooring production to China and other Asian countries has caused many companies to close with a permanent loss of 25-35% of productive capacity nationally. Indexed prices since 2004 show decline in all graded hardwoods with only lumber prices for pallets and railroad ties remaining stable or increasing slightly. 60% of hardwood now used for low priced industrial applications vs. 32% in 1972[35]. Growing capacity/efficiency of remaining mills. Downward pressure on hardwood grade logs probable[36]
- Green building is experiencing significant interest and is one of the few areas in forest products trending upward. Currently, green building volume as a proportion of the market remains rather low.

Existing efforts: a listing of known/ongoing efforts, organizations, etc.

Michigan: Michigan Forest Advisory Council, Forest Industry Work Group (informal entity among state agency leadership), Michigan Forest Products Council, Michigan Association of Timbermen. Lake States Lumberman's Association, Michigan Sustainable Forestry Initiative Implementation Committee, Great Lakes Forestry Alliance, Biomass Utilization and Restoration Network in the Upper Peninsula (BURN-UP), Michigan Forest Resource Alliance
Wisconsin: Wisconsin Country Forest Association, Great Lakes Regional Timber Producers Association, Governor's Council on Forestry, Wisconsin Woodland Owners Association, Wisconsin Paper Council, Wisconsin Consulting Foresters, US Congressman Steve Kagen's Forest Advisory Committee.
Minnesota: Governor's Forestry Subcabinet, University of Minnesota Duluth – Natural Resources Research Institute, Blandin Foundation, Minnesota Forest Industries, Minnesota Forestry Association, Minnesota Forest Resources Council, Minnesota Green Enterprise Assistance Team (The Minnesota Department of Employment and Economic Development manages the GEA program). Minnesota forestry sub-cabinet Forest BioEconomy Strategy http://files.dnr.state.mn.us/aboutdnr/legislativeinfo/2010/2010_factsheet_forestrysubcabinet.pdf
Indiana: Indiana Hardwood Lumber Association, Hoosier Historic Hills RC&D, Lincoln Hills RC&D, Sycamore Trail RC&D, Indiana Forest Woodland Owners Association.

Key contact persons, resources, organizations for the issue:
1) Jeff Settle Indiana Department of Natural Resources. (812) 358-2160
2) Terry Mace. Wisconsin Department of Natural Resources. Forest Products Marketing and Utilization Specialist. (608) 231-9333.
3) Anthony K. Weatherspoon, Michigan Dept of Natural Resources (517) 335-3332
4) Keith Jacobsen. Minnesota Department of Natural Resources. (651) 259-5270
5) Brian Brashaw. University of Minnesota , Natural Resources Research Institute. (218) 720-4248
6) Mike Seidl, Program Manager for Hardwoods, Indiana State Department of Agriculture

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[35] William Luppold. Condition of U.S. Hardwood Markets. Allegheny Society of American Foresters. 11/5/2009
[36] Paul Lyskava. Status and Future of Wood Products Markets. Allegheny Society of American Foresters. 11/5/2009

Multi-state priority issue: Promoting Sustainable Active Private Forest Management

The Upper Midwest contains some of the highest levels of private forestland ownership in the nation. Unfortunately, the vast majority of these private forestlands are unmanaged, undermanaged, or mismanaged. This represents a huge untapped resource of timber, fiber and associated forest-related employment opportunities. By promoting sustainable active management of these forestlands, the productivity of the regions' forestlands could be enhanced, thereby reducing pressure on existing productive forests and reducing the nations' dependence of outside sources of wood fiber. Active forest management can help to off-set the rising costs of forest ownership, while contributing to the health and resiliency of the regions forests.

St. Paul Field Office Service Area   0   100   200 Miles

States: Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana

Issues:

• Most land owners own woodlands for reasons unrelated to forest management. Typically private citizens own forests for hunting, recreation, or other reason unrelated to forest management.

