Strategic Plan
for the
Missouri Ozark Forest Ecosystem Project

2015-2021

MOFEP

MOFEP Steering Committee
June 2015

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Executive Summary

The MOFEP Steering Committee developed this MOFEP Strategic Plan for the period of 2015-2021. The planning period of this document covers the middle of the second treatment interval of the long-term MOFEP experiment (i.e., period between entries 2 and 3), which follows a period of intense pre- and post-treatment measurements of the second entry at MOFEP sites. Because of this, a focus of this plan is ensuring timely data management, analysis, and reporting of MOFEP research that now spans nearly a quarter century. MOFEP's third symposium will be held as part of the 20th Central Hardwood Forest Conference in 2016 to communicate multi-disciplinary findings of MOFEP. The three main objectives of this strategic plan are to:

1) Ensure that data management and analysis of MOFEP projects occur during this second treatment interval of the experiment
2) Facilitate transfer of science-based information from MOFEP research projects to resource managers and interested stakeholders
3) Identify future research directions for MOFEP and guide funding priorities

Core research areas are identified as those research areas deemed to be the highest priority information needs by the MOFEP Steering Committee. The core research areas are those that are considered essential for MOFEP to continue. There are also several areas of research as part of MOFEP that are not considered core projects, but are still addressing on-going information needs (Appendix 1). The following are identified as core research areas within MOFEP:

1) Forest interior birds
2) Ground flora
3) Overstory vegetation
4) Herpetofauna
5) Small mammals
6) Experimental design, data analysis and data management

The following five research areas are identified as possible future needs for MOFEP to address:

1) Influence of MDC even-aged and uneven-aged management systems on the resilience and adaptive capacity of Ozark forests and woodlands to mitigate future climate change
2) Understand forest management impacts on soil and water quality
3) Understand and mitigate biogenic threats to the health of Ozark forests and woodlands
4) Impacts of MDC forest management systems on species of conservation concern, including tree-roosting bats of the Ozarks
5) Invasive species impacts on Ozark forests and woodlands

Addressing core, on-going, and new research areas using the MOFEP experiment will provide critical information to MDC managers and policy makers working in Ozark upland forests. Three commitments are necessary for MOFEP to succeed in providing the scientific information necessary for MDC forest management: 1) a commitment to complete at least one full rotation of an MDC compartment under the even-aged system, 2) a commitment from forest managers to maintain the randomly assigned treatment protocols on each MOFEP site, and 3) a commitment of financial resources to data collection and analysis at critical times during the life of MOFEP.

Introduction

Forest management practices in North America have been controversial since the days of Gifford Pinchot. Much of the debate has focused on how forests are managed for timber products. In the modern era, this controversy caught the public's attention when the debate focused on the impacts of timber harvesting on northern spotted owls and fisheries habitat in the Pacific Northwest. Timber harvesting in large blocks was seen as a detriment to fish and wildlife (Salwasser and Tappeiner 1981). Territorial habitat for the northern spotted owl was perceived to be heavily impacted by clear-cutting of old-growth forests. Hillsides where clear-cutting had occurred were highly susceptible to erosion and landslides, which silted in spawning beds and clogged streams. These issues received national attention beginning in the late 1960s, which eventually prompted congressional action (Salwasser and Tappeiner 1981).

Congress required the US Forest Service to adopt a multiple use philosophy and develop forest management plans for each of the national forests (Salwasser and Tappeiner 1981; Kirkman et al. 1986). This action brought the forest management controversy to the forefront in Missouri. The US Forest Service developed their plan for the Mark Twain National Forest, which included the option of using even-aged management, including clearcutting, as an optimal regeneration method for managing oak-hickory forests. This option was challenged by several special interest groups and individuals.

The perceived decline of Neotropical migrant birds in the Midwest and Missouri due to forest fragmentation (Thompson et al. 1992; Wenny et al. 1993; Robinson et al. 1995) also added to the concerns for how forests were managed (Robinson 1993). In the late 1980s and early 1990s, there were concerns about possible declines in populations of Neotropical migrant birds that led to various symposia on the subject, and to the eventual development of the Neotropical Migratory Bird Conservation Program – *Partners in Flight*. The major factors thought to be responsible for these purported declines were: winter habitat limitation, stopover habitat limitation during migration, and habitat loss and fragmentation in the breeding grounds (Clawson et al. 1997).

Numerous studies have shown that fragmented breeding habitats have lower species diversity and reduced breeding success among mature-forest bird species that still occur in those habitats (Clawson et al. 1997). If the Missouri Ozarks are critical to maintaining populations of migrant birds across the Midwest, we need to understand the effects of forest management practices on migrant birds in this region. Most fragmentation studies have been executed in forests already heavily fragmented (Robinson et al. 1995; Clawson et al. 2002), unlike the heavily forested Ozarks of southern Missouri, which is not influenced by great amounts of edge or small forested tracts surrounded by open lands. The Missouri Ozark Forest Ecosystem Project (MOFEP) was designed to enhance our understanding of the effects of Missouri Department of Conservation (MDC) management practices on a landscape that is predominantly forested (i.e., $\geq$ 80% forested).

The issue of how an oak-hickory forest can be regenerated continues to be a factor in establishing forest management guidelines in Missouri. Much of the oak-hickory forests on lands owned by MDC in the 1980s were 60-80 years of age. These second growth forests were

rapidly reaching maturity with little diversity in their age structure. The older forest age classes were beneficial to wildlife requiring mature forest habitats, but a mature forest cannot be maintained as a static environment. With little diversity in forest age, the question was how to regenerate forests, and how to manage also for wildlife species requiring habitats provided by younger age classes. Species, such as ruffed grouse, woodcock, and early succession forest birds, were not benefited by these mature forest habitats.

The combined concerns about public perceptions regarding forest management methods (Palmer 1996; Kabrick et al. 2004), early forest successional habitat, and the impact of forest fragmentation on wildlife led MDC and others to recognize the need for improved science-based information in forest management decision making (Kabrick et al. 2004). It was during a wildlife research project review for a proposed study of how forest fragmentation might impact Neotropical migrant birds that MOFEP was born (Kurzejeski et al. 1993; Sheriff and He 1997; Kabrick et al. 2004). During this 1989 review, staff recognized the continual need for sound scientific information concerning the impact of forest management methods on the Ozark forest ecosystem. This science-based information would help ensure that the best forest management practices would be used in the decision-making process. Research based on long-term experiments, like MOFEP, helps to inform MDC on how best to manage and protect Missouri's natural heritage.

MOFEP provides the opportunity to learn about forest management in the Missouri Ozarks, particularly as practiced by MDC. It was designed to understand how changes in forest management through time impact this oak-hickory forest ecosystem (Brookshire and Hauser 1993; Kurzejeski et al. 1993; Brookshire et al. 1997; Larsen et al. 1997; Sheriff and He 1997; Sheriff 2002; Kabrick et al. 2004). The information derived from MOFEP enhances forest and wildlife management in the oak-hickory forests of southeastern Missouri. Information from MOFEP also supplies evidence used in active forest management and revisions of practices. It builds a body of knowledge for the education of forest managers and decision makers.

