Purpose and Need/Proposed Actions
Fernow Experimental Forest

Introduction

This document describes research projects proposed for the Fernow Experimental Forest over the next several years. This action is consistent with the Land and Resource Management Plan, Monongahela National Forest, Management Prescription 8, page 202, Vegetation.

Projects proposed here also are consistent with the General Plan for the Fernow Experimental Forest, the Research Work Unit Description, and individual Study Plans. The Research Work Unit Description (RWUD), the guiding document for Research Work Unit (RWU) activities, was prepared after consultation with a wide range of customers and is updated approximately every 5 years. Study plans have been reviewed for experimental and statistical rigor by scientists within and outside of the RWU, and for appropriateness and compliance with Station direction by Station personnel.

The 4700-acre Fernow Experimental Forest is located south of Parsons, West Virginia, and is administered by the staff of RWU- NE-4353, Sustaining the Diversity and Productivity of Appalachian Forests, located at the Timber and Watershed Laboratory in Parsons. The current mission of this research unit is to understand natural and human-induced influences on the sustainability of central Appalachian forest ecosystems, and to provide guidelines for managing these to maintain or improve the productivity and diversity of the soil, water, and forest resources. The research work unit description currently lists 3 major problems as follows:

> *Problem 1*. Ecologically sound silvicultural alternatives must be developed for intensive management of these forests to provide diverse forest products and to maintain or restore the integrity of ecosystem processes.
>
> *Problem 2*. Basic quantitative information is needed about important ecosystem processes and components and the impacts of both chronic stresses and acute disturbances on these.
>
> *Problem 3*. Tools must be developed which allow us to better assess and/or mitigate soil, water and other resource changes attributable to forest management and associated activities.

In addition, this RWU is responsible for managing the Fernow Experimental Forest for long-term ecological and silvicultural research.

Description of the Fernow Experimental Forest

The ecological land type of the Fernow Experimental Forest is referred to as the Allegheny Mountains Section of the Central Appalachian Broadleaf Forest (M221B) in the Forest Service National Hierarchical Framework of Ecological Units. The landtype association is designated as Allegheny Front Side slopes (Ba10) and vegetation is classified as mixed mesophytic. Characteristic species include but are not limited to northern red oak (*Quercus rubra*), yellow-poplar (*Liriodendron tulipifera*), black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), bitternut hickory (*Carya cordiformis*), sweet birch (*Betula lenta*), red maple (*A. rubrum*), and American beech (*Fagus grandifolia*). The topography is mountainous with elevations ranging from 1750 to 3650 ft above sea level. Mean annual precipitation is about 58 inches and distributed evenly throughout the year. The growing season is May through October with an average total frost-free period of 145 days.

Slopes ranging from 20 to 50 percent cover most of the area. The soils are predominantly from the Belmont and Calvin soil series. Belmont soils are moderately deep to deep, well-drained soils of medium texture, and medium acidity. The Belmont soils are derived from shale, sandstone, and interbedded limestone. The Calvin series develops both above and usually below the Belmont series and also is well-drained and moderately permeable. However, Calvin soils are more strongly acid than Belmont soils due to the absence of limestone parent material.

The Elklick watershed (which later became the Fernow) was initially logged between 1903 and 1911 during the railroad-logging era. However, many trees were not cut due to insufficient size, undesirable species, or poor form. Sugar maple, American beech, birch, and hickory at that time were considered some of the least desirable species. Additionally, merchantability standards were a function of the distance to the standard gauge railroad. Thus, portions of the Fernow were cut more heavily than others. Forest fire may have been an important disturbance agent prior to initial logging and perhaps after logging, although actual documentation of past fires does not exist for the Elklick watershed. Most of the watershed was not farmed and the forest was able to grow following the cessation of logging activities. The Federal government purchased the land in 1915 and dedicated it to forest and watershed research in 1933. The area was selected for the Fernow Experimental Forest because its topography, silviculture and fire history, and variety of forest types and conditions were representative of over 13 million acres of mountainous forestland in West Virginia and adjacent states. Since that time, fire and grazing have been excluded. Chestnut blight was the next major disturbance. First noted in West Virginia as early as 1909, the blight resulted in a 25 percent reduction in standing volume on the experimental forest in the 1930's. Closed during World War II, silviculture and watershed research began again in 1948 and has continued to date without interruption. ***The charter of the Fernow Experimental Forest is to facilitate scientific research into the ecology of central Appalachian forests in order to improve the management of these forests.***