• Landowner turnover rates are increasing due to the aging demographic of current forest owners. This creates opportunities to engage these new landowners who may be more receptive to active forest management.

• Average woodland parcel size is decreasing which leads to increasing the numbers of woodland owners. This creates a capacity issue for those agencies charged with providing landowner assistance.

• Rising land values, and associated property tax rates, are making woodland ownership less appealing to many would-be landowners. Existing landowners may be increasingly tempted to sub-divide large holdings for financial benefit or to reduce their tax burden.

• Many woodland owners are not knowledgeable about forest management and are not aware of programs or cost-share opportunities that might enable them to take an active role in the management of their woodlands.

Opportunities for partnership, cooperation, and projects:

• Most states have non-governmental woodland owner organizations that encourage woodland stewardship and provide educational opportunities for woodland owners.

Supporting or otherwise partnering with these organizations can help to increase their effectiveness.
- Cooperation with forestry extension could be expanded to help reach and educate landowners and to inform them of landowner assistance opportunities with the state and federal agencies.
- Peer-to-peer networks of forest landowners have proven very effective at conveying forest management information to private woodland owners who might otherwise be reluctant to take advantages of opportunities presented by well-intentioned "strangers".

Existing efforts:

- Call Before You Cut – Several Midwestern states have partnered together to create the Call Before You Cut campaign. The effort is targeted at those forest landowners who do not have a forest management plan, but are at the point of undertaking a harvest activity. It encourages these folks to seek out the help of a professional forester before making management decisions. The effort shares the same name and slogan despite operating in multiple states and they share a common website where landowners can find contact information. http://www.callb4ucut.com/

Key contact persons, resources, organizations for the issue:

- American Forest Foundation - http://www.forestfoundation.org/
- National Woodland Owners Association - http://www.woodlandowners.org/
- Call Before You Cut - http://www.callb4ucut.com/

Multi-state priority issue: Increase Urban Forest Inventory and Analysis

The Forest Service's Forest Inventory and Analysis (FIA) Program provides the information needed to assess America's forests. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. The Forest Service has significantly enhanced the FIA program by changing from a periodic survey to an annual survey, by increasing capacity to analyze and publish data, and by expanding the scope of data collection to include soil, under story vegetation, tree crown conditions, coarse woody debris, and lichen community composition on a subsample of our plots.

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States: Wisconsin, Missouri and possibly others.

Issues:

- The current FIA program does not consider urban areas as "forested" and therefore does not inventory urban forests.
- Continuous inventory data is currently lacking for urban forests, thus limiting the ability of state and regional managers to track conditions and trends.

Opportunities for partnership, cooperation, and projects:

- Partner with neighboring states that share contiguous urban areas for funding and data collection.

Existing efforts:

- Pilot projects were completed in Indiana, Wisconsin, and New Jersey in 2001, 2002, and 2003, respectively. Reports can be found at:
  http://na.fs.fed.us/urban/monitoring_projects.shtm

- Pilot projects have also been completed (4 panels over 4 years) in Colorado and Tennessee.

Key contact persons, resources, organizations for the issue:

1. Angie Rowe, Training Supervisor for Data Acquisition, U.S. Forest Service, Southern Research Station, 865-862- 2052, krowe@fs.fed.us (regarding current urban FIA projects in Colorado and Tennessee)

2. Dick Rideout, Wisconsin State Urban Forestry Coordinator, 608-267-0843,
   richard.rideout@wi.gov

3. Pam Louks, Indiana State Urban Forestry Coordinator, 317-591-1170,
   plouks@in.dnr.gov

4. Mike D'Errico, New Jersey State Urban Forestry Coordinator, 609-292-2532,
   michael.d'errico@dep.state.nj.us

Multi-state priority issue:
Invasive Species

Non-native invasive species have the potential to reduce forest diversity and cause huge economic and ecological damage to forests. Insect species such as the Emerald Ash Borer, Gypsy Moth and Asian Long Horned Beetle have already caused major damage in forests and in urban areas in the Midwest. Non-native disease causing organisms, typically fungi, that cause mortality such as those that cause White Pine Blister Rust, and Dutch Elm Disease are well documented historically. More recent examples include Beech Bark Disease and Sudden Oak Death. Dozens of invasive plants species spread and flourish in both urban and used forested areas. Resource agencies must have evolving and adaptive responses to detect and reduce the potential for the introduction and spread of new invasive species.

