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Eastern Hemlock and the Hemlock Woolly Adelgid in Connecticut: A Challenge to Forest Managers

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Eastern hemlock (Tsuga canadensis) is an important tree species in Connecticut - as a functional component of the forest, as a source of wood and fiber, and as a valued part of the forested landscape. According to the 1985 US Forest statistics, better than 8% of the growing stock volume on the state's timberlands is hemlock (Dickson and McAfee 1988).

Hemlock is threatened in Connecticut's forest, due to the invasion of an exotic insect pest, the hemlock woolly adelgid (Adelges tsugae). This small, aphid-like insect, which feeds by sucking the sap of young twigs, was first noticed in Connecticut in 1985 (McClure 1987). The hemlock woolly adelgid kills the trees upon which it lives, usually within 4-5 years after infestation. Although initially the insect was found only near to the coast of central and western Connecticut, it has steadily spread up the river valleys and out across the state. It is predicted that eventually every town in the state will have the adelgid present in it.

Challenges to forest managers

The spread of the woolly adelgid presents challenges to the forest managers of Connecticut. Examples of how the adelgid may affect forest harvesting can be seen in two recent operations in the lower Connecticut River Valley. Each operation occurred during the late fall of 1993 through the spring of 1994, under the supervision of the Madison, Ct. forest consultant team of Ferrucci and Walicki. Each had been infested by the adelgid for about the last 4-6 years.

The first site is located in Haddam, Ct. The owner is a private landowner, whose primary interests are aesthetics and recreation. Most of the harvesting of hemlock has occurred on a 26 acre parcel. Prior to the infestation, 90% of the volume of this parcel was in hemlock, and the rest in mixed hardwoods. Trees were large, with many of over 30 inches dbh. The pre-harvest volume averaged between 12,000-15,000 board feet per acre.

The foresters and landowner jointly made the decision to remove as many of the hemlocks as feasible in one operation. The choice of a buyer for the sale was guided partly by concerns about the appearance of the site following harvest. A harvest of this degree would be expected to present problems due to slash accumulation, rough logs, small trees and snags. The operator chosen has demonstrated a history of making thorough use of the wood fiber present. On this site he removed both pulpwood and sawlogs. The sale of the latter in Connecticut is somewhat unusual, as pulpwood harvests tend not to be profitable. The main buyer of these pulp logs is in upstate New York; the main buyers of the sawlogs are Canadian. Some 360,000 bd. ft. of hemlock was removed from the 26 acres, with 10-15% of that being pulpwood.

The second site is in Middletown, and is owned by a public utility. Before harvest, it was comparable to the first site in terms of acreage and degree of infestation by adelgid, although the ratio of hemlock to hardwoods and size of the hemlocks were somewhat less. The owner of this property had previously entered into an agreement with the state of Connecticut's Wildlife Division, which permitted hunting on the property under state supervision.

The state wildlife biologists became interested in this site, due in part to their concern that stands dominated by hemlock and infested by the adelgid will convert to hardwoods. According to the 1985 Forest Statistics (Dickson and McAfee 1988), forest types in which conifers dominate make up less than 14% of the timberland in the state. Hemlock is a

major contributor to those forest types. These biologists are concerned that the loss of hemlock will have a deleterious impact on wildlife, including such known hemlock users as songbirds, owls, white-tailed deer (Odocoileus virginianus), red squirrel (Tamiasciurus hudsonicus), turkey (Meleagris gallopavo), and ruffed grouse (Bonasa umbellus).

Peter Picone of the state Wildlife Division has designed an experiment on this second site that involves leaving various degrees of the existing overstory, and planting conifers seeds and seedlings. The seedlings planted are Norway spruce (Picea abies), red spruce (P. rubens), and eastern white pine (Pinus strobus); the seeds are of the same species, plus western hemlock (Tsuga occidentalis). The survivorship of these planted conifers will be monitored, as will their use by various kinds of wildlife.

Analysis of pollen records in central Massachusetts performed at the Harvard Forest lends justification to the expectation that hardwoods will replace hemlock in many of the current hemlock stands (Foster and Zebryk 1993). In recent centuries, American chestnut (Castanea dentata) has responded most aggressively to hemlock disturbance; a pattern that is highly unlikely today. On these two sites, observations during the summer of 1994 suggest that the excellent acorn crop of the previous fall may help the various oak species (Quercus spp.) gain early control of these sites.