Purpose and Need for the Proposed Action

The purpose of the proposed actions is to ***continue long-term research*** on the effects of various silvicultural practices on forest productivity, species composition and diversity, wildlife populations and ecosystem processes, and ***to initiate new research.*** We are also proposing ***management and maintenance activities intended to ensure the integrity of the Fernow for long-term research*** – these activities include control of invasive exotic plants using herbicides, culvert and road maintenance, among others. The goal of all of the proposed research actions is to improve understanding and management of central Appalachian hardwood forests. The studies are summarized below.

Large area comparisons of forest management practices (Study No. 4110-FS-NE-4101-2) was initiated in 1950. The objective of this study is to determine the effects of three uneven-aged silvicultural practices (single-tree selection, diameter-limit, patch clearcuts) on yield and stand growth in board feet, cubic feet, and basal area, replicated two times on three oak site index classes, Another objective is to determine the effects of the different silvicultural practices on species composition and log quality across site quality classes. This research is critical to understanding the effects of current harvesting practices, particularly those used on private land, on long-term sustainability and diversity of central Appalachian hardwood forests, and for developing management guidelines and recommendations for these forests.

Comparison of four cutting practice levels in Appalachian hardwood forest types. (Study No 4110-FS-NE-4101-8). The original objective of this study was to compare "good", "fair', and "poor" cutting practices as they were perceived to be in the late 1940s. The study involved observing the long-term impact of 4 management alternatives (single-tree selection, intensive single-tree selection, diameter limit harvesting, and commercial clearcutting) on wood volume production, stand quality and regeneration. More recently, the objectives have been broadened to include quantifying long-term stand dynamics, particularly species composition, and evaluating aesthetics. This study was set up with the four cutting treatments and a control on 5 5-acre compartments along the Zero-grade Trail to provide added demonstration value. These are among the oldest forestry research plots in North American and receive many visitors during the course of a year.

Financial rate of return areas on the Fernow Experimental Forest (Study No. 4110-FS-NE-1103-62) was initiated in 1971. The objective of this study is to determine the effects of financial rate of return harvests on growth and yield of hardwood stands, species composition and hardwood stand quality. The financial rate of return method is a selection system that incorporates economic guidelines for selecting trees to harvest. Two study areas are being utilized for each of the following estimated rates of return: 2, 3, 4 and 6%, as a test of the utility and accuracy of these criteria for selection, and to evaluate the effects on stand characteristics over time.

Evaluating prescribed fire as a silvicultural tool to promote oak regeneration in the central Appalachians (4300-FS-NE-4353-12). The principle objective of this research is to determine the effectiveness of using prescribed fire and fencing in conjunction with a shelterwood regeneration method to regenerate oak. Secondary objectives include evaluating treatment effects on coarse woody debris, forest floor and litter characteristics, seedbank composition and abundance, spring ephemeral wildflowers, herpetofauna, and acorn predation by weevils. The study is intended to develop a silvicultural technique related to the use of prescribed fire, but also will examine changes in ecosystem properties than can be considered at the stand or subwatershed scale.

Artificial acidification of several small watersheds at or near the Fernow Experimental Forest (4300-FS-NE-4301-59), and The effect of artificial watershed acidification on vegetation growth and nutrient status. (4300-FS-NE-4301-63).The principle objective of this research is to determine changes in soil chemistry, soil leachate chemistry, and streamflow chemistry resulting from increased levels of nitrogen and sulfur deposition, and to evaluate the effects of these changes on vegetation growth and ecosystem nutrient status. Ammonium sulfate fertilizer will be applied to one 85-acre watershed and the effects on ecosystem parameters will be determined. The study results will quantify the susceptibility of watersheds in the Central Appalachians to acidification by acid deposition. Also, the data will be useful for testing watershed acidification models. This whole system manipulation approach will quantify the integrated response of a watershed to sulfate and nitrogen loadings.