St. Paul Field Office Service Area

States:

Iowa, Illinois, Indiana, Michigan, Minnesota, Missouri, Wisconsin

Issues:

- Prevention of invasive insects and plants is time consuming and costly. Eradication efforts are very expensive. Doing nothing has far-reaching cost consequences.
- Invasive species management must be integrated with good land stewardship on millions of acres of privately owned forest.
- Invasive plant populations influence, and are influenced by, environment and co-occurring plant and animal species. An integrated ecosystem-based approach is therefore essential but difficult to achieve.
- Quarantines on timber product movement placed on states in infested areas cause economic hardship as well as difficult utilization and marketing challenges
- The loss of forest diversity reduces the ecological stability of forests
- Control techniques and methodologies need to be developed, shared and implemented for new invaders.
- The inability to effectively control plants introduced via the horticultural industry allows many problem plants to continue to be bought and sold in the marketplace.
- Our ability to identify and detect new invaders is extremely limited due to lack of knowledge.
- A changing climate may make our forests more susceptible to invasive species.

Opportunities for partnership, cooperation, and projects:

States realize that a cooperative approach to costly survey, detection and eradication efforts that focus on those infestations which pose the greatest threats to natural resource values are the highest priority. Developing invasive species best management practices, educating and instructing foresters, landowners and land managers to detect and control invasive species can be completed and shared across the 7 states. Cooperating to conduct coordinated survey and detection work is a multi-year task. Monitoring for spread of insects and plans as well as evaluating the threat to natural resources can be shared across landscapes. Rehabilitation of lands and forests adversely impacted by invasive plants and insects is crucial.

Existing efforts:

All states have forest health units within their respective natural resource management agency that are charged with detection and control responsibilities of invasive insects and disease pests and in some cases invasive plants. They also typically share some of that responsibility with their counterparts in their state's department of agriculture or its equivalent. The states' efforts are augmented by federal agencies such as the U.S. Forest Service and the Animal and Plant Health Inspection Service to assist states in the detection, management and control of damaging invasive species.

The development of local Cooperative Weed Management Areas (CWMA's) are popular grassroots efforts that mobilize land managers and other interested parties to work across political and jurisdictional boundaries to establish a cooperative "unified front" to address invasive species.

Many states have established information-sharing invasive plant groups such as the Invasive Plant Association of Wisconsin or advisory groups such as Minnesota Invasive Species Advisory Council and the Michigan Invasive Plant Council

The Midwestern Invasive Plant Network is a regional organization of land managers, resource professionals, landowners, and private citizens who are dedicated to reducing the impact of invasive plant species in the Midwest.

Key contact persons, resources, organizations for the issue:

- Midwest Invasive Plant Network - http://mipn.org/
- River to River Cooperative Weed Management Area - http://www.rtrcwma.org/
- The Emerald Ash Borer Detection Project - http://www.emeraldashborer.org/
- Northeastern Area Forest Health protection - http://www.na.fs.fed.us/fhp/index.shtm