Challenges to hemlock buyers

The bulk of the sawlogs off of the first site were shipped to Canada, for processing into dimension lumber, while the all of the hemlock off of the second site was shipped to Rhode Island, for conversion into industrial and construction lumber. Movement of raw hemlock materials out of the forest does raise some concerns. One of McClure's findings is that the movement of eggs and first instar crawlers can lead to dispersion of the adelgid (McClure 1990). It is possible that the transport of forest materials could accelerate the spread of the insect.

Since 1988, the northern New England states of Vermont, New Hampshire and Maine have sought to limit the spread of the hemlock woolly adelgid across their borders by imposing quarantines on the shipment of hemlock from states with active adelgid populations. Interestingly, these quarantines do not restrict the movement of loaded log trucks passing through these states to Canadian hemlock markets, providing the trucks do not stop en route.

More recently, the Connecticut State Entomologist has been working on Memoranda of Understanding with his counterparts in the northern New England states. These MOU's seek to take into account the biology of the insect and legitimate efforts at its control in a way that balances forest health concerns and economic considerations. The State Entomologist proposes to issue phytosanitary certificates, permitting free movement of hemlock logs, if one of the following conditions are met: the logs are from an area of the state free of infestation; the logs are harvested and shipped between August 1 and February 28, when crawlers are unlikely to be present; logs are debarked prior to shipment; or the logs are properly treated with an approved pesticide prior to shipment.

The issuance of a certificate would be contingent on an inspection. The implementation of these MOU's is currently being negotiated.

The future

Most people hope that natural controls for the hemlock woolly adelgid will arise. The record cold of this past winter may have caused a reduction in the adelgid population in Connecticut - good news if true for the forests of northern New England. Dr. McClure has been investigating several potential biological controls, including an orabatid mite he collected during a field trip to the native range of the adelgid in Japan. The results appear to be positive.

Discussion points

Handling the effects of the hemlock woolly adelgid raises several questions for forest managers in the state. Among these questions are:

How should forest landowners deal with the effects of the adelgid, and with the widespread mortality associated with the insect? Is this a profound shock to the ecosystem that warrants an intensive response? Is this a unique opportunity that can allow unexpected income from salvage harvests to be used to increase and improve the level of forest management?

If the hemlock woolly adelgid is going to cause hemlock stands to convert to hardwood stands, are silvicultural efforts to counter that trend, by creating stands dominated by conifers, practical, and are they worthwhile? Are there benefits to wildlife?

Is the introduction of non-native coniferous species (eg, Norway spruce, red spruce, western hemlock) desirable? Does the introduction of a non-native pest warrant the search for a non-native answer? In the past, outlets for Connecticut softwood have been fairly limited. In fact, hemlock was often called a dog in the woods - hard to sell and hard to be rid of. Whether it is the increased availability of hemlock or events affecting sources of softwood supply worldwide, there is an increased interest in Connecticut hemlock. How should Connecticut forest landowners and foresters deal with this new-found interest in their wood? Can this be used to re-evaluate the practice of forestry in the state?

The shipment of hemlock logs raises the risk of accelerating the spread of the hemlock woolly adelgid. How great is this risk, and how effective are the efforts that seek to minimize it, including quarantines and the agreements covered in the individual Memoranda of Understanding?

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Public-Private Partnerships for Ecosystem Management of Longleaf Pine Forests: A Research Agenda

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Abstract

Longleaf pine forests once occupied vast areas of the southeastern coastal plain of the United States. Today, only small fractions of this once-extensive forest type remain. Recent mandates for ecosystem management present a unique series of opportunities and challenges for people interested in stewardship of longleaf pine forests. We know relatively little about how ecosystem processes have shaped longleaf pine throughout history. The scope of these challenges and opportunities is far greater than what can be accomplished by any single agency or non-governmental organization. Therefore, we designed a series of collaborative and cooperative research initiatives to address what we believe are key concepts that pertain to informed, ecosystem management and restoration of longleaf pine forests.

Introduction

The Problem

Longleaf pine (Pinus palustris) forest once covered nearly 70 million acres of the southeastern coastal plain of the United States. Today, less than 5 million acres of this important southern pine forest type remain. The vast majority of remnant longleaf stands are second-growth. Examples of old-growth longleaf pine stands are extremely rare; a total of about 2,000 acres of these ancient stands remain; most are scattered as small fragments throughout the landscape. Despite recent concerns expressed over the recent declines of temperate and tropical rain forests, a far greater of proportion (99.9+%) of original longleaf forest has been lost.

