Using Silviculture to Increase Forest Health: A National Forest/Research/State and Private Demonstration Area

Kurt W. Gottschalk and W. Russ MacFarlane

Abstract

A cooperative area was established on the Glenwood Ranger District, Jefferson National Forest, to demonstrate the effectiveness of silvicultural treatments in minimizing gypsy effects to the public and forest resource professionals and provide additional research data on the effectiveness of the treatments versus direct insect treatments. The silvicultural treatments have been installed and the demonstration area is now available for tours.

Introduction

In 1989-90, several meetings of personnel with the Jefferson National Forest, Appalachian Integrated Pest Management Demonstration Project (AIPM), and Northeastern Forest Experiment Station resulted in an agreement (memorandum of understanding) that the three Forest Service groups would cooperate in establishing a gypsy moth (*Lymantria dispar* L.) silvicultural research and demonstration area on the Jefferson. The initial term of the agreement, 3 years, covered the installation of the demonstration area and expired in 1992. A new lo-year agreement in 1993 continued the demonstration project until gypsy moth reached the area and treatment effects could be evaluated. The expiration of the AIPM resulted in its replacement in the new agreement with the new National Center for Forest Health Management. Background on the use of silvicultural treatments to increase forest health for gypsy moth, history and design of the demonstration project, and case studies of some project treatments are discussed.

Silvicultural Guidelines

Silvicultural guidelines have been developed that provide stand treatments to minimize gypsy effects on forests (Gottschalk 1993, Gottschalk and MacFarlane 1993). Two mechanisms are used to minimize effects: (1) alteration of stand susceptibility to defoliation (probability of defoliation given that the insect is present), and (2) alteration of stand vulnerability (probability of mortality or other damage to forest, resources given that defoliation has occurred). These treatments are designed to increase the "health" of the forest so that disruption is minimal following defoliation of the forest, stand by gypsy moth. A variety of silvicultural treatments is prescribed based on stand conditions and insect populations.

The guidelines have three phases: pre-outbreak, outbreak, and postoutbreak. Pre-outbreak treatments concentrate on increasing the health of stands by thinning or regeneration cutting. Outbreak prescriptions include regeneration treatments and prioritization of stands for protection against, defoliation when necessary to protect values for management objectives. Postoutbreak treatments concentrate on salvaging dead trees and increasing the health of stands through thinning and regeneration cutting. The demonstration area is installed ahead of the gypsy moth defoliation area; pre-outbreak treatments are used rather than outbreak or postoutbreak prescriptions. The following are major treatments on the demonstration area.

Pre-salvage thinnings are conducted in areas with more than 50 percent oak (*Quercus* spp.). Their primary purpose is to reduce the vulnerability of a stand by removing the fair- and poor-crowned oaks and other preferred food species of gypsy moth. Trees with poorer crowns are more likely to die following defoliation, so their removal should reduce total stand mortality and increase the health and vigor of the remaining trees (Gottschalk and MacFarlane 1993, Herrick and Gansner 1987).

Sanitation thinnings are conducted in stands with less than 50 percent oak. These thinnings target the removal of most preferred food species, thus reducing the susceptibility of a stand. Reduction of preferred food species of gypsy moth to about 20 percent of the stand basal area will lower stand susceptibility to a point where little defoliation will occur (Herrick and Gansner 1986).

Project Leader, USDA Forest Service, Northeastern Forest Experiment Station, Morgantown, WV, and Silviculturist. USDA Forest Service, Glenwood Ranger District, Jefferson National Forest, Natural Bridge. VA (respectively).

The primary objective of pre-salvage harvest cutting is to harvest the stand before defoliation, to use the adequate advanced regeneration present, and to preserve stump sprouting to regenerate a new stand. The new stand may be similar in composition to the previous stand or may differ if the advanced regeneration is different and satisfies management objectives. These stands are within 5 years of maturity or they have an unacceptable density of acceptable growing stock.

Pre-salvage shelterwoods do not have adequate advanced regeneration and stump sprouting potential stockings. Their primary objective is to develop adequate regeneration by shelterwood cutting. Selection of trees to be left in the residual stand should be based on seed productivity, species desired, crown condition, and spacing. The species composition of the residual stand can be shifted by the shelterwood cut if desired. When advanced regeneration stocking becomes adequate, usually in 5 to 7 years (though oaks may take longer), the residual trees can be removed.