Appendix F – List of Data Gaps

- Urban Forest Inventory and Analysis Data
- i-Tree Eco and i-Tree Street analyses
- Green Infrastructure Analyses
- Urban Tree Canopy Assessments
- Updated "44 City Street Tree Inventory" data
- Updated National Land Cover Data and/or higher resolution Vegetation Cover Mapping for Missouri, including forest cover change data
- 2010 Census Data
- Updated Housing Density Projections Data which incorporates 2010 Census Data
- Updated Wildland-Urban Interface Data which incorporates 2010 Census Data
- Data on the existing and potential range of invasive plants, animals and diseases
- Widely available LIDAR data
- Enhanced data on recent major storm events
- Updated Timber Product Output survey data and resulting maps of harvest pressure
- Data on structural diversity of forests
- Continuous Forest Inventory data for select public ownerships
- Complete Ecological Land Type mapping for Missouri
- Updated Woodland Owners Survey data
- Updated Conservation Opinion Survey data
- Enhanced data on the extent of "high-grade" harvesting
- Continue to update Forest Inventory and Analysis Data on an annual basis
- Enhanced data on the extent of privately-owned land protected by conservation easement
- Enhanced data on carbon sequestration rates and forest management implications
- Enhanced data on BMP implementation rates
- Enhanced Insect and Disease Risk data
- Forest productivity data (comparable across all soils)
- Enhanced fire location data

Appendix G – List of Other Plans Consulted

- Missouri Department of Conservation – Next Generation of Conservation Plan
- Missouri's Comprehensive Wildlife Strategy – including individual assessments by MDC, The Nature Conservancy, Audubon Missouri, Mark Twain National Forest and North American Bird Conservation Initiative
- Missouri Department of Conservation – Forestry Division Program Reviews
- Missouri Department of Conservation – Forestry Division Operational Plan
- U.S. Forest Service – State and Private Forestry Redesign Initiative
- U.S. Forest Service Strategic Framework for Addressing Climate Change
- Public land management agency mission statements provided by: Missouri Department of Conservation, Missouri Department of Natural Resources, U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. National Park Service, U.S. Army and Army Corps of Engineers

Appendix H - Literature Cited

Barnes, M.C, A.H. Todd, R.Whitney Lilja, and P.K. Barten. 2009. Forests, Water and People: Drinking water supply and forest lands in the Northeast and Midwest United States. Newtown Square, PA: U.S. Dept. of Agriculture, Forest Service, Northeastern Area State and Private Forestry. http://www.na.fs.fed.us/watershed/fwp_preview.shtm

Butler, B.J. 2008. Family forest owners of the United States, 2006. Gen. Tech. Rep. NRS-27. Newtown Square, PA: U.S. Dept. of Agriculture, Forest Service, Northern Research Station.

Gardner-Outlaw, T. and R. Engelman. 1999. Forest futures: population, consumption and wood resources. Population Action International, Washington, D.C. pg 95.

Guyette, R., D. Dey and M Dey. 1999. "An Ozark Fire History". Missouri Conservationist. 60(3). http://www.mdc.mo.gov/conmag/1999/03/10.htm

Howard, James L. 2007. U.S. timber production, trade, consumption, and price statistics 1965 to 2005. Research Paper FPL-RP-637. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 91 p

Intergovernmental Panel on Climate Change, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Jacobs, B. and J.W. Wilson. 1997. Missouri breeding bird atlas 1986-1992. Natural History Series, No. 6, Missouri Department of Conservation, Jefferson City.

Johnson, T.R. 2000. The amphibians and reptiles of Missouri. 2nd ed. Missouri Department of Conservation, Jefferson City.

Malmsheimer, R.W., et. al. 2008. Forest Management Solutions for Mitigating Climate Change in the United States - A Society of American Foresters Task Force Report. Journal of Forestry. 106(3): 119.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco S.E.; Gardner, S.L.; Cozad, S.K.; Xiao, Q. 2005. Midwest community tree guide; benefits, costs, and strategic planting. NA-TP-05-05. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry

Missouri Conservation Commission Annual Report. 1944. Pg. 51-55.

