The Vermont Forest Ecosystem Management Demonstration Project

Project Description

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ABSTRACT

The Vermont Forest Ecosystem Management Demonstration Project (FEMDP) will bring together researchers from diverse fields in an experimental test of forest management effects on northern hardwood ecosystems. Coordinated by the Vermont Monitoring Cooperative (VMC), FEMDP will provide policy makers and forest managers with ecological and socio-economic information on a range of forest management options. Experimental treatments include a spectrum of silvicultural approaches, ranging from existing forest management practices to new, evolving silvicultural systems designed to enhance structural complexity. Specifically, treatments include three commercial harvests: single-tree selection, shelterwood, and crop tree release; and three structural complexity enhancements of escalating intensity. The study is being conducted at the Stevensville Brook Research Area on the Mount Mansfield State Forest.

Research already initiated will investigate the effects of FEMDP treatments on multiple parameters. These include overstory structure and species composition, tree regeneration, growth, and mortality rates, understory plant communities, forest health, and above-ground carbon sequestration. An evaluation of economic tradeoffs and operational feasibility is also planned. Researchers at the University of Vermont also will study responses by the avian community, soil invertebrates, and soil macro-nutrients. The experimental design consists of six treatment units (six manipulations and a control) each of which is 2 ha. (ca. 5 acres) in size. Permanent plot establishment, stem mapping, and one year of pre-treatment sampling have been completed. Manipulations will be introduced following an additional year of pretreatment sampling and prescription design. Near-term (1 to 5 years), mid-term (5-50 years), and long-term (50-500 years) effects will be analyzed using direct observations of stand responses (sample data) and successional simulation (based on stem maps) using the SORTIE model. The results will improve our understanding of forest management effects across a range of taxa and ecosystem processes and will help forest managers evaluate the benefits, tradeoffs, and feasibility of silvicultural alternatives.

The FEMDP is specifically designed to provide a framework for multiple or supplemental research components to be added as interest and expertise allow. Researchers are encouraged to contact VMC regarding potential participation.

INTRODUCTION

The Vermont Forest Ecosystem Management Demonstration Project (FEMDP) was launched in 1995 with the objective of bringing together researchers from diverse fields in an experimental test of forest management effects on northern hardwood ecosystems. The long-term goal is to design a model for sustainable forestry across larger landscape areas based on an information gathering process tiered to multiple spatial scales. Coordinated by the Vermont Monitoring Cooperative (VMC), FEMDP will provide policy makers and forest managers with ecological and socio-economic information on a range of forest management options. The study is being conducted at the Stevensville Brook Research Area on the Mount Mansfield State Forest. The FEMDP is specifically designed to provide a framework for multiple or supplemental research components to be added as interest and expertise allow. The purpose of this paper is to promote participation in the FEMDP by interested researchers. It provides basic information on the research objectives and experimental design that collaborators might find useful for grant writing purposes.

Rationale for Experimental Treatments

In 2001 VMC expanded the FEMDP's scope to cover a spectrum of silvicultural treatments, ranging from existing forest management practices to new, evolving silvicultural systems. The intent is to evaluate the effects of forestry practices relative to the body of ecosystem science developed over the last several decades. There are several areas of particular interest, including differences between natural disturbance and forest management effects, impacts on both native and exotic biodiversity, forest health dynamics, and impacts on ecosystem processes, such as nutrient cycling, carbon storage, and hydrologic regimes.

To this end the project includes two disparate sets of treatments. The first set, consisting of single-tree selection, shelterwood, and crop-tree release, is representative of regionally common forest management practices. Under traditional silvicultural guidelines they would be prescribed at the project site for "stand improvement" and to increase regeneration of commercially desirable tree species. However, their effects on flora and fauna are not completely understood; they typically result in shifts in community composition over time and truncated structural development. Evaluating the positive and negative potential of these practices – from silvicultural, economic, and ecological perspectives – will be an important component of the FEMDP.

The second set of treatments address a growing regional interest in managing for a diversity of forest structural conditions, including those associated with natural disturbance effects and late-successional forest development (Hagan 2001; Keddy and Drummond 1999; Mladenoff and Pastor 1993). The treatments are designed to promote structural complexity and the associated biodiversity and ecosystem functions by accelerating rates of stand development. Termed "structural complexity enhancement," this experimental system builds on previous research that identified structural characteristics associated with mature and old-growth northern hardwood and mixed hardwood/conifer forests and tested the effects of treatments on a subset of these. Research tiered to these treatments will help forest managers evaluate the benefits, tradeoffs, and feasibility of silvicultural alternatives.