MOFEP uses a manipulative experiment with replication and randomization to determine the effects of forest management systems (i.e. even-aged management, uneven-aged management, and no harvest management) on the oak-hickory forest sites where the project is being conducted. The experimental design has the advantage over observational studies by being able to show cause and effect differences among various forest management systems as they impact the forest ecosystem (Kurzejeski et al. 1993; Sheriff and He 1997; Sheriff 2002). The specific silvicultural regeneration and tending methods are applied in the same manner as practiced by MDC forest managers for even-aged and uneven-aged management systems. Presently, even-aged management includes regenerating stands using either clearcutting or shelterwood methods on a 100-year rotation and thinning for improving stand quality and regulating growing space. Uneven-aged management includes a combination of group and single-tree selection harvests designed to create complex structure at sub-stand scales as an alternative to even-aged management. Under both systems, a 15-year harvest interval is currently used and similar guidelines are applied for providing specific kinds of habitats through the regulation of reserve trees (e.g., den trees, snags, other "wildlife" trees; old growth reserves).

The even-aged and uneven-aged systems offer considerable flexibility in how they are implemented. With each system, different regeneration methods, harvest intervals, and residual stocking levels can be selected and different numbers and configurations of reserve trees can be retained for wildlife habitat. For example, shelterwood establishment cutting was not included in the 1996 harvest entry as part of the even-aged management system, but was implemented in the 2011 harvest entry (Knapp et al. 2014). Similarly, uneven-aged methods offer considerable flexibility in how selection harvests are conducted. For example, single-tree selection and group openings were implemented during the 1996 harvest entry, but only single-tree selection was used in 2011 (Knapp et al. *in press*). Under both systems, regeneration and tending methods can be applied to favor specific species groups or produce alternative forest structures.

Obviously, the no-harvest treatment provides the least flexibility for adjustment since harvesting is not done in this treatment. However, as presently and routinely done on most state-owned lands, wildfires are suppressed on the no-harvest sites and some preventative measures are taken to reduce the severity of damaging insect outbreaks adjacent to the no-harvest sites (Brookshire et al. 1997). Under MOFEP's objectives, these activities can be altered should the Department change these strategies for other state lands under a no-harvest regime.

What is necessary for MOFEP to succeed in providing the scientific information necessary for current and future forest managers is 1) a commitment to continue through the entire management schedule, 2) a commitment from forest managers to maintain the randomly assigned treatment protocols on each MOFEP site (Sheriff and He 1997; Sheriff 2002), and 3) a commitment of financial resources. MOFEP can then provide not only insights as to the history of how MDC managed oak-hickory forest in southeastern Missouri, but it will provide forest managers with information concerning how rotation length, small diameter tree harvesting, pine regeneration, and other future forest management options within the three methods affects this oak-hickory forest ecosystem. To add even greater benefits from MOFEP, the project can be expanded in terms of landscape and temporal scales by adding replicate blocks in other locations.

The latitude given to MDC researchers in program development established the climate necessary for the inception of long-term management experiments (Kurzejeski et al. 1993). MOFEP is well funded and supported through MDC's strategic plan and Forestry and Wildlife Divisions' operational plans which continue to stress the importance of broader, community/ecosystem level approaches to research and management. While some direction in plans is dynamic over time, the longer term direction provided by MDC's Mission Statement is strongly supportive of MOFEP's long-term nature and goals.

MOFEP seeks to address practical forest management problems facing land managers, in addition to providing information for evaluating forest management effects on the flora, fauna, and abiotic components of southeastern Missouri forests. MDC forest managers have continued to be interested in the progress of MOFEP, and have provided long-term support of this project in the agency. The project is particularly well suited to provide information to managers, because the implementation of harvest treatments can change over time in order to mimic the current inventory and forest management schedule and practices within MDC. Likewise, management practices and current ways of thinking can change as a reflection on what is learned from the project.

Many stakeholders have an investment or can benefit from the scientifically-based information that is derived from MOFEP (Table 1). This table of stakeholders should be dynamic as groups are more specifically defined. Through the addition and redefining of stakeholders, it should become obvious that MOFEP has wide interest and potential benefit. It will be these and future stakeholder groups that ensure MOFEP has a long and productive life.

Table 1. MOFEP Stakeholders.

Stakeholders with a Direct Investment	**Stakeholders Who Should Benefit Indirectly**
• Forestry Division – MDC • Wildlife Division – MDC • Private Lands Division – MDC • Fisheries Division – MDC • Resource Science Division – MDC • University of Missouri • Central Methodist University • The Nature Conservancy	• US Forest Service • Consulting foresters • Missouri forest product industries • Missouri Society of American Foresters • Missouri Wildlife Society • Southeast Missouri Farmers & farm groups • Private forestry groups and associations • Forest industry in similar oak-hickory forests • Academic institutions with natural resources departments or centers • Missouri residents concerned with the impacts of forest management

Development of the Plan

This strategic plan was developed by the MOFEP Steering Committee over the last three years to serve as a planning tool for guiding MOFEP for the 6-year period during 2015-2021. This is the third strategic plan for MOFEP, and it builds on the two previous plans developed by the Steering Committee (2000-2004 and 2006-2011). The timeframe of this plan covers the remaining period leading up to the start of intensive, pre-treatment sampling before the next experimental harvest of MOFEP sites in 2026. This timeline will allow enough time for developing the next plan, which will need to address both intensive, multi-disciplinary data collection and implementation of experimental treatments.

The Steering Committee intends the plan to be used as a guiding document for MOFEP. However, there will be continual effort by the Steering Committee, by other MDC employees, and by scientists from other agencies and universities to identify and prioritize research throughout the course of MOFEP as new informational needs emerge.

Past and present members of the Steering Committee contributed to the development of this plan. These are:

- Matt Olson (chair), Resource Scientist, Resource Science Division, MDC
- Randy Jensen (field coordinator), Resource Scientist, Resource Science Division, MDC
- Dawn Henderson (administrator), Supervisor, Resource Science Division, MDC
- Charles Anderson, Supervisor, Resource Science Division, MDC
- Mike Bill, Ozark Region District Forester, Forestry Division, MDC
- Tim Bixler, GIS Specialist, Resource Science Division, MDC
- Rich Blatz, Field Programs Supervisor, Forestry Division, MDC
- Julie Fleming, Database Specialist, Resource Science Division, MDC
- Sherry Gao, Biometrician, Resource Science Division, MDC
- Joe Garvey, SE Region Supervisor, Resource Science Division, MDC
- Vicky Heidy, Supervisor, Resource Science Division, MDC
- John Kabrick, Research Forester, USDA Forest Service-NRS
- David Larsen, Associate Professor, University of Missouri-Columbia
- Gary Oakley, Former Ozark Region Super. and Dist. Forester, Forestry Division, MDC
- Rochelle Renken, Unit Chief, Resource Science Division, MDC
- Larry Rieken, Ozark Region Supervisor, Wildlife Division, MDC
- Mike Roell, Supervisor, Resource Science Division, MDC
- Dave Rowald, SE Region District Forester, Forestry Division, MDC
- Terry Thompson, Ozark Region Supervisor, Forestry Division, MDC
- Terry Truttmann, Former Ozark Region Supervisor, Forestry Division, MDC

Objectives of the Plan

The MOFEP Steering Committee has decided to focus this plan on addressing data management and analysis, project reporting, and information transfer during this first part of the second treatment interval (2015-2021). Focusing on these will ensure that we are communicating the science-based information from MOFEP research projects to our stakeholders. The Steering Committee is also committed to identifying and guiding future research at MOFEP sites. However, this function will be stressed more in the next planning process set to commence in 2019.