Missouri Department of Conservation. 2006. The Next Generation of Conservation. http://mdc4.mdc.mo.gov/applications/MDCLibrary/Library.aspx?ArtID=17531 (April 19, 2010)

Missouri Department of Conservation. 2008. Missouri forestry and wood products. Missouri Department of Conservation Public Profile 2008-6, Missouri Department of Conservation, Jefferson City, MO. 1 p.

Missouri Department of Conservation. 2009. Forestry Division Fire Program Review (unpublished)

Missouri Department of Conservation. 2010. About the Department – Our Mission. http://mdc.mo.gov/about/

Missouri Department of Natural Resources. 2009. About the Missouri State Park System. http://www.mostateparks.com/aboutus.htm (April 21, 2009)

National Audubon Society. 2009. Birds and Climate Change – An Ecological Disruption in Motion, *A Briefing for Policymakers and Concerned Citizens on Audubon's Analyses of North American Bird Movements in the Face of Global Warming.*

National Park Service. 2010. The National Park Service – Caring for the American Legacy. http://www.nps.gov/legacy/mission.html (April 21, 2010)

Nelson, P.W. 2005. The Terrestrial Natural Communities of Missouri. Missouri Natural Areas Committee, Jefferson City.

Nigh, T.A., W.L. Pflieger, P.L. Redfearn, Jr., W.A. Schroeder, A.R. Templeton, and F.R. Thompson, III. 1992. The biodiversity of Missouri: definition, status, and recommendations for its conservation. Report of the biodiversity task force. Missouri Department of Conservation and Mark Twain National Forest.

Nigh, T.A., and W. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City.

Northeastern Area Association of State Foresters. 2008. Suggested Framework for State Assessments. http://www.northeasternforests.org/FRPC/files/1228323127NAASF%20State%20Assessment%20Framework%20(final)%2011-08.pdf (April 19, 2010)

Oesch, R.D. 1995. Missouri naiads: a guide to the mussels of Missouri. Missouri Department of Conservation, Jefferson City.

Pflieger, W.L. 1989. Aquatic Community Classification System for Missouri. Aquatic Series Number 19. Missouri Department of Conservation, Jefferson City, Missouri.; and Sowa, S.P., G. Annis, M.E. Morey, and D.D. Diamond. 2007. A gap analysis and comprehensive conservation strategy for riverine ecosystems of Missouri. Ecological Monographs 77(3): 301-334.

Pflieger, W.L. 1996. The crayfishes of Missouri. Missouri Department of Conservation, Jefferson City.

Pflieger, W.L. 1997. The fishes of Missouri. Missouri Department of Conservation, Jefferson City.

Prasad, A.M., L.R. Iverson, S. Matthews and M. Peters. 2009. Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA) NRS-4151. Delaware, OH: USDA Forest Service, Northern Research Station. www.nrs.fs.fed.us/atlas/ (April 20, 2010)

Radeloff, V. C., R. B. Hammer, S.I Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The Wildland Urban Interface in the United States. Ecological Applications 15:799-805.

Riemann, Rachel, et al. USFS Northern Research Station. 2009. "Development of Issue Relevant State Level Analyses of Fragmentation and Urbanization".

Schwartz, C.W. and E.R. Schwartz. 2001. The wild mammals of Missouri. University of Missouri Press, Columbia and Missouri Department of Conservation, Jefferson City.

Shifley, Steven. 2007. Fairly Sustainable Forestry: Seven Key Concepts for Defining Local Sustainability in a Global Ecosystem. As published in Deal, R.L., tech. ed. 2008. Integrated restoration of forested ecosystems to achieve multi resource benefits: proceedings of the 2007 national silviculture workshop. Gen. Tech. Rep. PNW-GTR-733. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 306 p.

Stein, B.A. 2002. States of the union: ranking America's biodiversity. NatureServe, Arlington, Virginia.