Research Needs

Research already initiated by the FEMDP's project director will test treatment effects on multiple parameters, pending funding to implement experimental timber harvests. The parameters include overstory structure and species composition, tree regeneration, growth, and mortality rates, understory plant communities, forest health, and aboveground carbon sequestration. An evaluation of economic tradeoffs and operational feasibility is also planned. Other researchers at the University of Vermont's School of Natural Resources and Entomology Research Laboratory will study responses by the avian community, soil invertebrates (Carabidae and Collembola specifically), and soil macro-nutrients. Additional collaborators plan to study hydrologic and mercury mobilization effects within a portion of the project area.

Additional participation in the FEMDP is welcome. There is particular interest in collaboration to help monitor taxa not currently being investigated, such as small mammals, meso-predators, herpetofauna, canopy-dwelling arthropods, mollusks, fungi, and lichens, as well as sociological dimensions, such as visitor perceptions of treatment effects. Collaboration is also needed to monitor ecological process dynamics not currently addressed by FEMDP researchers. Graduate students at the University of Vermont may assist with some of these areas. Researchers are encouraged to contact VMC regarding potential participation in the FEMDP.

Explanation of Structural Complexity Enhancement

Management for structurally complex forests across a larger portion of the landscape is central to sustainable management of northern forest ecosystems (Aplet and Keeton 1999; Keddy and Drummond 1999; Mladenoff and Pastor 1993). The goal of this approach is to enhance biodiversity found in older, late-successional forests, and increase carbon storage as per carbon sequestration certification. A limitation in our current ability to actively restore or promote structurally complex forests is that relatively few studies have field tested silvicultural systems addressing the full range of structural and compositional characteristics associated with old-growth northern hardwood or mixed northern hardwood-conifer forests. Is it appropriate to base the design of a comprehensive, structural enhancement system on natural disturbance dynamics and natural processes of stand development (Franklin et al. 2002)? Can we use silvicultural techniques to accelerate these developmental processes? How would effects on rates of forest development vary between specific structural and compositional parameters? How might wildlife and carbon storage respond? What are the economic tradeoffs involved? The FEMDP addresses these and related questions.

Structural complexity enhancement promotes forest habitat attributes such as multi-layered canopies, standing dead trees, downed large woody debris, variable horizontal tree density, and a full range of tree sizes including large trees. It is a management approach of increasing interest to both public and private forest managers in the northeastern U.S. and eastern Canada (Hagen 2001). Some timber companies, conservation organizations, and public land managers are presently using, on a trial basis, forestry practices specifically designed to promote structural complexity while also providing opportunities for timber harvest (Balch 2001; Burgason and Stockwell 2001; Dann 2001). On private timberlands, interest in structural complexity enhancement has developed through collaborative projects involving the transfer of development rights or "green" certification. This is relevant where restoration of varying degrees of old-growth character to a subset of stands is used as one element of an overall sustainable forest management strategy.

Positive relationships between structural complexity and the habitat requirements of many plant, animal, and fungal species in the northern hardwood region have been unequivocally established (Keddy and Drummond 1999; McGee et al. 1999; Goodburn and Lorimer 1998). But there is a widespread need for experimental, empirical studies on the effectiveness of active or manipulative enhancement practices (Hagan 2001; Trombulak 1996; Mladenoff and Pastor 1993). The FEMDP will address this need (Keeton et al. 2001). The objective is to develop and validate a silvicultural system that is advantageous where management objectives include generating timber revenue while also promoting under-represented elements of biological diversity, buffering fragmented older stands, enhancing riparian functionality, and increasing net carbon sequestration.

The FEMDP's experimental structural complexity enhancement system was developed from previous research in the northern hardwood region on three main topical areas: (1) modified silvicultural treatments; (2) structural attributes of mature and old-growth stands; and (3) stand development processes, including natural disturbance effects (Table 1). From previous research we can begin to quantify a range of structural attributes that can be actively targeted by stand manipulations, although these targets of course must be modified on a site-by-site basis (Tables 2 and 3). The silvicultural system incorporates several manipulations, including the following:

- variable density thinning, including small gap creation;
- crown release of selected shade tolerant trees;
- coarse woody debris (CWD) creation through girdling and felling;
- accelerated understory reinitiation of late-successional tree species through under-planting and/or scarification (where needed);
- and creation of pit and mound topography by pulling down selected overstory trees.