The three objectives of this strategic plan and corresponding approaches are:

Objective 1: Ensure that data management and analysis of MOFEP projects occur during this second treatment interval of the experiment

Approaches:

1) Communicate the importance of timely updates of the MOFEP database to project PIs
2) Request that MOFEP project PIs present their most up-to-date research findings at the 3rd MOFEP symposium in 2016

Objective 2: Facilitate transfer of science-based information from MOFEP research projects to resource managers and interested stakeholders

Approaches:

1) Hold the 3rd MOFEP symposium as part of the 20th Central Hardwood Forest Conference in 2016
2) Lead a field tour of MOFEP sites to update managers and scientists on current results of MOFEP
3) Establish an expectation that all core projects of MOFEP will publish research through 2014 in peer-reviewed journal outlets by 2017

Objective 3: Identify future research directions for MOFEP and guide funding priorities

Approaches:

1) Work closely with MDC resource managers to identify information gaps impacting forest management in the Ozarks
2) Collaborate with scientists from the University of Missouri and US Forest Service to determine key uncertainties in our ecological understanding of Ozark forests
3) Periodically hold meetings for principal investigators of MOFEP projects to share their research and discuss multi-disciplinary research needs
4) Periodically convene the MOFEP Steering Committee to discuss informational needs and to prioritize areas of research for MOFEP

Focusing on analysis and reporting of research findings over the next decade will contribute significantly to ensuring that the next wave of science-based information from MOFEP is provided to MDC managers and policy makers as well as other interested stakeholders.

MOFEP Vision

The Goal of MOFEP

MOFEP is a large-scale, long-term experiment to evaluate the effects of even-aged, uneven-aged, and no-harvest management on the flora and fauna in Missouri Ozark forests. However, MOFEP's purpose is not merely to gather information about how Ozark forests respond to a restrictive set of forest management practices. Rather, it was designed as an adaptive experiment that allows treatments to be modified, to some degree, based upon what is being learned through experimentation. This approach provides the mechanism for "learning while managing" that is so fundamental to the goal of adapting forest management practices for optimizing resource objectives (Sheriff and He 1997).

The vision for MOFEP was not to conduct a pure experiment implementing rigid treatment protocols to be evaluated at the end of the study. Rather, MOFEP emphasizes an adaptive management approach by learning while managing. MOFEP was designed so that MDC managers could use the knowledge gained through experimentation to adjust and "improve" these management systems during the course of the project. As new information is generated about how the flora and fauna of the forest are responding to these management systems, the specific management actions can be modified to better meet the Department's conservation mission.

The Role of Integration

Central to the mission of MDC is conserving the state's biodiversity by managing land sustainably. Accordingly, management objectives within MDC are increasingly being set with broader consideration for the integrity of ecosystems rather than simply the abundances of a few plant or game species (Brookshire et al. 1997). This broader concern about ecosystems requires understanding how plant and animal species interact with each other as well as responding to management. It also requires understanding fundamental processes governing habitat dynamics and animals associated with the successional habitats created by management. This level of understanding cannot be derived by assembling information from a series of studies or independently evaluating faunal responses to habitat manipulations. Rather, it requires the simultaneous evaluation of multiple species responses to management actions over long periods of time to provide a more complete understanding. MOFEP seeks to accomplish this objective through the synthesis of findings from many studies being conducted. It is through this integration of component studies that MDC managers will develop a more comprehensive understanding about how forest systems in the Missouri Ozarks respond to even-aged, uneven-age, and no-harvest management.

The Long-term Commitment

Forest systems are dynamic. However, many of the successional changes in habitat structure and composition occur over long time periods. In forests managed with even-aged methods, the

rotation age largely determines the full range over which succession takes place. In most central hardwood forests, rotation ages typically are about 100 years. With uneven-aged methods, there is no specified rotation age, but it may require several cutting cycles before the forest is fully regulated under an uneven-aged regime. In unmanaged forests, successional processes continue until interrupted by major disturbances, such as catastrophic wildfire or an extreme wind event. Although wildfires and tornados occur frequently, they seldom would affect a very large proportion of a forest at one time. Because understanding successional processes and responses to natural disturbances or harvesting requires long periods of time, MOFEP was purposely designed to extend for up to three even-aged rotations (300 years).

Although all research projects present difficulties, conducting a study for a century or more presents unique challenges. In particular, the project's duration will exceed the life spans of everyone who initiated the study as well as those who presently administer the project. For MOFEP to remain successful, all who are presently involved must inspire the new scientists, managers, and administrators to continue the commitment to this effort.

MOFEP Research Areas

Since MOFEP's inception, many studies have been completed and others are on-going (Appendix 1). This plan identifies core (high priority) and potential future research needs. Core research areas are identified as those research areas that are critical information needs for MOFEP. The core research areas are those that are highest priority for continued study and funding. See Appendix 2 for a listing of current principal investigators of MOFEP's core research areas and on-going projects.

Any new research being proposed that would include use of MOFEP sites needs to be critically reviewed and granted permission by the Steering Committee before moving forward. Any research proposed by researchers other than current PIs to use existing MOFEP data must adhere to the data access guidelines (Appendix 3). A short proposal must be submitted to the MOFEP Chair, Matt Olson, for consideration by the Steering Committee. Investigators are encouraged to seek outside funding, but, if MDC funds are sought, investigators must comply with the requirements of the Resource Science Division's proposal process.

Core Research Areas

Six areas of study were identified as core projects by the MOFEP Steering Committee. The first five focus on the information requirements of resource managers. The experimental design, data analysis and data management component focuses on how the information can be obtained and analyzed in a more efficient and effective manner. Below is a listing of the core research areas and a short description of each.

The six top priority studies are:

1) Forest interior birds
2) Ground flora
3) Overstory vegetation
4) Herpetofauna
5) Small mammals
6) Experimental design, data analysis and data management.