The widespread loss of original longleaf forest is especially problematic because we need examples of such ancient stands to understand how this forest originally functioned. Such information is crucial if principles of ecosystem management are to be applied in an informed manner. Certain aspects of longleaf pine forest ecology can, however, be pieced together from the early natural history and forestry literature, records from early settlers, and observations from remnant old-growth stands. For example, we know that longleaf pine forests are among the most fire dependent forest types in the world; naturally-recurring fire regimes regularly burned most original longleaf forests on a frequency of 2-7 years. The natural structure of longleaf stands resembles a classic, open canopy park-like forest maintained by fire. Scores of vertebrates and hundreds of plants have co-evolved with longleaf pine and the frequent fires that burned the understories of these forests through the millenia.

The widespread suppression of wildland fires in longleaf has seriously compromised the integrity and health of this system. For example, of the

remnant stands of longleaf suffer from midstory hardwood encroachment. Additionally, endemic vertebrates such as the red-cockaded woodpecker, gopher tortoise, indigo snake, and Bachmann's sparrow have suffered widespread declines as a function of fire supression and type conversion in longleaf pine.

The strategy

Given the scope of the problems described above, it is clear that no single organization or agency can conduct a comprehensive program of applied, land management research for longleaf pine. Such a program is, however, needed to produce the body of reliable knowledge required by people who want to apply ecosystem management concepts to longleaf pine. Clearly, cooperative research partnerships between and among public agencies and private organizations are necessary to meet contemporary longleaf pine research objectives at both local and landscape scales. To this end, we have undertaken a series of cooperative research partnerships to conduct research projects on key aspects of longleaf ecology. The purpose of this paper is to describe these projects. Perhaps they may serve as models for similar research partnerships for research on environmental issues and forest management elsewhere in the eastern United States.

The projects

Season-of-burn effects

Historically, the natural fire regime that shaped the ecology of the original longleaf stands most frequently occurred between April and September. Since the turn of the century, however, most applications of prescribed fire in longleaf have occurred during February and March. One of the truly unique features of longleaf pine forests is that fire can be applied to the landscape during virtually all months of the yea. Dormant-season fires, while easy to prescribe and manage, do not typically have sufficient intensity to kill the encroaching hardwoods that will eventually invade the longleaf midstory. During the past half-century, most forest managers have been reluctant to apply lightning-season fires in longleaf and other southern pine forests because of fears that such a burning regime will harm ground-nesting birds, and native legumes that provide key food resources for upland game birds.

Three of us (Brennan, Engstrom and Hermann) have initiated a study to examine how dormant and lightning-season burning regimes influence the distribution and abundance of terrestrial vertebrates in stands of longleaf pine of the Apalachicola National Forest in the Florida panhandle. This work is funded by the National Fish and Wildlife Foundation in cooperation with the National Forests in Florida. We hope to secure additional funding for replicate sites in the Red Hills physiographic province along the border of Georgia and Florida, and in the Sand Hills of eastern North Carolina.

Restoration of longleaf stands by removal of midstory hardwoods

Lack of regular lightning-season fire has resulted in hundreds of thousands of acres of mature, second-growth longleaf that have extensive hardwoods throughout the midstory of the tree canopy. Numerous opinions exist about the "best" ways to remove midstory hardwoods and thus restore these stands to a structure that is more characteristic of natural longleaf stands. Three of the most commonly applied methods to achieve this management goal are 1) application of herbicide, such as velpar, 2) mechanical removal with on-site chipping for pulp wood, and 3) application of lightning-season fire.

Three of us (Hardesty, Provencier and Brennan) are cooperating with other Nature Conservancy and Eglin Air Force Base personnel on a manipulative field experiment to test how the three restoration strategies described above influence plants, arthropods and birds in experimental stands.

Red-cockaded woodpeckers and uneven-aged forest management

The endangered Red-cockaded Woodpecker (RCW) exists in relatively large numbers on private lands managed for bobwhite hunting in the Red Hills of southern Georgia and northern Florida. The Red Hills RCW population represents the sixth largest population of this bird anywhere, and the largest population now remaining on private land. Most of the longleaf pine forests that support RCWs in the Red Hills are managed with uneven-aged silviculture and single-tree selection. These lands have produced a constant stream of timber and other forest products over the past 60 years, while at the same time have maintained apparently healthy populations of RCWs.

Curiously, many areas of public lands in the southern U.S. that contain RCWs are not available for logging because large-block clear-cuttings are detrimental to the RCW. We believe that the type of uneven-aged management practiced in the Red Hills may be applicable to certain areas of public land in Florida, and perhaps elsewhere.

We (Brennan, Engstrom and Hermann) have therefore designed a manipulative field experiment to test what happens to the annual productivity of RCWs when their the structure of their resident stands are shifted from an even to an uneven-aged silvicultural regime. Like the initial phase of the season-of-burn project, this project is being conducted on the Apalachicola National Forest, and is being supported by the National Forests in Florida and the National Fish and Wildlife Foundation.