Table 1. Selected studies from the northern hardwood region that provide an empirical basis for structural objectives, choice of silvicultural treatments, testable hypotheses, and predicted effects

Topical Area	**Research***	
1. Demonstrations of the effects of modified treatments on a subset of structural parameters, including overstory growth rates, canopy structure, and coarse woody debris.	Kenefic and Brissette (2001) Goodburn and Lorimer (1999) Carlton and Bazzaz (1998) Singer and Lorimer (1997) Leak (1996) Strong et al. (1995)	Cole and Lorimer (1994) Rominske and Busch (1991) Hansen and Nyland (1986) Gore and Patterson (1985) Crow et al. (1981) Ellis (1979)
2. Quantifications of mature and old-growth forest characteristics, including contrasts with younger stands	Hagan and Whitman (2001) Whitman and Hagan (2001) Goodburn and Lorimer (1998) Dunwiddie et al. (1996) Frelich and Reich (1996)	Tyrrell and Crow (1994b) Dahir and Lorimer (1996) Keddy and Drummond (1996) McGee et al. (1999)
3. Interactions between natural disturbance effects and rates of structural development, which provide a basis for treatments that mimic both density dependent processes (e.g. self-thinning) and density independent processes (e.g. gap formation).	McLachlan et al. (2000) Foster et al. (1998) Abrams and Orwig (1996) Dahir and Lorimer (1996) Peterson and Pickett (1995) Frelich et al. (1993) Foster (1992) Foster et al. (1992)	McClure and Lee (1992) Frelich and Lorimer (1991) Abrams and Scott (1989) Foster (1988a) Foster (1988b) Canham and Loucks (1984) Hibbs (1983) Runkle (1981)

* in reverse chronological order

Although previous research has demonstrated the effectiveness of several of these treatments when employed alone (Table 1), they have not been integrated and tested as a single silvicultural system. In addition, previous research has not tested the effects of variable treatment combinations and intensities on rates and pathways of stand development as the FEMDP proposes to do. Finally, there is still much that we do not know about the effects of active manipulations across a wide range of taxa. It is hypothesized that in response to experimental treatment: (a) stand development rates will increase for a number of structural and compositional parameters; and (b) that taxa associated with multi-layered canopies, coarse woody debris, horizontal variation in tree density, and pit and mound topography will increase in relative abundance as structure develops.

Table 2. Structural characteristics of old-growth hemlock-northern hardwood forests.*

Structural Attribute	Minimum Requirement	Average Value in PA	Avg. Value in NY
Very Large Hemlocks	>3/ha > 70 cm dbh	19/ha	
Large Hemlocks	> 30/ha > 50 cm dbh	45/ha	
Large Trees of All Species	> 40/ha > 50 cm dbh	94/ha	55/ha
Coarse Woody Debris (Hemlock Only)	> 50 m^3/ha	171 m^3/ha	
Coarse Woody Debris (All Species)	> 100 m^3/ha	275 m^3/ha	
Downed Logs (Hemlock Only)	> 25 m^3/ha	142 m^3/ha	
Downed Logs (All Species)	> 55 m^3/ha	204 m^3/ha	139 m^3/ha
Downed Logs in Advance Decay	> 20 m^3/ha	93 m^3/ha	
Hemlock Snag Basal Area	> 0.5 m^2/ha	2.7 m^2/ha	
Hemlock Snag Volume	> 15 m^3/ha	32.9 m^3/ha	
Snag Basal Area (all Species)			8.6 m^2/ha
Snag Density (All Species >10 cm dbh)			42.8/ha
Canopy Gap Area	> 3.5 % of stand	5.8	
Canopy Gap Size	> 30 m^2 mean canopy gap size	143	

* Data from Tyrrell and Crow (1994a; 1994b); Haney and Schaadt (1996); and McGee et al. (1999)

Table 3. Indicators of old-growth character in eastern deciduous forests.*

Indicator	Measurement	Suggested Value
Tree Size	Basal area (m^2) per hectare	> 29
Canopy Composition	Proportion of shade-tolerant tree species	> 70%
Coarse Woody Debris	Megagrams per hectare	> 20
	Presence of large decaying logs (> 8 logs/ha)	
Herbaceous Layer	Number of ephemeral species	≥ 6
Corticulous Bryophytes	Number of bryophyte species	≥ 7
Large Diameter Snags	Number of snags (> 50.8 cm dbh) per 10 hectare	≥ 4
Mycorrhizal Fungi	No information	

* Adapted from Keddy and Drummond (1996)

Economic Tradeoffs

A central goal of the FEMDP is to evaluate the economic tradeoffs of different approaches for managing northern hardwood ecosystems. These tradeoffs are poorly understood for structural complexity enhancement in particular. For this approach to have appeal for private woodlot owners and forest managers not interested in purely restorative or ecologically oriented treatments, it is necessary for the system to generate sufficient revenue to allow a landowner to either break even or turn a profit. For this reason, FEMDP research will evaluate the economic tradeoffs of alternate treatment scenarios, ranging from less intensive structural enhancements (high revenue generating potential) to more intensive structural enhancements (low revenue generating potential).