Sullivan, W.C.; Kuo, F.E. 1996. Do trees strengthen urban communities, reduce domestic violence? Arborist News 5:33-34

Theobald, D.M. 2004a. bhc2000 v.1. Environmental Systems Research Institute (ESRI) raster digital data. On file with: David M. Theobald, Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO 80526

Theobald, D.M. 2004b. bhc2030 v.1. Environmental Systems Research Institute (ESRI) raster digital data. On file with: David M. Theobald, Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO 80526.

Treiman, T. and J. Gartner. 2004. Community Forestry in Missouri, U.S.: Attitudes and Knowledge of Local Officials. J. Arboric. 30(4):205-213.

Treiman, T. and J. Gartner. 2005. Urban Forestry in Missouri Communities: Attitudes and Knowledge of Missouri Citizens. An Attitude Survey and Analysis for the Missouri Department of Conservation

Trial, L. 2005. Atlas of Missouri odonata - revised. Missouri Department of Conservation report.

U.S. Army Corps of Engineers. 2010. Operations Mission Statement. http://www.usace.army.mil/CECW/Operations/Pages/ArticleHome.aspx

U.S. Department of Agriculture, Forest Service. Eastern Region. 2005. U.S. Forest Service – Eastern Region – Our Vision. http://www.fs.fed.us/r9/about/ (April 21, 2010)

U.S. Department of Agriculture, Forest Service. Northern Research Station. Forest Inventory and Analysis Data.

U.S. Department of Agriculture, Forest Service. Northern Research Station. 2008. Whose Woods Are These? U.S. Forest Service Northern Research Station Research Review #4: Autumn 2008

U.S. Department of Agriculture, Forest Service. Rocky Mountain Research Station-Wildlife Habitat Policy Research Program. 2009. Climate Change Stress Index (as presented by Linda Joyce on February 5, 2009 at the Missouri Natural Resources Conference).

U.S. Department of Agriculture, Forest Service. State and Private Forestry. 2010. National Themes, Objectives, Outcomes and Core Performance Measures. http://www.northeasternforests.org/FRPC/files/1270739113Themes_Objectives_Outcomes_Measures_RICapproved.doc (April 19, 2010)

U.S. Department of Agriculture. Natural Resources Conservation Service. Natural Resources Inventory.

U.S. Fish and Wildlife Service. 2010. National Wildlife Refuge System – Mission Statement. http://www.fws.gov/refuges/about/mission.html (April 21, 2010)

U.S. Global Change Research Program. 2000. Climate Change Impacts on the United States - *The Potential Consequences of Climate Variability and Change* - Overview: Our Changing Climate By the National Assessment Synthesis Team, US Global Change Research Program. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm (April 19, 2010)

U.S. Global Change Research Program. 2001. Climate Change Impacts on the United States - *The Potential Consequences of Climate Variability and Change* By the National Assessment Synthesis Team, US Global Change Research Program http://www.usgcrp.gov/usgcrp/Library/nationalassessment/LargerImages/OverviewGraphics/Precip.jpg , and, http://www.usgcrp.gov/usgcrp/Library/nationalassessment/LargerImages/OverviewGraphics/Temp.jpg , and, http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewlooking.htm (April 19, 2010).

University of Missouri-Columbia. July 2004. "Your Ideas Count!": Report of Results of the 2003 Conservation Opinion Survey for the Missouri Department of Conservation

Wolf, K.L. 1999. Nature and commerce: human ecology in business districts. In Kollin, C. ed. Building Cities of Green: Proceedings of the 1999 National Urban Forestry Conference, Washington, DC: American Forests: 56-59.

Woodall, C.W.; Oswalt, C.M.; Westfall, J.A.; Perry, C.H.; Nelson, M.D.; Finley, A.O. 2009. An indicator of tree migration in forests of the eastern United States.   Forest Ecology and Management. 257: 1434-1444.

Yatskievych, G. 1999. Steyermark's flora of Missouri, Volume I. Revised edition. Missouri Department of Conservation in cooperation with the Missouri Botanical Garden Press, St. Louis, Missouri.