The primary objective of sanitation conversions is to reduce susceptibility and/or vulnerability by converting to nonpreferred species before the stand can be infested by gypsy moth. Because of high susceptibility or vulnerability, these stands will have frequent, high defoliation levels or high mortality levels. Low-quality sites could be converted naturally to pines such as white, Virginia, and pitch, or artificially to pitch-loblolly hybrids and other conifers. High-quality sites could be converted naturally to mixed hardwoods, white pine, hemlock, or northern hardwoods. Clearcut harvests or shelterwood cutting can be used to obtain adequate advanced regeneration with either natural conversion strategy, while artificial conversion may incur substantial costs. Conversion of mixed-oak stands to other species may be economically undesirable because oaks often are the most valuable species that grow on these sites. However, conversion may be more economically desirable eventually because of fewer impacts on the stands from the gypsy moth and lower or no costs for stand protection.

Demonstration Area

The primary objective of the Silvicultural Demonstration Project (SDP) is to demonstrate the effectiveness of the pre-outbreak phase (Gottschalk 1993) in reducing stand susceptibility and vulnerability before gypsy moth infestation in Appalachian hardwood forests. The area will be used to educate the public and forest resource professionals about gypsy moth effects and the use of silviculture to maintain forest health. The secondary objective is to compare the effectiveness of silvicultural and direct high- and low-level gypsy moth treatments (i.e., pesticide applications). Given these objectives, this project contains demonstration. education, and research aspects.

The Arnold Valley Silvicultural Demonstration Project, a cooperative effort, was begun in 1990. The AIPM project within the Northeastern Area, State and Private Forestry provided funding for the first 3 years. The Southern Region (Region 8) of the National Forest System provided the facilities, land, and support staff needed to implement the project. The Northeastern Forest Experiment Station provided technical guidance and advice for implementing the guidelines and design of the research portion of the demonstration as well as partial funding to continue data collection. The Northeastern Station will analyze the data as they are collected. Most recently, Region 8 Forest Health provided funding to complete the implementation of the project, and to continue the data collection and monitoring. The National Center for Forest Health Management has taken over the AIPM role in the application and evaluation of high- and low-level gypsy moth treatments.

The project is located on the Glenwood Ranger District of the Jefferson National Forest in southwestern Virginia. The Glenwood District comprises 76,000 acres on the Blue Ridge just south of the dames River gorge and north of the city of Roanoke, VA. Arnold Valley, opportunity area selected as the specific site for the project on the Glenwood, is a 26,000-acre area with emphasis on multiple use. Approximately 11,000 acres of wilderness, a popular, developed campground and lake, and about 9,500 acres of land suitable for timber production are within Arnold Valley. More important to this discussion, the area is characterized by high-quality timber and good sawtimber and pulpwood markets. Forests are

dominated by mature oak/hickory and oak/poplar stands. Site indices of suitable land range from 65 to 80 feet, for red oak. Ages of the stands range from 60 to 120 years.

Methods

The design of the demonstration area has two complete series of treatments: (1) one in moderately susceptible stands with less than 50 percent basal area in oak, and (2) one in highly susceptible stands with more than 50 percent basal area in oak (table 1). There were at least, three replications of each treatment, in each series to meet research objectives. Selection of the specific stands to be included in the project was made after the available stand inventory database was screened and approximately 2,000 acres were sampled. Upon completion of the project, 46 stands (counting each group selection as a "stand") occupying approximately 434 acres will have received a silvicultural treatment. An additional 19 stands occupying 491 acres are assigned to research control or insecticide treatments. Thus, 65 stands and approxirnately 925 acres are included in the SDP (table 1).

The thinning treatments in areas containing more than 50 percent oak are pre-salvage thinnings. Sanitation thinnings are located in the moderately susceptible stands. Shelterwoods are intended to regenerate stands that lack advanced reproduction in the understory. The same principles of pre-salvage and sanitation described for thinnings can be used for shelterwoods. However, one must recognize that the regeneration of the stand is the primary goal of a shelterwood treatment. This may require consideration of seed productivity of individual trees when deciding which trees should be removed. Clearcut harvests regenerate stands that contain adequate numbers of advanced reproduction reducing both the susceptibility and vulnerability of a stand for 20 to 40 years. Group selections are used to create uneven-aged stands that regenerate intolerant and midtolerant species. High-level gypsy moth treatments to be applied when populations exceed thresholds will be application of Bacillus thuringensis (Bt) or Dimilin; low-level treatments will include the application of pheromone flakes to disrupt mating. A series of untreated controls will be used to show the effects of gypsy moth on these same types of stands.