Proposed new research: "Prescribed burning and variable intensity overstory mortality for enhanced wildlife habitat structure and long-term oak restoration" (Study number yet to be assigned). The object of this research is to address, in the short-term, the need for Indiana bat summer habitat, and in the longer term, to create a mosaic of sites where oak regeneration is an eventual surety. Through a series of prescribed burning and periodic overstory mortality treatments (herbicides and/or girdling), we will be assessing in the short term, improvements in bat roosting and forage habitat. Over the longer period, overstory mortality treatments will focus on non-oaks such that over time all remaining live overstory trees will be oak; and only oak seedlings/saplings (or other fire tolerant species) will be present for future accession into the overstory. Unlike previous oak-fire-light studies, this will not have timber management as an immediate management goal. Such information would be useful for those managers that wish to manage specifically for bats and other important wildlife species, and restore high-graded stands over longer time periods. This study would take place on 6 compartments (6 replicates): located along John B. Hollow (4 compartments totaling 330 acres), and compartments 13 and 21 (from the Farm Woodlot study, Study No. 1, total of 62 acres). A study plan would be prepared and peer-reviewed prior to any treatments being implemented.

Management activities include such activities as: applying gravel to road surfaces as needed, replacing culverts on skid roads and haul roads as needed, maintaining water bars on skid roads, maintaining ditches and culverts, seeding decks and landings, using herbicides to control the spread of Japanese stiltgrass (*Microstegium vimineum*) on approximately 20 acres, and tree-of-heaven (*Ailanthus altissima*) on an individual tree basis, as needed. One new landing will be created, and one will be abandoned.

What Do We Want to Achieve

Most of the proposed actions are ongoing research studies, and some of these are experiments that were designed to last 80 years or more. These data represent some of the most complete, continuous long-term records on ecosystem processes in the world. ***We want to continue these experiments as designed, and continue to glean information about the effects of various silvicultural practices on forest ecosystems in the central Appalachians***. ***We also propose to start a new research study evaluating our ability to create suitable habitat for Indiana bat.*** We will use these data to provide information on basic ecosystem processes in nonmanaged and managed forests, on species diversity of plants and animals, and on other ecological parameters. ***We also want to maintain the Fernow Experimental Forest for long-term research.***

Proposed Actions

Proposed actions are shown in Table 1. Most of the proposed actions involve application of a silvicultural treatment to compartments (See map in the Appendix for locations) as part of an ongoing research study. Treatments involve cutting individual trees, according to the silvicultural prescription, and removal from the stand. Ground-based and cable logging systems will be used to remove the trees. Existing skid trails and roads will be utilized. No new roads will be constructed for the on-going studies. After completion of treatment, skid roads and decks will be closed, and seeded to prevent erosion. Best Management Practices will be followed.

Table 1.

Compartment/ Subcompartment	Treatment	Study number	Date established	Acres to be treated
5B	Single-tree selection	4110-FS-NE-1103-2	1956	56.5
7A&B	Patch clearcut	4110-FS-NE-1103-2	1956	13.6
WS5A	Single-tree selection	4110-FS-NE-1103-2	1955	78.2
17A	Patch clearcut	4110-FS-NE-1103-2	1957	4.0
19A	Patch cut	4110-FS-NE-1103-2	1957	3.2
20A	Single-tree selection	4110-FS-NE-1103-2	1952	25.2
20B	4% Financial maturity – extensive selection	4110-FS-NE-4101-62	1952	25.3
20C	Diameter-limit cut (17.0”)	4110-FS-NE-1103-2	1952	27.7
R1	Shelterwood cut,prescribed fire	4300-FS-NE-4353-12	2000	74.0
8B	Diameter limit cut (15.6”)	4110-FS-NE-4101-8	1949	5.0
8C	Single-tree selection	4110-FS-NE-4101-8	1949	5.0
8D	Single-tree selection			