Assessing economic tradeoffs is frequently used to evaluate the utility of experimental, alternative cutting systems. Researchers typically assess either the timber revenue generated by experimental timber harvests (Niess and Strong 1992; Niese et al. 1995; Buongiorno et a. 1994), project the net present value of planned future treatments (Berg 1995), or use successional models to simulate potential harvest scenarios and the resulting revenue (Hansen et al. 1995). FEMDP researchers will use a combination of approaches, including a comparison of revenue generated by initial treatments as well as stand-level growth and harvest modeling, to project the net present value of future potential revenue-generating opportunities. This will provide landowners with the economic data needed to determine whether active structural complexity enhancement is a viable option.

Significance of Research

The FEMDP will provide policy makers and forest managers in the northeast with empirical information on the ecological consequences of a range of forestry practices, including alternative practices that are untested though currently in use (see Hagan 2001). For forest management companies experimenting with new approaches, our results will help guide the integration of structural complexity enhancement into commercial forestry operations. Other beneficiaries will be non-profit organizations, such as conservation groups and land trusts, that hold easements to thousands of acres of industrial forestland in the northeastern United States. These lands will continue to be managed for sustainable timber production but must also meet conservation objectives. As a result, easement holders are searching for sustainable forestry methods that will allow them to balance multiple objectives. In addition, there is increasing interest among forest managers in forestry systems that enhance net carbon storage in forest stands. Through increased biomass retention forest managers can participate in international carbon sequestration credit trading systems being developed under the Kyoto Protocol on climate change (Harmon et al. 1990; Krankina and Harmon 1994; Turner and Koerper 1995). Finally, over the long-term the FEMDP will provide important baseline information on the effects of forestry practices on stand development, a wide array of taxa, and important ecological processes. This will inform further refinement of forest management practices designed to maintain biological diversity and other ecological values.

RESEARCH OBJECTIVES

1. Evaluate the relative ability of silvicultural alternatives to achieve desirable forest management outcomes.

2. Evaluate the operational effectiveness and economic tradeoffs of alternate silvicultural systems, including those designed to enhance structural complexity.

3. Determine the effects of forest management alternatives on selected elements of biological diversity and ecological processes.

4. Test the ability of silvicultural manipulations to accelerate the development of late-successional structural and compositional characteristics in northern hardwood forests.

5. Provide an experimental framework for collaborative research on relevant ecological, sociological, and economic dimensions.

METHODS

Experimental design, manipulations, and vegetation sampling and analysis

The Vermont Forest Ecosystem Management Demonstration Project (FEMDP) is being conducted at the Stevensville Brook Research Area on the western slope of the Mount Mansfield State Forest. Elevations in the project area range from approximately 450 to 606 m above sea level. Forest stands encompassed by this study include two strata: one that is highly productive (site class I) and one that is moderately productive (site class III). They are mature stands dominated by sugar maple, American beech, and yellow birch. A minor red spruce component becomes increasingly abundant as elevation increases. The study area has been selectively logged many times, most recently in the mid-1980s; the 1998 ice storm caused moderate canopy damage but little overstory mortality.