<u>Forest interior birds</u>

Understanding the relationships between forest management and bird populations is a top priority in MOFEP. Many bird species, including some Neotropical migrant species that are facing long-term population declines, depend on forest ecosystems that are routinely managed for timber resources. Identifying and understanding the mechanisms that link forest management to bird population processes will help scientists sustain species that use these ecosystems. The project directly monitors the impacts of forest management on avian demography and explores these relationships at expanded temporal and spatial scales. Other research into the impact of forest management on bird populations is frequently conducted at limited spatial and temporal scales that are not relevant to maintenance of bird populations or communities, and many studies

lack rigorous experimental designs with adequate replication and randomization. Furthermore, many researchers measure only species' abundance and habitat use, but these patterns may not reflect reproductive success or habitat quality.

The overall, long-term objectives of the MOFEP bird study are:

- To determine differences in breeding densities of selected a) mature forest and b) early-successional songbirds in managed and unmanaged forests.

- To determine rates of nest parasitism, nest predation, and reproductive success of songbird species in managed and unmanaged forests.

Project Years
1991-95, 1997-2015

Ground flora

Ground flora is an important component of any forested landscape. The composition and structure of the ground vegetation contributes greatly to the overall forest biodiversity, to wildlife habitat quality and to the character of future stands.

Fundamental knowledge of ground vegetation is needed in order to interpret wildlife responses and processes under investigation in other studies. For example, changes in composition and structure of herbaceous ground vegetation may affect the relative abundance of several wildlife species. Also, changes in ground flora may be interpreted relative to changes in overstory vegetation. Information on the effects of management practices on species diversity and regeneration is required to make decisions in forest management.

An additional element of this project is estimation of berry, or soft mast, production using the same plots to estimate ground flora abundance.

The objectives of the MOFEP ground flora study are:

- To determine effects of management practices on ground flora species richness and diversity.

- To determine the abundance and production of berry producing plants.

Project Years
1993-95, 1997 (sub-sample), 1999-2001, 2002 & 2007 (sub-sample), 2009-10, 2011 (sub-sample), 2012-14

Overstory vegetation

Like ground flora, overstory vegetation is an important component of any forested landscape. The composition and structure of the overstory vegetation contributes greatly to overall wildlife habitat quality and to the character of future stands.

Fundamental knowledge of overstory vegetation is needed to interpret wildlife responses and processes under investigation in other studies. Also, changes in overstory vegetation may be interpreted relative to changes in ground flora. Information on the effects of management practices on forest structure, composition, succession and regeneration is required to make decisions in forest management.

The objectives of the MOFEP overstory vegetation project are:

- To quantify the effects of even-aged, uneven-aged, and no-harvest management systems on forest structure and reproduction.

- To quantify forest composition, regeneration, succession, and site quality in relation to environmental factors (e.g., site factors, topography, and soils).

- To quantify factors governing the growth and dynamics of individual trees and their competitors in stands under different management systems.

- To quantify snags and tree cavity abundance, size and use.

- To use MOFEP data in part, or in its entirety, to examine important issues affecting Missouri Ozark forests (e.g., oak decline/red oak borer, evaluating the effectiveness of uneven-aged silviculture for perpetuating oak forests, historic role of disturbance, the ecology of Ozark forests, concern about impending gypsy moth infestation).

Project Years
1990-92, 1994-95, 1997-98, 2001-02, 2005-06, 2009-10, 2012-13

Herpetofauna

Herpetofauna make up a significant proportion of biomass in forest ecosystems, are non-migratory or short-distance migrants and are sensitive to abiotic changes in the environment. In Missouri, information is available on the effects of management practices on game species, but there is a lack of information on the effects of forest management practices on herpetofauna.

The objectives of the herpetofauna project are:

- To determine effects of management practices on the species composition, species richness, and relative abundance of herpetofaunal communities.

- To determine if selected forest habitat characteristics and environmental factors are related to the presence and relative abundance of selected herpetofauna species.

Project Years
1992-95, 1997-2001, 2008-10, 2012-14

Small mammals

Small mammals are integral components of the oak-hickory forests in Missouri. They are prey for a number of predator species, disperse plant seeds and mycorrhizal fungi spores, consume significant amounts of insects, including pest species, aerate and mix soil through tunneling activity, create refuge tunnels used by other wildlife and add to the organic content of forest soils. Abundance and composition of small mammal species may be affected differently by different management practices. As with herpetofauna, information is available on the effects of management practices on game species, but there is a lack of information on the effects of forest management practices on small mammals. Understanding the relationships between forest management and small mammal communities is a priority in MOFEP.

The objective of the MOFEP small mammals study is:

- To determine the effect even-aged, uneven-aged and no-harvest forest management have on the species composition, species richness, and relative abundance of small mammal communities.

Project Years
1994-95, 1998-2001, 2009-10, 2012-14

Experimental design, data analysis, & data management

MOFEP facilitates a better understanding of how forest management practices impact different components of the forest ecosystem. The mechanism that accelerates this learning process and makes MOFEP so valuable is that it is designed as an experiment that allows for the collection of data from a vast number of ecosystem components. To garner value-added information from the data collected, advanced statistical techniques need to be applied. Fortunately, the statistical sciences are not static, but like a forest are highly dynamic with much growth and change. Therefore, to be able to derive as much value from the investment in these data and to better understand the reactions and interactions of ecosystem components under differing forest management practices, a continual need exists to develop and implement advanced statistical methods for gaining as much information from MOFEP as possible.

MOFEP is a long term and multi-disciplinary project. Thus, it is vital that all MOFEP data be archived in one central location and that it be well documented so that present and future scientists and managers can easily access the data, and understand it today and in the distant future. The ability to integrate data from many years of related studies can only be of great value

to future researchers if the data is managed well. Well archived quality data will facilitate data exchange among scientists, and will ensure that data collected today will be useful to scientists that come after us, even in 300 years. Data need to be submitted on a regular basis.

Because database management and integration is absolutely critical to the success of a long-term, multi-disciplinary study, MOFEP needs a person who is dedicated (at least 50% time) to database management and integration. One of this person's responsibilities would be to directly contact principal investigators for their data. A database manager could also ensure that the data, where possible, were tied to a GIS.

The objectives of the experimental design, data analysis and data management studies are:

- To develop and implement advanced statistical methods.
- To archive all MOFEP data in one central location.
- To facilitate availability and use of MOFEP data.

Project Years
Not applicable

Future Research Needs

Although the focus of this strategic plan is information transfer, identifying future research directions is still an important function of MOFEP's strategic plan. To this end, an email message was sent to Forestry and Wildlife Division leadership and staff working in Southeast and Ozark Regions requesting input on present and future information needs for managing Ozark forests. This input was used to identify future research directions along with needs identified in MDC's 2010 Forest Resource Assessment and Strategy (FRAS) document. The following research areas were developed from these sources and represent possible future directions for MOFEP.