Enhancement of communication

For management to be effective, research results must be effectively communicated from the researcher to the practitioner. Since the early 1960s, Tall Timbers Research Station has published a series of 17 conference proceedings on fire ecology. These proceedings have played a key role in communicating the importance of fire as an ecosystem process. Originally, the Tall Timbers Fire Conference Proceedings were the exclusive domain of the Research Station. The two current proceedings, both of which are in press, will be the product of a cooperative arrangement between Tall Timbers, The Nature Conservancy Fire Management and Research Program (Directed by Ron Myers) and the southeastern region of the U.S. Fish and Wildlife Service (Regional Fire Ecologist Frank Cole). Both Myers' and Coles' programs are based at Tall Timbers Research Station.

Other related initiatives

Restoration of pyrogenic native grasses

Florida Gas Transmission Pipeline Co. and the Florida State Division of Forestry have administered a project with Hermann to perform a series of experiments to determine the most effective and economical ways to restore native, pyrogenic grasses to gas transmission pipeline corridors.

Northern bobwhite habitat ecology

Plantation owners in the Red Hills of southern Georgia and northern Florida a passionate about hunting northern bobwhites. They are currently supporting a major research initiative to address a series of questions that pertain to factors that regulate bobwhite numbers. Brennan is principal investigator of this project.

Monitoring prescribed fire effects

A standard, comprehensive method for assessing the effects of prescribed fires has been developed for western regions of North America, and may be applicable to fire-maintained systems of the southeast. Hermann and Cole are collaborating on this project, which is being supported by the U.S. Fish and Wildlife Service.

Synthesis: The advantages of cooperation

Cooperative, interdisciplinary studies are clearly needed to provide the reliable knowledge needed for the informed management of forest resources. Longleaf pine forests are no exception to this axiom. In fact, the numerous management problems faced by people interested in longleaf stewardship present classic opportunities for integrated, interdisciplinary studies.

The collaborators for the projects described here bring expertise in fire ecology, ornithology, plant ecology, entomology, forest policy, and wildlife management to each of these investigations. Clearly, these partnerships represent a collaborative arrangements where the whole has a greater potential to produce useful research products than the sum of the individual parts.

Suitability of Softwood Boiler Ash for Inclusion in a Rubbish Landfill

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Abstract

To reduce power cost and solid waste volume, forest products industries rely heavily on wood–fueled boilers. The residue from this process, ash, has recently drawn increased attention from state and federal environmental agencies. Frequently, these governmental entities conclude that wood ash is too toxic for current disposal methods or company owned landfills, and recommend more stringent disposal criteria. The purpose of this study was to ascertain if any environmentally pernicious results could be expected if the ash were to be applied to a rubbish landfill or, alternatively, land–farmed.

The data used in the study were from TCLP tests performed on softwood ash obtained from a southeastern forest products company. Results of this study indicate the toxic leachate potential for either solid, semi–solid or liquid samples to be negligible. Therefore, the inference can be made that no harm would be posed to the environment if this ash were applied to the top soil. This further suggests that either rubbish landfilling or land–farming should be acceptable means of ash disposal.

Introduction

Softwood ash disposal has recently become an important issue within the forest products industry. Currently, many southern wood products industries use a softwood–fueled boiler to reduce power costs and solid waste volume. Recently, environmental agencies in Mississippi have specifically stated that the resulting ash should not be included in a rubbish site. The basis for this decision was that this material is too toxic for inclusion in such a low–risk facility. This will result in higher operating expenses due to the cost associated with ash disposal in a more stringently–regulated landfill. The purpose of this study was to determine if any environmentally harmful results could be expected if softwood ash were applied to a rubbish landfill or, alternatively, land–farmed.

Background

Landfill types and operating expenses

Several types of landfills exist under the guidelines promulgated by regulatory agencies. Each type of landfill has regulations that govern the type of waste that can be accepted, necessary geological conditions, maintenance and groundwater monitoring, etc. There are four recognized landfill classifications: hazardous, sanitary, special/industrial, and rubbish landfills.

Hazardous waste landfills are operated under strict guidelines that allow little flexibility. Hazardous facilities can accept one or several of the following: carcinogenic, infective, mutagenic, toxic and radioactive wastes. The regulations governing these facilities will not permit the natural geology to suffice for the landfill liner, and a synthetic liner has to be used. Equipment must be in place to capture (and in some cases to treat) storm–water runoff and leachate. A groundwater monitoring system must also be installed to ensure that contamination does not occur.