Prescribing and documenting these treatments was the primary activity during the first several years of the SDP. As mentioned previously, stand selection began with screening the available data on stand inventory. The search was limited to stands in oak forest types on land suitable for timber production in areas that were accessible. The District Silviculturist and Timber Management

Table l----Treatment design and allocation of stands and acreages for the Arnold Valley Silvicultural Demonstration Project

	Moderately susceptible stands (<50 percent oak)			Highly susceptible stands (>50 percent oak)		
Treatment	Number of stands	Number of acres	Size range (acres)	Number of stands	Number of acres	Size range (acres)
Thinnings	3	35	10-15	5	109	15-35
Clearcuts	3	63	li-25	3	37	10-15
Shelterwoods	5	111	10-40	3	49	10-20
Groups	12	15	0.5-2	12	15	0.5-2
Control	4	121	12-45	3	36	10-16
Pheromone	3	51	15-18	3	51	12-24
Insecticide	3	157	39-52	3	75	10-40
Total	33	553		32	372	

Assistant were heavily involved throughout the selection process. Once a randidate stand was identified, the forester responsible for implementing the project performed a cursory stand examination. If the stand appeared to have good potential for inclusion in the project. it was formally sampled. A basal-area factor 10 prism cruise was performed in each stand according to protocols established for the Silviculture of Allegheny Hardwood Expert, System (SILVAH) (Marquis and others 1992). SILVAH takes raw data from a point,-sample or prism cruise. analyzes and summarizes the data in many forms, and assigns tentative silvicultural prescriptions. SILVAH has been programmed with gypsy moth hazard-rating functions and can compute both susceptibility and vulnerability estimates for a stand. Using the SILVAH summary, each stand was assigned a prescription based on the decision chart for the pre-outbreak phase presented in Gottschalk (1993).

Once the decision was made to include a specific stand in the project. permanent monitoring points were installed in the stand. These are perrnanent 0. l-acre circular overstory plots with three 0.385-acre regeneration subplots. A variety of vegetation data was taken on these plots before the treatments were installed. The stands to be treated silviculturally were then incorporated into the normal timber sale program on the Glenwood. National Environmental Policy Act requirements were documented in an Environmental Assessment. Stands were laid out. marked, and appraised by District staff. The forester responsible for irnplementing the project supervised the marking crews to ensure proper marking of the stands based on the prescription. Approximately 25,000 board feet of sawtimber and pulpwood were produced from seven sales over a ‘L-year period.

After cutting, both point-sample cruises and remeasurements of the permanent monitoring points were done. The permanent plots were monumented and trees within them painted to facilitate future remeasurements. In the future, annual vegetation measurements such as crown condition and defoliation will be made. In addition. gypsy moth populations are monitored in the stands using pheromone traps and egg-mass surveys. A good record of defoliation in each stand is vital to draw correct conclusions. After defoliation has occurred, gypsy rnoth populations have collapsed, and sufficient time for mortality to accrue has passed. a final remeasurement of all the permanent plots will be made. Then the data will be analyzed and conclusions and recommendations will be made

Case Studies

While results will not be available until gypsy rnoth populations have run their course through the area, we can make predictions about, the efficacy of the silvicultural treatments based on the SILVAH estimates of stand susceptibility and vulnerability from point-sample cruises. Case studies using this data are presented for some treatment, stands within the SDP.

Stand 16

Stand 16, a 27-acre upland oak stand. has a site index of 75 feet (red oak). is approximately 65 years old, and contained 120 square feet, of basal area. This stand was dominated by chestnut. oak, yellow-poplar. and red maple. A component of red and black oak also was present, and the total oak component accounted for 67 percent of the stand. This percentage of oak results in a high susceptibility. Much of the red and black oak was declining in vigor: this was evident by the fair and poor crown conditions throughout the stand. A predicted 15.8 percent of the stand would die because of defoliation stress. A thinning treatment also was prescribed for this stand because of its youth and density. However, because of the-large oak component and declining vigor, a pre-salvage thinning was prescribed. This thinning concentrates on removing the poor and fair crowned trees (those rnost likely to die because of defoliation stress). After all poor/fair crowns have been removed. the rest of the stand is thinned from below to meet spacing and stocking targets.