- Influence of MDC even-aged and uneven-aged management systems on the resilience and adaptive capacity of Ozark forests and woodlands to mitigate future climate change
- Understand forest management impacts on soil and water quality
- Understand and mitigate biogenic threats to the health of Ozark forests and woodlands
- Impacts of MDC forest management systems on species of conservation concern, including tree-roosting bats of the Ozarks
- Invasive species impacts on Ozark forests and woodlands

Implementation of the Plan

This section provides information on the existing coordination strategies to support MOFEP. The implementation component of our Strategic Plan consists of three implementation strategies:

- Partnerships — Work in partnership with universities, federal and state agencies interested in ecosystem research. Also, work closely with forestry and wildlife resource managers – users of research results.
- Coordination – Ensure there are structures in place to manage MOFEP activities.
- Dissemination— Ensure timely and effective dissemination of research findings.

Partnerships

MOFEP has intimate collaborations with universities, such as University of Missouri-Columbia and Central Methodist University, through cooperative agreements. MOFEP also works in cooperation with Federal and other state agencies, and with resource managers. These partnerships will continue to be improved, because they enhance and extend the research capability of MDC.

Coordination

MOFEP Steering Committee

The role of the Steering Committee is to provide overall vision, guidance, oversight and direction for MOFEP. In addition, the committee provides scientific and administrative advice on MOFEP to MDC. The purpose of the committee is to:

- Maintain MOFEP direction
- Identify new research projects
- Prioritize research projects
- Facilitate collaboration among scientists
- Review proposals
- Review research reports
- Arrange conferences and workshops
- Promote dissemination and the application of research results
- Develop and revise the strategic plan
- Facilitate funding for projects that address priorities in the MOFEP plan
- Promote MOFEP vision to MDC and other agencies

The committee meets at least once a year to review progress on all projects and to review MOFEP's strategic direction. In addition, periodic meetings are held to review proposals or to review any changes in direction of existing projects.

Membership

The MOFEP Steering Committee currently consists of 17 members. Fifteen members are representatives of different Divisions within MDC: 9 from Resource Science Division, 5 from Forestry Division, and 1 from Wildlife Division. Members represent concerns and opinions of their divisions and sections within MDC. In addition, two experts outside MDC representing public institutions and academia were appointed to provide independent opinion on the project: 1 from the US Forest Service and 1 from the University of Missouri. A new standardized membership has been approved by the Steering Committee to take effect upon completion of this plan (Appendix 4). Standardizing membership based on positions rather than personnel will help to avoid confusion about membership when personnel changes occur.

Current members of the MOFEP Steering Committee are:

- Matt Olson, Resource Scientist, Resource Science Division, MDC
- *Open* (field coordinator), Resource Scientist, Resource Science Division, MDC
- Dawn Henderson, Supervisor, Resource Science Division, MDC
- Charles Anderson, Supervisor, Resource Science Division, MDC
- Dyanna Pursell, GIS Specialist, Resource Science Division, MDC
- Rich Blatz, Field Programs Supervisor, Forestry Division, MDC
- Julie Fleming, Database Specialist, Resource Science Division, MDC
- Sherry Gao, Biometrician, Resource Science Division, MDC
- Joe Garvey, SE Region Supervisor, Forestry Division, MDC
- Terry Thompson, Ozark Region Supervisor, Forestry Division, MDC
- Vicky Heidy, Supervisor, Resource Science Division, MDC
- John Kabrick, Research Forester, USDA Forest Service-NRS
- David Larsen, Associate Professor, University of Missouri-Columbia
- Rochelle Renken, Unit Chief, Resource Science Division, MDC
- Larry Rieken, Ozark Region Supervisor, Wildlife Division, MDC
- Dave Rowald, SE Region District Forester, Forestry Division, MDC
- Mike Bill, Ozark Region District Forester, Forestry Division, MDC

General Coordination

The MOFEP chair is in charge of general coordination of MOFEP. Specific duties are:

- Serve as liaison between the principle investigators, project leaders and MDC Resource Science administration
- Serve as the information clearinghouse on MOFEP issues
- Work with the Field Coordinator
- Facilitate principal investigators meetings to discuss status and future for MOFEP studies
- Chair the MOFEP Steering Committee

The MOFEP chair is Matt Olson.

Administrative Oversight

Administrative oversight of MOFEP is the job of the Forest Systems Field Station Supervisor.

The MOFEP administrator is Dawn Henderson.

Field Coordination

Field coordination entails assisting the principal investigators with field measurements, field visits, locating and maintaining multi-project plots, and coordinates harvest activities with Forestry Division.

The MOFEP field coordinator position is unfilled.

Data Manager

The data manager is responsible for data management, quality control and archiving all MOFEP metadata and data in one central location. Data management is critical to the success of long-term and multi-disciplinary studies, such as MOFEP. Good data management will facilitate integration and synthesis of MOFEP studies, and will ensure that scientists can find and understand the data today and in the future. The data manager is working on three areas to ensure that the value of the information collected on MOFEP is preserved for future use:

- Timely submission of data and metadata by the principal investigators
- Revise guidelines for access to MOFEP data as appropriate
- Continue to improve the metadata/data upload process

The MOFEP data manager is Julie Fleming.

GIS Specialist

The GIS specialist is responsible for providing GIS and associated technical support to MOFEP principal investigators. Geospatial data and technology is an everyday part of the science and management of natural resources.

The MOFEP GIS specialist is Dyanna Pursell.

Biometrician

The MOFEP biometrician provides statistical advice to principal investigators and the Steering Committee regarding the experimental design of MOFEP and any projects that use MOFEP as a research platform.

The Biometrician for MOFEP is Sherry Gao.

Dissemination of Information

MOFEP is committed to improving the processes and mechanisms through which research information and technology are shared with fellow scientists and resource managers. The implementation strategies which allow for distribution of research products include:

- MDC Technical Series Reports or Science Notes
- Articles in scientific journals
- Publications in magazines and newsletters (e.g. Conservationist, Currents, etc.)
- Provide information on MOFEP website (http://mofep.mdc.mo.gov/)
- Conference presentations
- Conference proceedings dedicated to MOFEP
- Internal presentations (e.g., expanded staff meetings)
- Field tours

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Appendix 1: On-going and Completed MOFEP Projects

Soils nutrient dynamics & soil quality

One of the most important factors governing forest sustainability is the soil's short- and long-term ability to supply nutrients and provide other ecosystem benefits. However, the influence of forest management on soil nutrient status and quality is not fully understood. This study is a new 4-year project starting in FY 2014, which builds upon on-going research as part of the Missouri Department of Conservation's Missouri Ozark Forest Ecosystem Project (MOFEP) investigating the impacts of current forest management systems on soils of the southeast Missouri Ozarks. Understanding the effects of timber harvest practices on nutrient pools and processes is important for managing long-term forest productivity in Missouri. The overall goal of this project is to enhance our understanding of soil nutrient pools, nutrient dynamics, and soil quality in MOFEP sites using existing samples, field studies, and laboratory analyses.

The objectives of the soil nutrient dynamics and soil quality project are:

- Evaluate the dynamics of nutrient concentrations in soil solution and quantify nutrient flux following clearcut and single-tree selection harvests in EAM and UAM sites, respectively, harvested between 2011 and 2012.