Sanitary landfills, which accept household wastes, are also highly regulated. A synthetic liner must be installed and the geologic conditions of the site have to meet certain criteria to be acceptable. Additionally, equipment must be in place to collect,

and in some cases treat, the leachate formed by rainfall percolating through the landfill. Regulations also require the waste to be covered daily and a monitoring system to be installed to continually observe groundwater quality. Upon closure of the facility, a network of piping must be installed to vent the gases formed from waste degradation.

Special/industrial landfills can vary in regulatory complexity depending on the waste produced by the industrial entity. In some cases, a liner and a leachate collection system will be required. Operators may propose the use of an alternate liner system (e.g., in situ clays, recompacted clays, etc.). If an alternate liner will be used, it must be demonstrated that the liner system will offer adequate protection to regional groundwaters and surface waters. Groundwater monitoring systems may be required of these facilities, again, depending on the waste to be disposed of. Regulations additionally require the waste to be covered daily in most cases.

Rubbish sites are classified as Class one or Class two. Class two landfills can accept natural vegetation, mortar, brick, concrete, stone and asphalt for disposal. Class one sites can accommodate all the waste allowed in class two sites plus wood, sawdust, wood shavings, wood chips, furniture, plastic, glass, metal, cardboard and appliances (other than refrigerators and air conditioners) which have had the motor removed. Regulations require the liner to consist of adequate naturally–occurring geologic materials and to be present immediately below the disposal area and on all sidewalls. Such materials shall generally consist of clay, silty clays, or other soils which have an average hydraulic conductivity of 1×10^{-6} cm/sec or less. Also, the rubbish shall be managed so that it shall not become windblown, and an earthen cover shall be applied to the waste approximately every two weeks.

Land farming

Land farming is the process by which the waste (ash in this case) is incorporated into the top soil. Regulations require that land application sites be located in a hydrologic section where the historic high water table is at a safe depth below the zone of incorporation. Additionally, waste must be applied uniformly and incorporated into the soil during or immediately following its application. Incorporation should normally be accomplished by disking or plowing until the waste is adequately turned under the soil or thoroughly mixed. An additional requirement is that the soil pH shall be maintained at or above 6.5. Currently no loading rates exist that specifically pertain to ash. Therefore, state officials have suggested the use of regulations that apply to sewage sludge such as; the maximum plant available nitrogen levels listed in Table 1 and the maximum cumulative heavy metal loading rates listed in Table 2 which hinge on the cation exchange capacity of the soil.

Experimental procedure

A representative softwood ash samples was collected with the cooperation of a mill site in the southeastern U.S. and sent to an independent laboratory for analysis. Toxicity characteristic leaching procedure (TCLP) tests were performed to assess the mobility of organic and inorganic constituents in the waste. The abbreviated TCLP test procedure is as follows:

1) If the waste contains 0.5 % or greater solids, the liquid is filtered and retained. The solid phase is reduced in size if necessary and extracted with 20 times its weight using an extraction fluid (the extraction fluid used is a function of the alkalinity of the waste). Following extraction, the waste is filtered through a 0.6–0.8 micron filter.

2) If the retained liquid and the filtered extract fluid are compatible, (i.e. miscible), they are combined and analyzed as one. If not, they are analyzed separately and the results are combined to yield a volume–weighted average concentration.

Results and discussion

TCLP test results report the metal concentrations in our leachate samples (that could result under adverse conditions) in milligrams per liter. As can be seen from Table 3, the metal concentrations were very low. Comparatively, the metal concentrations in this softwood ash are less than one–tenth of the hazardous waste regulatory levels (see Table 4.) Additionally, the metal concentrations reported by TCLP analysis are in the same range as the metal concentrations allowed by drinking water standards (also in Table 4.) The only elevated characteristic reported by the analysis was the pH, which is inherent to all ash.

As noted above TCLP test results indicate metal concentrations to be below one–tenth of hazardous levels. A Mississippi state environmental administrator stated that, as a rule of thumb, his agency considers material to be environmentally safe if toxic concentrations are below the one–tenth level. If soil borings prove the site to be geologically acceptable, the relative toxic concentrations, coupled with the close relationship between drinking water standards and the TCLP results indicate that this material should be allowed to enter the company's rubbish site. The only issue that needs to be addressed is the elevated pH of this material.

An elemental analysis should be performed on the ash to determine land farming applicability. As noted earlier, loading rates for this material depend on the cation exchange capacity of the soil and the concentrations of metals in the waste.