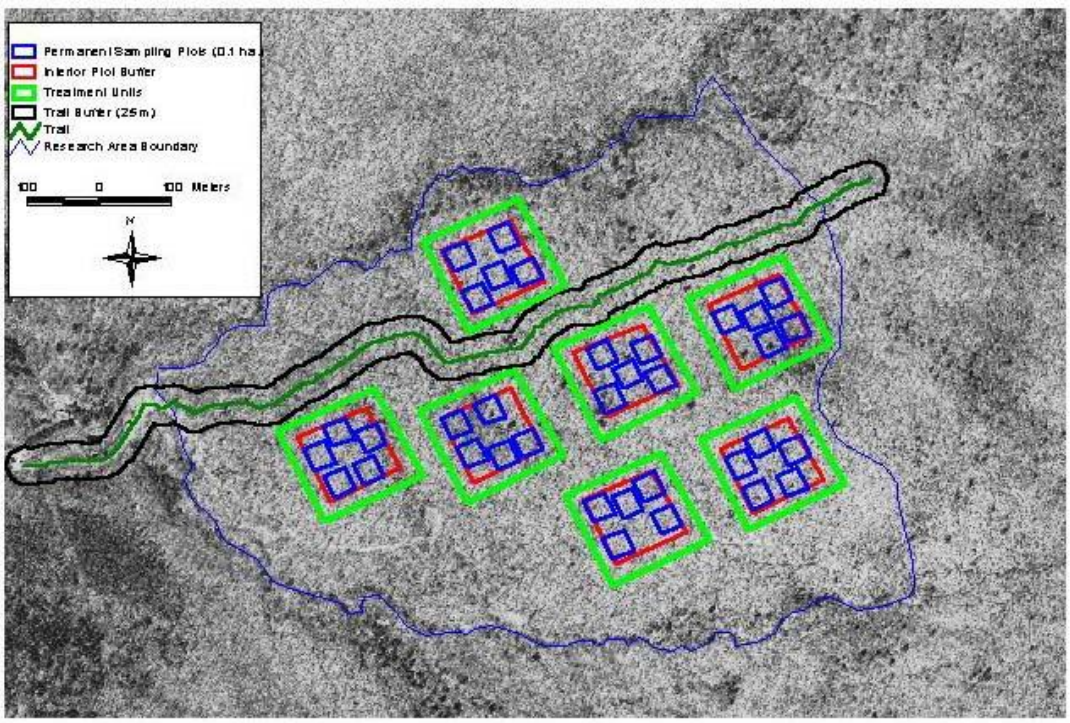

Figure 1. Layout of experimental treatment units at the Stevensville Brook Research Area, Mount Mansfield State Forest, Vermont. The units consist of one control, three structural enhancement units, and three commercial treatments.

The study design consists of a system of seven experimental treatment units (Figure 1). Experimental units (2 ha per unit) include one control (no manipulation) and six manipulative treatments. The manipulations consist of three commercial treatments and three structural complexity enhancement treatments. The three commercial treatments are as follows:

Treatment 1. <u>Single-tree selection</u>: Uniform density stand improvement to uneven size class distribution
Treatment 2. <u>Shelterwood</u>: 80% overstory removal plus scarification
Treatment 3. <u>Crop-tree release</u>: following Perkey et al. (1993)

The three structural complexity enhancement treatments are cumulative rather than independent: each successive treatment represents increasing manipulation intensity and decreasing volume removal of commercially marketable timber. Structural complexity enhancement treatments are as follows:

Treatment 4. <u>Lowest intensity</u>: Variable density thinning for multi-size class distribution, crown release of dominant late-successional species, release of late-successional (primarily shade-tolerant) regeneration
Treatment 5. <u>Medium intensity</u>: Treatment B + CWD enhancement (standing and downed) + under-planting of late-successional conifers
Treatment 6. <u>Highest intensity</u>: Treatment C + pull-down of selected canopy dominants