Compartment/ Subcompartment	Treatment	Study number	Date established	Acres to be treated
		4110-FS-NE-1103-8	1949	5.0
26A	6% Financial maturity cut	4110-FS-NE-4101-62	1951	32
26B	6% Financial maturity cut	4110-FS-NE-4101-62	1951	14
61	3% Financial maturity cut	4110-FS-NE-4101-62	1975	118.4
WS3	Fertilization with ammonium sulfate at twice ambient levels	4300-FS-NE-4301-59 and 4300-FS-NE-4301-63	1988	84.7
JBH1-4,13, 21	Overstory mortality, and prescribed burning	Study number to be assigned	2006	392

APPENDIX

Definitions

A ***compartment*** is an area of forest generally making up a specific experimental treatment area. This is the unit of land treated in the various experiments.

In the ***diameter-limit*** treatment, all trees having a specified diameter (in this case, 17.0 inches d.b.h. [diameter at breast height]) and larger are cut and removed from the stand on a recurring basis: every 20 years on SI 60 sites, and every 15 years on SI 70 or 80 sites (See definition of Site Index below). This type of harvest practice is commonly applied on non-industrial private forestlands in the Appalachians because it is easy to apply, and results in a significant immediate monetary gain.

Financial rate of return management is based on the silviculture-economic guidelines established by Trimble in 1974[1]. These economic guidelines are in the form of rates of return for individual trees. Application of these marking guides is limited to saw timber-size trees (stems above 11.0 inches d.b.h.). Trees are designated for cutting or for leaving with the intention of retaining a residual stand adequately stocked for attainment of specific objectives. Trees expected to exceed minimum acceptable rate of return because of rapid growth or quality improvement should be left to grow, while those expected to fall below the minimum acceptable rate are financially mature and should be harvested. Periods between cuts are based largely on growth rates.

The system of ***patch clearcutting*** was designed to replicate conditions needed for regeneration of shade intolerant tree species, without creating large clearcuts. Each patch clearcut is 150 feet in diameter (0.4 acre). All stems 1.0 inch d.b.h. and larger are felled. On lower site index sites (SI 60), patches are cut on a 15-year cycle, with an estimated rotation of 90 years. On sites with site index 70-80, patches are cut on a 10-year cutting cycle, with an estimated rotation of 80 years. The number of patches to be cut is based on rotation length, number of periodic cuts and study area size.

A ***rotation*** is the number of years required to regenerate a forest to a specific condition of maturity. The length of the rotation will vary with species, forest type and regeneration technique. In central Appalachian hardwoods, a typical rotation is 80 years.

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[1]Trimble, G.R., K. J. Mendel, R.A. Kennell. 1974. A procedure for selection marking in hardwoods combining silvicultural considerations with economic guidelines. Res. Pap. NE-292. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 13 p.

The ***shelterwood method*** of regeneration involves the gradual removal of the entire stand in a series of partial cuttings that extend over a fraction of the rotation (usually less than 20 years). Natural reproduction is secured under the shelter of a portion of the old stand, and released by removing the remainder of the stand (the older trees) when it becomes desirable for the new regeneration to have full use of the growing space.

Silviculture is the art and science of producing and tending a forest, and incorporates the application of the knowledge of silvics in the treatment of a forest. Silviculture is directed at the creation and maintenance of the kind of forest that will best fulfill the objectives of the owner.

Single-tree selection is designed to promote an all-aged forest stand. The practice is based on a concept that such a stand continually yields benefit and regenerates itself steadily. In practice, such stands are created by marking individual trees for harvesting that meet specific criteria, which include specifying the number of residual trees by diameter classes, and the largest diameter trees to retain in the stand. The relationship between the number of trees and diameter classes is a reversed J-shaped curve and is expressed as a Q factor.

Site index (SI) is an indicator of site quality. It is defined as the total height of trees (usually Northern red oak in the Appalachians) that consistently have been in a dominant or codominant position in well-stocked stands at a specified age, usually 50 years. For example, SI 70 indicates that dominant trees will average 70 feet in height at 50 years of age. In the central Appalachians, SI 80, 70 and 60 indicate excellent, good and fair site quality, respectively.