Conclusions

If the softwood ash analyzed for this study is typical of that resulting from softwood–fired boilers throughout the south, there should be no significant technical challenges involved in the disposal of this material in a rubbish landfill. It would be prudent, however, to verify the TCLP for each mill site before assuming that the all ash properties are similar to those found in this investigation (which is, admittedly, limited in scope). If land farming is contemplated, additional analyses must be conducted to verify the metals content so as not to exceed the loading rates stipulated by regulatory agencies.

Table 1. MAXIMUM PLANT AVAILABLE NITROGEN LEVELS TO BE APPLIED TO CROPLANDS

CROP	MAXIMUM P.A.N. (LBS/AC/YR)
Bahia grass	160
Bermuda grass	300
Fescue	120
Grain sorghum	180
Silage sorghum	300
Millett	150
Rye grass	220
Alfalfa, clover, vetch	450
Cotton	180
Corn	240
Soybeans	300
Wheat	135

Table 2. MAXIMUM CUMULATIVE HEAVY METAL LOADING RATE TO BE APPLIED AT LAND APPLICATION SITES

	CEC* <5		CEC* 5-15		CEC* >15	
	kg/ha	(lb/ac)	kg/ha	(lb/ac)	kg/ha	(lb/ac)
Lead (Pb)	500	(455)	1000	(890)	2000	(1780)
Zinc (Zn)	250	(222)	500	(445)	1000	(890)
Copper (Cu)	125	(111)	250	(222)	500	(445)
Nickel (Ni)	125	(111)	250	(222)	500	(445)
Cadmium (Cd)	5	(4.4)	10	(8.9)	20	(17.8)

*CEC - Cation Exchange Capacity, meq/100

Table 3. SOFTWOOD ASH TCLP RESULTS

COMPONENT CONCENTRATION	(mg/l)
Arsenic	<0.20
Barium	1.6
Cadmium	0.021
Chromium	<0.050
Lead	<0.20
Selenium	<0.50
Silver	<0.010
Mercury	<0.020
Phenol	<0.050
pH	11.45

Table 4. TCLP TEST RESULTS AND COMPARISONS

COMPONENT	TCLP ASH mg/l	ONE-TENTH HAZ. LEVEL mg/l	DRINKING WATER mg/l
Lead	<0.20	0.5	0.05
Mercury	<0.020	0.02	0.002
Cadmium	0.021	0.1	0.01
Arsenic	<0.20	0.50	0.050
Barium	1.6	10	1.0
Chromium	<0.050	0.50	0.05
Selenium	<0.50	0.10	0.01
Silver	<0.010	0.50	0.05

Factors Influencing Material Substitution in the United States Pallet Industry

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Abstract

The grocery industry is one of the major markets for wood pallets. This industry uses approximately 20 percent of the wood pallets produced in the United States. However, current trends suggest that this reliance on wood pallets could be changing in response to unacceptably high materials handling costs. For some grocery distributors, the use of substitute material pallets (plastic, corrugated, and wood composite pallets) is one approach for reducing these costs. The objectives of this study were to quantify substitute material pallet use for shipping goods downstream from grocery distributors to customers, to investigate the reasons for use of substitute material pallets, and to predict trends in substitute material pallet use by the industry. One hundred percent of the responding companies were using solid wood pallets in 1994. Responding companies indicated that they plan to increase their use of alternative material pallets by 1997. Plastic was the dominant substitute pallet material. In terms of overall performance, respondents perceived plastic pallets to be superior to solid wood, wood composite, and corrugated pallets. Respondents considered cost per use, durability, employee handling safety, and quality to be the four most important factors when choosing a pallet to be sent downstream. On all four of these factors, respondents rated plastic pallets to be superior to solid wood pallets.

Introduction

The solid wood pallet is used by many industries including the grocery industry. The grocery industry is a major market for solid wood pallets because of the quantity of pallets used. In 1985, the grocery and related products industry purchased 42 million standard 48 by 40-inch GMA (Grocery Manufacturers of America)solid wood reusable pallets (Anderson 1987).

However, current trends suggest that the grocery industry's reliance on wood pallets could be changing in response to high product handling costs (Anonymous 1989). These unacceptably high costs (whether real or not) are a signal that the traditional solid wood pallet is falling short of meeting the grocery industry's needs. To satisfy these unmet needs, some grocery distributors are investigating and even turning to alternative product handling devices (e.g., plastic, corrugated paperboard, and wood composite pallets). The United States Department of Commerce, International Trade Administration (1992) also reported that alternative shipping materials (including slipsheets, plastic, and metal pallets) have been pressuring sales of traditional wood pallets.

Unfortunately, very little information is available on pallet material substitution in the grocery distribution industry. If the hardwood pallet is to remain the dominant force in the increasingly competitive grocery pallet market, producers must be aware of the factors influencing material substitution and be prepared to meet the changing needs of pallet consumers.