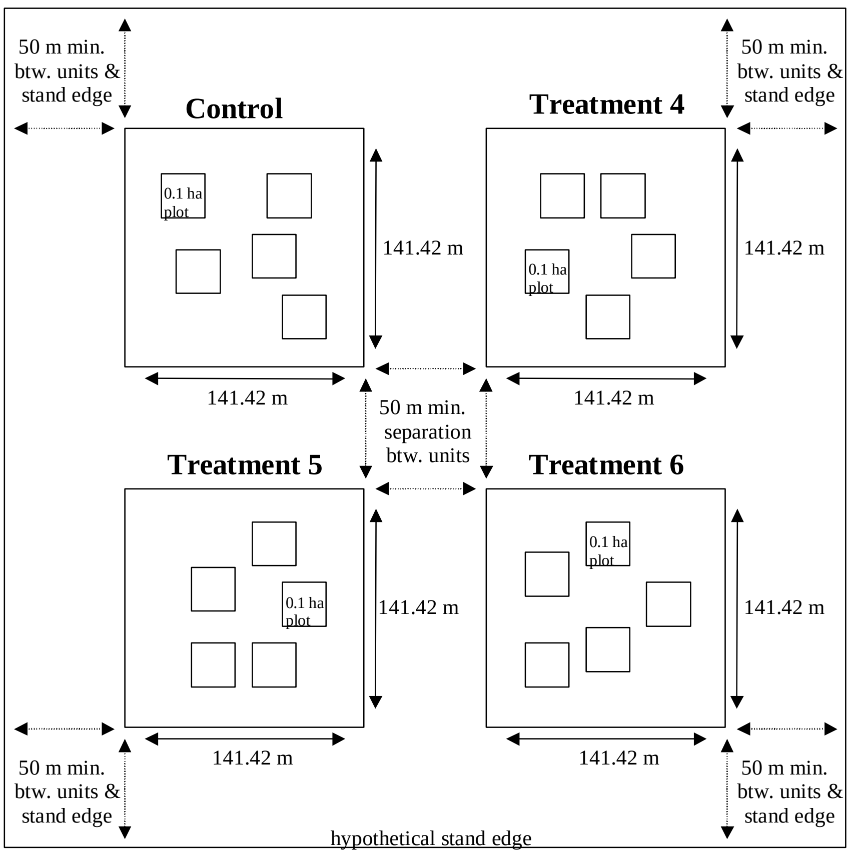

Figure 2. Experimental design of structural complexity enhancement units and permanent sampling plots. The three commercial treatment units (not shown) follow the same design.

To date FEMDP researchers have established experimental treatment units and permanent sampling plots and have conducted one year of pre-treatment sampling. Manipulations will be introduced following an additional year of pretreatment sampling and prescription design. Standardized prescriptions are based on silvicultural objectives identified from the literature and will be finalized after evaluations of pre-treatment data. To reduce possible edge effects, separation is maintained between treatment units; units also are buffered within the stand's interior (Figure 2). Five permanent sampling plots are established within each treatment unit. Plots are placed in a stratified random pattern within the inner core of treatment units (i.e. 20 m minimum buffering from the exterior edge). Pre-determined plot centers are located in the field using a Trimble Pro XRS Global Positioning System.

Each permanent plot unit consists of several nested square plots and transects (Figure 3). These are used for annual sampling of overstory structure and species composition, tree regeneration, growth, and mortality rates, understory plant communities, wildlife habitat characteristics, forest health, and above-ground carbon sequestration. Tree height, canopy depth, gap area, and other structural attributes are measured with an Impulse 200 laser rangefinder. All trees > 5 cm dbh are permanently tagged and measured within the largest (0.1 ha) plot size.

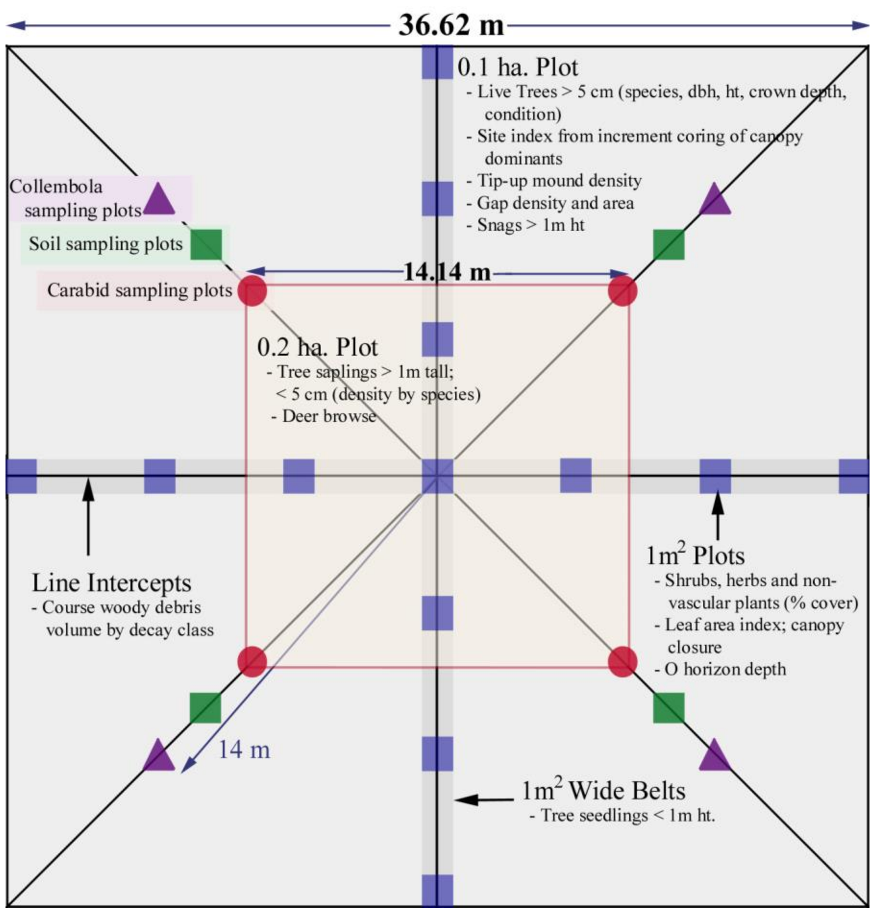

Figure 3. Design of and parameters currently being sampled in permanent, fixed-width plots. Soil macro-nutrient and soil invertebrate research are directed by researchers at the UVM Entomology Research Laboratory.