- Initiate work investigating changes in total and extractable soil nutrient pools following clearcut and single-tree selection harvests in EAM and UAM sites, respectively, harvested between 2011 and 2012.

- Investigate changes in soil quality indicators (SQI) through time in the surface soil horizons (0 – 10 cm and 10 – 20 cm depths) of differing nutrient status soils after clearcut and single-tree selection harvests in EAM and UAM sites, respectively, harvested between 2011 and 2012.

- Use archived MOFEP soil samples (collected in the mid-1990's) to evaluate soil and landscape determinants of phosphorus and determine if correlations between P and tree species exist at MOFEP.

Project Years
1997 (samples collected & archived), 2007-2013

Hard mast

Managers of Missouri's forests and wildlife have a great interest in learning more about the dynamics and patterns of hard mast production, the impacts that forest management techniques may have on production, and conversely, the impact mast production may have on management

techniques. The hard mast project, was designed specifically to gather data that could be used to determine the effects of forest management on hard mast production. These data will lead to information about the natural cycles of hard mast production, the effects of forest management on hard mast production, and inferences about the resulting effects on both wildlife forage availability and forest reproduction potential.

The objectives of the hard-mast study are:

- To determine long-term, landscape-scale effects of EAM, UAM, and NHM systems on hard mast production
- To ascertain covariate factors (other MOFEP studies such as the Small Mammal study, temperature, precipitation, ELT) affecting hard mast production
- To evaluate long-term patterns in masting cycles that may be predictive in nature and useful for forestry or wildlife management planning

Project Years
1993-95, 1997-2002, 2005-10, 2011 (controls only), 2012-2013
Hard mast overstory tree measurements – 1995, 1998-99, 2005, 2009-10, 2012-13

Canopy mapping

There is a lack of information on how fast tree regeneration develops under even-aged and uneven-aged silviculture in the Missouri Ozarks. This growth rate will determine if the reproduction will be recruited into the overstory or simply remain an understory tree. The canopy mapping project is addressing this question. Additionally, the canopy mapping data set is being used to determine if an overstory tree is thinned how long it takes to reoccupy the space made available during the thinning. Both of these questions are important to determining the intensity and type of treatments to impose on Missouri's forests.

The project objectives are:

- To determine how MOFEP treatments affect understory regeneration abundance.
- To determine the rate of overstory tree crown filling of available growing space after a partial removal of overstory trees.

Project Years
0.05-ac plot, >1m: 1994-95, 1999, 2000 (24 plots in 1996 clearcuts), 2004
0.5-ac plot, >4.5" DBH: 2011-12

Down coarse woody debris

Down coarse woody debris (CWD) is an important indicator of forest structure, fire risk, habitat quality, nutrient cycling, and carbon storage. For example, the volume of coarse woody debris of various sizes is indicative of fuel loading and ultimately of fire intensity if ignited.

The project objectives are:

- To quantify the magnitude and variability of the accumulation of CWD in relation to forest management systems

- To determine rates of decomposition for down wood.

Project Years
1990-92, 1994-95, 1999-2000, 2013-2014

Stump sprouting

Oak stump sprouts are important in obtaining adequate oak regeneration. In young stands, stump sprouting may account for the majority of the reproduction. In older stands, stump sprouts can supplement advance reproduction populations to ensure the adequacy of oak in the new forest. Managers need to be able to predict the contribution of stump sprouts to the overall population of oak reproduction to judge whether (1) reproduction is adequate, (2) artificial regeneration by planting or direct seeding is needed to supplement natural reproduction, (3) competition control is needed to maintain oak in a free-to-grow state, or (4) harvesting should be delayed to give time for the development of large advance reproduction. Understanding the contribution of oak stump sprouts to oak regeneration potential of Ozark forest would not only inform managers of what to expect following harvesting, but could help in developing silvicultural prescriptions.

The objective of this project is:

- To determine the effect of forest management, neighborhood-scale factors, and individual tree attributes on development of sprouts arising from stumps of cut trees.

Project Years
X-sections cut in 1997 for parent tree age, sprout data collected in 1998, 2001, 2006, 2013-14

Integration & synthesis

To rigorously evaluate the effectiveness of forest management on Missouri Ozark forests, we must examine treatment effects at a variety of temporal, spatial, and ecological scales. Multi-disciplinary analyses can potentially identify patterns among taxa and environmental characteristics that will help us to understand the ecological effects of forest management. Integration of MOFEP data encourages collaboration among principal investigators which is likely to yield both additional insights into interpretation of results and novel ideas for future management and research activities. Integration can also help identify shortcomings in data collection and scale-issues for the MOFEP community to address as research continues.

The main objective of this study is:

- To integrate data from multiple MOFEP studies across spatial and temporal scales in order to determine the effects of forest management on Ozark forest ecosystems.

Project Years – Not applicable

Harvest impacts

Tree injuries resulting from harvest activity affect: tree health, levels of forest pest activity contributing to tree- and stand-level forest decline, and future value of residual injured trees. Tree injuries ultimately constrain forest management activities from marking to harvest planning.

The primary objectives of this project are:

- To quantify postharvest damage.
- To determine the effects of skidding and felling under different silvicultural treatments.

Project Years
1997, 2009, 2012-13

Carbon flux and storage

Principle Investigator
Jiquan Chen

Project Summary
Terrestrial ecosystems have been hypothesized to serve as a sink for atmospheric carbon. However, intensive timber harvesting, like clear-cutting, can offset carbon storage due to increases in decomposition. Quantifying carbon storage under different management regimes is important to inform managers of the capacity of the system to store carbon. Quantifying carbon storage and fluxes in our managed forests will establish a foundation for Missouri to enter the developing market of carbon credits.

The primary objective of the carbon flux project was:

- To quantify differences in carbon flux and storage within mixed oak forests of the southeast Missouri Ozarks resulting from alternative management practices, landscape form, and climate change.

Project Years
2002-12

Developing a Comprehensive Statistical Models for MOFEP

Principal Investigator
Zhuoqiong He

Project summary
MOFEP consists of 32 different studies that each has one or more response variables. Therefore, there are about 80-100 response variables in MOFEP and traditional statistical models are not well-suited for studying the interrelations among so many ecosystem attributes. Most MOFEP studies collect spatial and temporal information on response variables. Some studies also collect spatial and temporal information on environmental variables. All the response and environmental variables are related to each other to some extent. The traditional statistical methods do not efficiently utilize spatial information or interrelationships among response and environmental variables. Using the spatial information and interrelationships among variables will increase the power to test multiple effects of forest management practice and to study the interrelation among ecosystem attributes.

In the recent years, many new statistical methods are developed to deal with complex models. Those new methods have been successfully used in biological, medical and genetic research. Adapting those new methods to MOFEP will enable us to develop a comprehensive statistical model for MOFEP by incorporating spatial-temporal effects and interrelationships among attributes.