Methods

The study focused on the downstream shipment of goods, from distribution center to the retail store.

Grocery distributors involved in company pallet decisions were surveyed through mail questionnaires and interviews. Of the 444 questionnaires mailed nationwide, 245 were usable resulting in a response rate of 55 percent.

Results and conclusions

Respondents were asked to indicate the types of pallets (solid wood, plastic, corrugated paperboard, and wood composite) they were currently using in 1994 and projected use in 1997 (Figure 1). One hundred percent of the surveyed grocery distribution companies used solid wood pallets to send groceries downstream to their customers in 1994. Plastic was the dominant substitute pallet material used by 22 percent of the respondents in 1994.

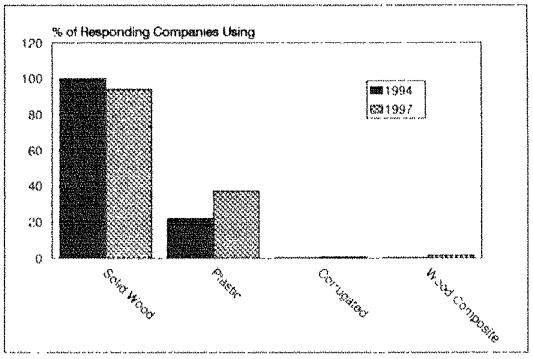

Figure 1. Reported 1994 and estimated 1997 rates of use for selected pallet types by grocery distributors.

Figure 1. Reported 1994 and estimated 1997 rates of use for selected pallet types by grocery distributors.

In the next 3 years, the percent of surveyed companies planning to use solid wood pallets to ship goods downstream is predicted to decrease slightly to 94 percent. Over the same period, responding companies indicated that they plan to increase their overall use of alternative material pallets (Figure 1). Plastic also is predicted to be the dominant substitute pallet material. By 1997, 37 percent of the responding companies indicated that they would use plastic pallets.

Respondents assessed the relative importance of specific factors when choosing a pallet to ship goods downstream to their customers by rating them on a scale from 1 (low importance) to 7 (high importance). The four most critical factors reported by respondents included cost per use, durability, employee handling safety, and quality; however, the four least critical factors noted by respondents included ability to nest, ability to sanitize, weather resistance, and fire resistance. On all four of the most critical factors, respondents rated plastic pallets to be superior to solid wood pallets.

Respondents were asked to rate the overall performance of various pallet types on a scale from 1 (very poor performance) to 7 (excellent performance). Mean scores were collected for each pallet type by averaging performance scores across respondents. Plastic pallets were perceived to have the best overall performance while corrugated paperboard pallets were perceived to have the worst overall performance (Figure 2). Advantages of solid wood pallets as reported by respondents include "availability," "multipurpose," and "repairability;" while disadvantages include "easily damaged," "short life," and "high repair and replacement costs." The advantages of plastic pallets as reported by grocery distributors include "overall savings," "cut costs in repair, sorting, and labor;" and "safe for the selector."

Respondents rated various pallet types on nine factors (initial cost, durability, recyclability, ability to sanitize, environmental friendliness, cost per use, disposal cost, quality, and employee handling safety). Differences in agreement scores for each pallet type (solid wood, plastic, corrugated paperboard, and wood composite pallets) were examined on the nine factors. Respondents perceived plastic pallets to be superior to solid wood pallets on all factors except low initial cost.

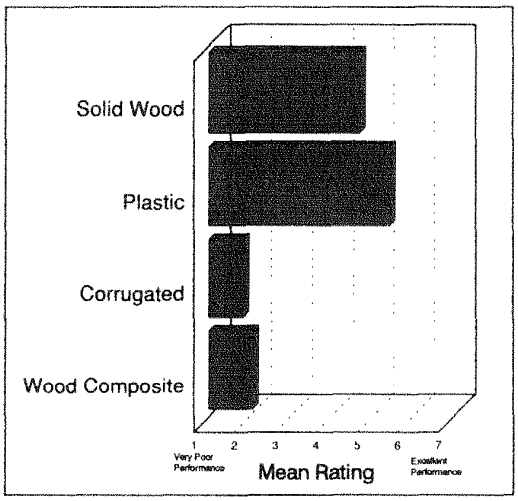

Figure 2. Perceptions of selected pallet types on overall performance for downstream shipments of groceries.