All tagged trees within one treatment unit have been mapped using an integrated GPS/digital electronic compass/laser rangefinder surveying system (Figure 4). Another set of stem maps will be produced post-treatment.

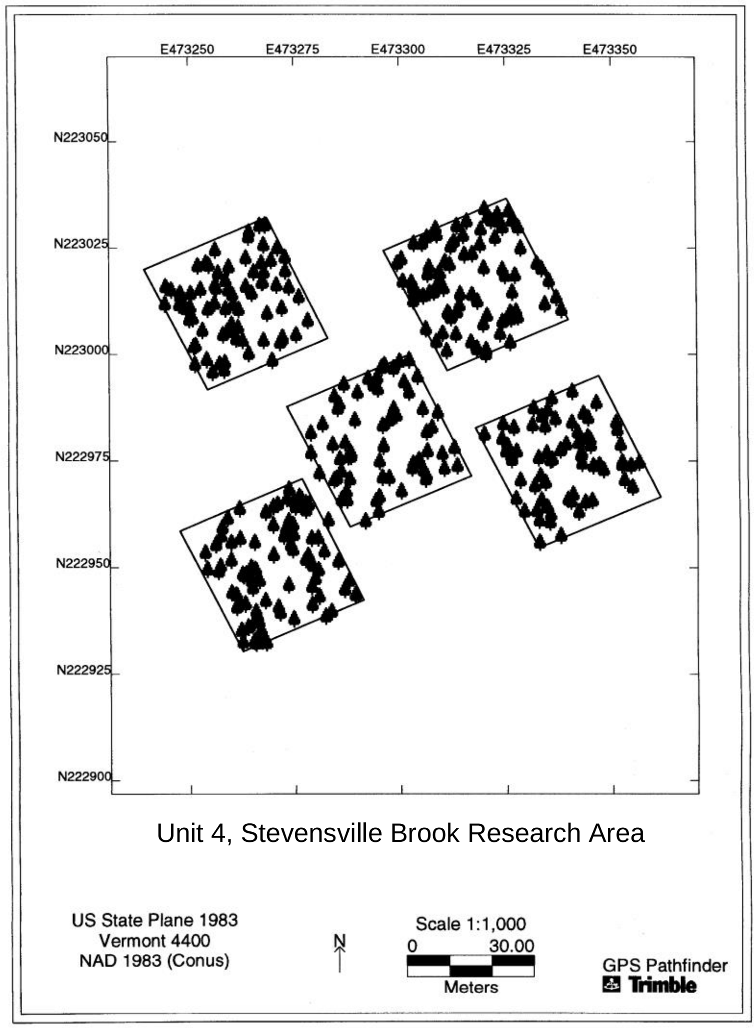

Figure 4. Surveyed tree positions in the five 0.1 ha. sampling plots located within one of the structural complexity enhancement units on the Stevensville Brook Research Area, Mount Mansfield State Forest, Vermont. Positions shown are for all trees > 5 cm diameter at 1.37 m ht. Tree positions have horizontal precisions ranging between 0.1 and 0.5 m with an average precision of 0.3 m.

Vegetation data analysis will consist of two primary components: (i) analyses of observed stand development responses to experimental treatments and (ii) successional modeling using tree position data.

The first analysis component will include multivariate analysis, time series analysis, and analysis of variance to evaluate treatment responses. Response variables will include all aspects of stand structure and composition interpretable from sample data, including overstory and understory composition, vertical and horizontal structure, wildlife habitat typing (Kruse and Porter 1994) inferred from habitat association models, and total above-ground carbon sequestration. Covariation and relationships among response variables will be analyzed using ordination and other multivariate methods. Response trends will be assessed, using time series analysis and predictive modeling, relative to stand developmental trajectories (or pathways). A key factor of interest in all ecological analyses also will be differences between control and treatment units in rates of development for specific structural and compositional parameters.