Stand 16 now contains 72 square feet, of basal area and is dominated by yellow-poplar. chestnut oak, and hickory. The percentage of oak was lowered to 42 percent. More important, because of the removal of poor/fair crowned red and black oaks, it is now estimated that 11.3 percent of the stand would die because of defoliation stress. The pre-salvage thinning significantly lowered the vulnerability of the residual stand and “captured mortality” of trees that would most likely die once defoliated.

Stand 13

Stand 13 is IO acres and occupies a cove site. This stand has a site index of 75 feet, [red oak), is 80 years old, and contained **121** square feet of basal area. It was dominated by yellow-poplar, chestnut oak, and hickory. Only 30 percent of the basal area in this stand was oak. resulting in moderate susceptibility. Stand vigor as indicated by crown condition was good throughout the stand. An estimated 10.9 percent. of the stand was predicted to die because of defoliation stress. Advanced regeneration was lacking. though the amount of yellow-poplar in the stand all but guaranteed sufficient regeneration potential in seed stored in the litter layer. Given the species composition. high stocking, and good vigor of this stand, a sanitation thinning was prescribed. This thinning concentrates on reducing the basal area of oak in a stand to 20 percent or lower. At these lower percentages of oak, research has indicated that gypsy moths do not severely infest a stand. Although thinning in a stand of this age would be recommended by few silviculturists, it was felt that this stand could be carried for at least another 20 years.

Stand 13 now contains approximately 75 square feet of basal area and still is dominated by yellow-poplar and chestnut. oak. Black birch has replaced hickory as the third most, dominate species. Hickory, being moderately to highly preferred by gypsy moth also was targeted for reduction in this treatment. Because of thinning, this stand contains only 16 percent oak, making it significantly less susceptible to severe defoliation. Further. only vigorous, good-crowned oaks were left, lowering predicted mortality in the stand to 9.6 percent.

Stand 20

Stand 20, a 15-acre upland oak stand, has a site index of 65 feet (red oak), is 90 years old, and contained 107 square feet of basal area. The stand was dominated by chestnut oak, black oak, and white oak; oak comprised 74 percent of the basal area resulting in a high susceptibility. Further, the black oak and scarlet oak (a lesser component) had reached pathologic maturity for this site. This was evident by the many fair and poor crowns, indicating low vigor and a high mortality risk of the stand. An estimated 15.5 percent of the stand was predicted to die because of defoliation stress. The amount of advanced regeneration combined with the expected sprouting potential for the stand was sufficient to ensure adequate stocking of a future stand. Given the maturity of the stand and presence of regeneration, a pre-salvage harvest, by clearcutting was prescribed.

Removal of the entire overstory except where protection of other resources was necessary has greatly reduced both the susceptibility and vulnerability of this newly regenerated stand. It now contains a much greater diversity of both woody and herbaceous plants. In terms of biomass, the percentage of preferred food species of the gypsy moth has been greatly reduced. This should make the stand much less attractive to invading gypsy moth. The regenerated stand also is in a much more vigorous state of growth. Young saplings and sprouts can withstand defoliation stress much better than the aging stems present on the site before treatment. Therefore, predicted mortality because of defoliation in this stand also is greatly reduced. How long these effects will last is subject to debate, though most scientists agree that effects should last 20 to 40 years.

Summary

The SDP has been installed successfully on the Glenwood Ranger District, of the Jefferson National Forest. Defoliating gypsy moth populations are 25 to 30 miles north of the area and should reach the demonstration area in 2 to 3 years. As gypsy moth defoliates the stands and the high- and low-level treatments are applied for population control, we can collect, the data necessary to evaluate the various treatments. Treatment influences on forest health and the response of the forest to gypsy moth will be the final determinants of success. The demonstration aspects of the project are available for use by foresters, other professionals, and the public. Tours can be scheduled by contacting either of the authors of this paper.

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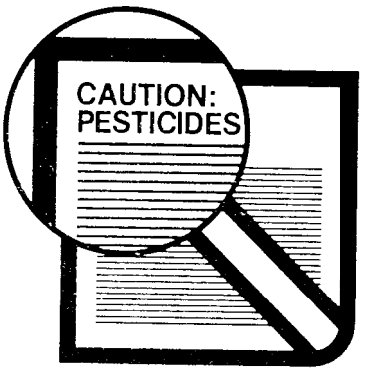

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