The project objectives were:

- To identify the response variables simultaneously affected by treatments
- To develop spatial-temporal models for important variables
- To develop a comprehensive statistical model for MOFEP that includes spatial-temporal effects and interrelationships among ecosystem attributes

Project Years
2002-2003, 2004-2005

Role of *Armillaria* in forest management

Principal Investigator
Johann Bruhn

Project Summary
Armillaria is a ubiquitous genus of opportunistic, root-parasitic, white-rot wood decay fungi. *Armillaria* species often serve as pivotal contributing factors in stress-mediated forest declines, including oak decline. Stump creation, stem injury, and root damage are silvicultural disturbances which lead to elevated levels of *Armillaria* root disease. Forest managers need to know the extent to which forest decline and associated *Armillaria* root disease are responses to silvicultural disturbances *vs*. other stand and/or environmental dynamics. Forest managers also need to know the impact of various classes of tree injury on long-term tree and stand health. This project used monitoring to help explain the relationships between *Armillaria* and forest management operations.

The project objectives were:

- To document tree wound closure and explain *Armillaria* species interactions with each other, with forest stand composition and structure, and with anthropogenic disturbances, in the context of site factors.

- To evaluate of the role of *Armillaria* spp. in stump sprout growth and survival.

Project Years
1993- 2005

Economics

Principal Investigators
John Dwyer, Tom Treiman, and Dave Larsen

Project Summary
The goal of the project was to inform land managers or landowners of the results of management alternatives, as well as to reinforce the need to consider aesthetics, non-traditional forest products, and other non-market values in their decision matrix. Various measures of harvest quality and quantity were made, including simulations of tree growth, regeneration and harvest into the future. Cost/benefits analyses of even and uneven-aged silvicultural management systems were estimated, and compared to that of the control treatment. Using data on trees 1.5" DBH and larger from MOFEP, the project adapted the widely available Landscape Management System (LMS) and Forest Vegetation Simulator (FVS) software to make long-term simulations using even and uneven-aged silvicultural management systems. To simulate the economic outcomes of even-aged, uneven-aged and control treatments, the project used both standard algorithms and new LMS algorithms which simulated the effects of uneven-aged harvesting.

The objective of the economics project was:

- To determine the long-term economic sustainability of the even-aged, uneven-aged and control treatments on the MOFEP research sites.

Project Years
Data collected during 1996 harvest.

Oak herbivore fauna

Principal Investigator
Robert Marquis

Project Summary
Insect herbivores are major components of Ozark forest communities, both in terms of their ecological and economic role, and their diversity. Because oaks dominate Ozark forests, leaf damage by insects that feed on oaks potentially could affect forest productivity. Furthermore,

these insects are important components of forest food webs, providing food resources for birds, small mammals, and parasitic insects and nematodes. Characterizing the impacts of logging treatments on these insects, therefore, is essential to developing mechanistic explanations for treatment effects on plant productivity, vertebrate abundance, as well as nutrient cycling and forest regeneration.

The objectives of the oak herbivore fauna project were:

- To document the impacts of the forest management treatments on the abundance, richness, and community structure of leaf-chewing herbivores feeding on black and white oak in the canopy and the understory.

- To determine interactions between birds and insect herbivores on white oak.

Project Years
1992-2009

Carbon and sulfur cycling

Principal Investigator
Henry Spratt

Project Summary
The purpose of this research was to determine potential effects of large-scale disturbances on surface soil microbial communities and the nutrient transformations they drive. Specifically, changes in surface soil carbon, sulfur, or exchangeable base (i.e., Mg and K) pools, along with indicators of microbial activity associated with timber management techniques as applied in the Missouri Ozark Forest Ecosystem Project were investigated. This work has implications to the long-term sustainability of surface soil microbial communities responsible for nutrient cycling, including lignocellulose and organic sulfur compounds, in habitats managed by clear-cutting or (possibly) by selective harvest, and potentially to ecosystem-level nutrient cycling.

The objectives of this research were:

- To determine the relatively short-term effect of clear cutting and selective timber harvest on soil sulfur constituents and total carbon in surface soils of selected MOFEP plots.

- To assess any changes in indicators of soil microbial activity (e.g., biosynthesis of organic sulfur or catabolism of lignocellulose) due to clear cutting or selective timber harvest in surface soils of selected MOFEP plots.

- To determine any linkages between soil nutrient cation content and organic sulfur content in surface soils of selected MOFEP plots.

Project Years
1992-2002

Microclimate

Principal Investigator
Jiquan Chen

Project Summary
This study provided quantitative summaries of microclimate in the forested landscapes of Missouri Ozarks. Weather stations were installed at MOFEP sites to quantify the changes in major microclimatic variables before and after the first harvest entry. These variables included air and soil temperature, soil heat flux, relative humidity, vapor pressure and deficit, short-wave radiation, wind speed and direction, precipitation, and soil moisture. Daily and monthly summaries as well as diurnal patterns were generated to investigate the impacts of forest management on microclimate and to make this data available to other MOFEP projects.

Project Years
1992-1997

Forest history

Principal Investigator
Richard Guyette

Project Summary
Forest history is a critical link in understanding the treatment effects of harvest methods. The harvesting of MOFEP study sites provided an opportunity to gain a long-term perspective on Ozark forests and their response to disturbances. The major objective of the forest history project was to document forest disturbances and their ecological consequences. Information about tree growth, climate, wildland fire, disturbance, and human-environmental interactions can be salvaged from recently cut trees, woody remnants, and increment cores. This information was used in the interpretation of treatment effects and in assessing the overall ecological role of present and past disturbances on MOFEP flora and fauna. This project used a dendro-chronological approach to provide a long-term perspective on ecological processes and silvicultural harvesting systems.

Specific objectives of this project were to:

- Construct fire history chronologies from dated fire scars,
- Construct disturbance histories for the MOFEP sites,
- Quantify anthropogenic variables and effects at the MOFEP sites,
- Use disturbance, landscape, and human variables to examine long and short-term ecosystem responses,
- Examine climate-ecosystem interactions via growth increments of organisms.

Project Years
1996-2004

Tree genetics

Principal Investigator
Victoria Sork

Project Summary
This study used three major approaches:

Mating system describes how gametes unite to form the next generation. We examined here mating systems in 3 species of forest trees (mockernut hickory (*Carya tomentosa*), white oak (*Quercus alba*), and sassafras (*Sassafras albidum*)) for effects of forest structure and aspect on multilocus outcrossing rates, single locus outcrossing rates, parental relatedness, and the probability that 2 randomly selected individuals share paternity. Fruits were collected from randomly selected individuals and genotyped for analysis.

This study examined patterns of genetic diversity and structure in 3 commonly occurring tree species. Leaf material from randomly selected individuals was collected from 48 individuals in each of 4 subpopulations in all 9 MOFEP sites. Electrophoresis separated isozyme alleles at a number of loci to generate multilocus genotypes for analysis.