The second analysis component, simulation modeling, will complement the near-term and long-term analyses of sample data. It will employ an ecological succession model called SORTIE (Pacala et al. 1996, 1993). SORTIE is a mechanistic, spatially explicit, stochastic model designed and calibrated for northern hardwood forests in the northeastern United States. The model uses empirically derived responses of individuals to simulate local competition among nine species of trees. The nine species modeled are dominant or subdominant species common to mid- and late-successional forests. SORTIE consists of two sub-units: (i) a routine that measures the local availability of light, and (ii) the life history responses for all nine species, including patterns of growth, reproduction, seed dispersal, and mortality as direct or indirect functions of light (Pacala et al. 1993; Ribbens et al. 1994; Pacala et al. 1996). Stem maps with associated species and tree size information are input and successional development simulated over 500 to 1,000 years. Simulations provide both an immediate prediction of successional responses to treatment and a benchmark for comparison with observed (i.e. measured) near-term and long-term responses. The stem maps (Figure 4) and associated attribute data used to run the SORTIE model also will be used for calculations of the structural complexity index developed by Zenner (2000, 1998).

Economic Data Collection and Analysis

Accounting methods will be used to tract all expenses involved with prescription planning and implementation as well as revenue generated by the sale of any timber removed from treatment units. Both quantitative and qualitative data will be collected on harvesting operations, such as equipment and labor requirements, worker safety precautions, and special safeguards taken to avoid tree bole damage, protect streams and seeps, and minimize soil compaction. Economic analyses will compare revenue generation versus operational costs. The analysis methodology will follow Niese and Strong (1992), Berg (1995), and Niese et al. (1995) in evaluating the profit margin associated with varying treatment intensities and calculating the net present value of future timber harvests associated with hypothetical subsequent treatments (e.g. thinning).

Timetable and Project duration

Phase 1 of the study began in summer 2001 and is expected to last seven years. It consists of two years of pre-treatment and five years of post-treatment sampling and simulation modeling.

The VMC will implement the experimental manipulations in winter of 2002-2003. Following this initial period of annual re-measurements the study will enter Phase 2, which will consist of long-term monitoring with periodic (e.g. every 3 to 5 years) plot re-measurements. Phase 2 will continue indefinitely contingent upon funding.

CONCLUSION

The FEMDP will test the stand-level ecological consequences of silvicultural options for the northern hardwood region. It will help forest managers better understand the effects of commercial forestry practices across a range of taxa and ecosystem processes. In addition, the FEMDP will provide a demonstration of a new silvicultural approach designed to emulate natural stand development processes, including natural disturbance effects. This will help forest managers integrate multiple objectives at the stand level, including generation of timber revenue and restoration of under-represented habitat characteristics. The Stevensville Brook research site will be useful for educational purposes, such as class field trips and public visits, providing students and the general public with an opportunity to see an “on-the-ground” example of innovative, alternative forestry practices. In this respect, the project will help inform the public of the range of alternatives – the tools available in our tool bag – for implementing sustainable forest ecosystem management in Vermont. Finally, the project will provide exceedingly timely information to public and private forest managers currently in search of methods for structural complexity enhancement. It will serve a similar function for non-profit organizations, community and watershed organizations, and private timber companies engaged structural complexity enhancement and sustainable forest ecosystem management on private lands. Ultimately, the results of this project will help private and public forest managers evaluate the benefits, tradeoffs, and feasibility of alternate silvicultural systems, including both traditional approaches and structural complexity enhancement.

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COLLABORATION

School of Natural Resource, University of Vermont: Associated personnel have responsibility for project design and management, data collection, analysis, and publication of research findings related to vegetation and avian wildlife. Dr. William S. Keeton, Assistant Professor of Sustainable Forest Ecosystem Management, is the project director for the FEMDP. In this capacity he will coordinate collaboration with participating researchers.

Entomology Research Laboratory, University of Vermont: Donald R. Tobi and Dr. Margaret Skinner, University of Vermont Entomology Research Laboratory, are responsible for soil invertebrate and soil nutrient analysis related to this study.

Vermont Monitoring Cooperative (VMC): The VMC is a cooperative program of the University of Vermont, the Vermont Agency of Natural Resources, and the U.S. Forest Service. The VMC provides oversight and limited funding support for the Vermont Forest Ecosystem Management Demonstration Project (FEMDP).

Department of Forests, Parks, and Recreation, Vermont Agency of Natural Resources: The Vermont Department of Forests, Parks, and Recreation, Forestry Division is providing the study site for this project, which is the Stevensville Brook Research Area on the Mount Mansfield State Forest .