Alteration of forest landscapes can result in changes in pollen dispersal patterns for forest canopy tree species. In this project we examined the pollen pool structure as measured from chloroplast microsatellite loci (CPSSR) in shortleaf pine (*Pinus echinata*) across the MOFEP landscape. Our specific objectives were: (1) determine spatial heterogeneity in pollen pools, (2) examine the influences of local stand structure (both hetero- and conspecific) on pollen pool composition, and (3) ascertain whether pollen pool heterogeneity is related to distance between sample sites.

Project Years
1992-2002

Leaf litter arthropods

Principal Investigator
Jan Weaver

Project Summary
The goal of this study was to measure the distribution and abundance of leaf litter arthropods on the MOFEP sites, and to evaluate the impact of cutting on their communities. The study was limited to MOFEP sites 1,2, and 3. In each site, 12 5x5 m plots were randomly placed. From each plot, four 0.03 sq m leaf litter samples were collected between May 30 and Jun 6, 1993-95 and 1997-99. The arthropods were extracted from the litter using a Tullgren funnel and identified

and counted in the lab. In addition to measuring treatment effects, the study also generated a list of arthropod species present at MOFEP sites.

Project Years
1993-95, 1997-99

Lichen communities

Principal Investigator
Douglas Ladd

Project Summary
Little is known about the composition, dynamics, diversity, and disturbance responses of lichens in the Midwest, particularly in the Ozark Highlands. A comprehensive study of lichen vegetation on the MOFEP sites was initiated in 1996. In addition to floristic surveys of all nine compartments, lichens were sampled at a subset of previously established vegetation plots. Corticolous lichens were sampled at basal, mid-bole and canopy levels of trees. Line transects were sampled for lichens growing on various ground layer substrates. Results indicated a diverse and well distributed lichen biota in all MOFEP sites, with nearly 300 taxa documented. There was a high degree of similarity in lichen species composition and distribution patterns among the nine compartments. Corticolous (tree) and saxicolous (rock) substrates supported the highest lichen diversity, with 166 and 105 taxa identified, respectively. Approximately 10% of the species encountered occurred on multiple substrates. Patterns in composition and richness were highly correlated with vertical location on the tree and, to a lesser extent, tree species. There was no strong relationship between tree size and lichen richness or composition, with a few exceptions related to bark traits. On all but the youngest canopy branches, macrolichens exhibited high relative importance values compared to the higher overall diversity of crustose taxa. We identified guilds of species associated with microhabitat. These included a suite of crustose taxa on small canopy branches, a diverse group of foliose taxa on tree trunks, and a suite of taxa, including gelatinous lichens, found on tree bases. Lichens are a significant component of biological diversity in the Ozarks, and we recommend that forest management strategies include considerations for functional assemblages of lichen biota.

Project Years
1996-97

Appendix 2: List of Current Principal Investigators

No.	Project title	Principal investigator(s)
Core research		
1	Forest interior birds	P. Porneluzi, J. Haslerig, J. Faaborg
2	Ground flora	E. Olson
3	Overstory vegetation	M. Olson, J. Kabrick, D. Larsen
4	Herpetofauna	A. Wolf
5	Small mammals	A. Wolf
6	Experimental design, analysis, and data management	S. Gao, J. Fleming
On-going research		
7	Soil nutrient dynamics and soil quality	J. Kabrick, K, Goyne
8	Hard mast	M. Olson
9	Canopy mapping	D. Larsen
10	Down wood coarse debris	J. Kabrick
11	Stump sprouting	M. Olson, D. Dey
12	Synthesis and integration	J. Millspaugh, L. Vangilder

Appendix 3: Data Access Guidelines

The following document is the form to be used by researchers other than current MOFEP PIs when proposing new research that uses any existing MOFEP data.

APPLICATION FOR PROPOSED EXTERNAL RESEARCH ON THE MOFEP STUDY AREA AND/OR DATA ACCESS

Missouri Ozark Forest Ecosystem Project (MOFEP)
Missouri Department of Conservation (MDC)

All proposed research and/or data requests must be discussed with the MOFEP Chair or Field Coordinator prior to official submission of an application. Request for access to data or the study area may require approval of the MOFEP Steering Committee, depending on the nature of the request. Signatures by Missouri Department of Conservation personnel does not constitute approval of access to data or the study area until written notice through letter or e-mail is given; a Memorandum of Understanding or Cooperative Agreement may be required prior to approval. If approved, a MDC researcher will be assigned to be closely involved with this project.

1) Applicant Name:

2) Organization:

3) Phone:

4) E-mail:

5) Request type (Check one or both): [ ] Research Proposal [ ] Data Access

6) Statement of purpose/objective of this proposed research or request for data (2 sentences max):

7) If applicable, what specific data is requested (attach extra sheet if more space is needed):

8) If applicable, please attach proposal (2-page max). Please note that a more detailed proposal may be requested.

9) If applicable, sampling type (Check one or both):

[ ] Observational (e.g., basal area, canopy cover, etc.)
[ ] Destructive (e.g., soil sample, tree core, clippings, etc.)

Internal MDC Use Only

1) Date Application Received:_____

2) Is Steering Committee Approval Needed (Per judgment of Chair and Field Coordinator):

[ ] Yes Steering Committee Decision: [ ] Approved [ ] Not Approved [ ] Not Applicable
[ ] No If No, why:

3) Is a Memorandum of Understanding and/or Cooperative Agreement needed:
[ ] Yes [ ] No If No, why:

Signatures:

_____ _____ [ ] Approved [ ] Not Approved
MOFEP Chair Date

_____ _____ [ ] Approved [ ] Not Approved
MOFEP Field Coordinator Date

_____ _____ [ ] Approved [ ] Not Approved
Supervisor of MOFEP Chair Date

_____ _____ [ ] Approved [ ] Not Approved
Resource Science Field Chief Date

_____
Staff assigned to work with this request.

_____ _____
Name Date

Date when notification of decision was sent to applicant: _____

Appendix 4: Standardized Steering Committee Membership

MOFEP Steering Committee Members

MDC Internal
Resource Science Division

1) MOFEP Chair, Research Silviculturist
2) MOFEP Field Coordinator, Resource Scientist
3) MOFEP Administrative Oversight, Supervisor of MOFEP Chair
4) Resource Science Field Chief
5) Biometrician
6) GIS Analyst
7) Database Manager

Forestry Division

8) Regional Supervisor, Ozark Region
9) Regional Supervisor, Southeast Region
10) Divisional Administrative Representative

Wildlife Division

11) Regional Supervisor, Ozark Region
12) Regional Supervisor, Southeast Region
13) Divisional Administrative Representative

External

14) Research Forester, US Forest Service, Northern Experiment Station
15) Forestry Professor, University of Missouri-Columbia

Members At-large

16) Biologist from either Fisheries Division or Resource Science Division, MDC
17) Heritage Program Supervisor, MDC
18) Representative from The Nature Conservancy