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Interpreting Forestry to the Public: Master Planning the Forest Stewardship Center at Conway Robinson Memorial State Forest

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Abstract

Interpretive programs at public or private forests present a special opportunity to inform the general public about forest stewardship and the sustainable use of forest resources. To enhance visitor enjoyment and recall, program elements must be organized into a clear and well defined storyline. An interpretive paradigm focusing on the general themes of forest history, forest ecology and forest management can utilize a forest's natural and cultural attributes and management activities to present a message of forest stewardship. The Master Plan for a Forest Stewardship Center at the Conway Robinson Memorial State Forest, Prince William County, Virginia, uses this approach to organize interpretive stations with diverse, but linked content, into a system of trails for guided or self directed visitor use. A short introductory loop provides an overview of the three knowledge areas and connects the visitor center building to the three main trails. The forest history loop covers the topics of subsistence, indigenous site inhabitants, colonial settlement and farming, the civil war, reversion to forest, and growing urban and suburbanization.

The forest ecology loop focuses on diversity, inter-relatedness, cycles, stress and systems. Sustainability, silviculture and multiple use make up the forest management trail message. Interpretive stations emphasize one of the these three areas, but each station contains related secondary messages.

Forest setting and history

The 440 acre Conway Robinson Memorial State Forest (CRMSF) contains mature and immature hardwoods, pine-hardwoods, pine plantations, prehistoric and historic sites, rare plants and attractive wildflowers, streams and rolling topography. The CRMSF is located 1500 feet east of the intersection of Route 29 and Interstate Route 66 in Prince William County, Virginia. The Forest is slightly more than one mile west of the Manassas National Battlefield Park, and 30 miles west of Washington, D. C. While currently surrounded by undeveloped land, the local area is experiencing significant development. Over 1,400 housing units are approved for construction immediately west of the Forest. Land across Route 29 from the Forest is designated on the County Comprehensive Plan for regional retail and commercial development.

On February 14, 1938, CRMSF was conveyed to a precursor of the Virginia Department of Forestry. The donor organization gave the land in tribute to its namesake, the founder of the Virginia Historical Society. A covenant signed at the same time stipulates that the land be administered as a State Forest and Wild Flower and Wild Life Preserve and states that land then in forest should remain so except "as it may be desirable to cut for the purpose of eliminating fire hazards, improving the growth and development of other nearby trees or vegetation, or eliminating dead, decayed, or unsightly growth." (Dean 1956).

Forest resources

Approximately 431 of the CRMSF's 440 acres are now forested, including areas recently harvested and replanted or naturally regenerated. The forests can be divided into two general types, those which were extant prior to the gift of the site to the Commonwealth, and those which were unused or abandoned farm fields and which were planted by the state beginning in 1939. The former, consisting largely of upland hardwoods and mixed pine-

hardwoods are found in the western two-thirds of the site. Individual mature oak trees range in age up to 250 years old, dating back to the site's earliest settlement and cultivation in small farms. The latter pine plantations are to the east. Plantings of loblolly and white pines were accomplished with Civilian Conservation Corps help in the 1930s. The balance, approximately 9 acres, is an open "savannah" at the picnic area directly off Route 29, and the open field of a gas transmission right-of-way easement.

Detailed timber stand information has been collected periodically to support development of forest management plans. The most recent survey occurred prior to the preparation of the 1984 Management Plan. In general, timberlands were mature to over-mature, exhibited poor growth rates, overstocking, and high levels of mortality (Warner 1984). Table 1 was developed from this data and updated to reflect more recent harvests, planting and regeneration. Commercial harvests have been limited due to forest size, deed restrictions, and small local market.

The Forest contains a great variety of other natural and historic features. Three rare plant species have been identified on site, and the forests have entertained visitors with masses of flowering trillium, Virginia bluebells and other wildflowers. A rock outcrop overlooking the Little Bull Run floodplain on the north boundary may have provided shelter to the site's earliest inhabitants. More recently this area has served as a nesting site for black vultures. Historic road traces, and the Manassas Gap Railroad roadbed, abandoned before the civil war, describe the regions initial transportation system and commercial growth. Old homestead foundations, remains of rock walls and a standing chimney testify to the Forest's gradual reversion to fallow land and forest. Historic markers celebrate early stewardship efforts of the Virginia Garden Club and the Daughters of the American Revolution. Another marker notes the site of an historic civil war meeting between Confederate generals Lee, "Stonewall" Jackson and Longstreet at the Battle of Manassas.

The market for an educational program

Over 1.6 million people live within a one hour drive of the CRMSF. The number of school age children within this area is expected to increase from 257,000 in 1993 to over 331,000 public school students by the year 2,000 (Center for Public Service 1992). Results of a survey conducted as part of the planning effort indicate that students within the market area now travel up to 60 miles for a natural history oriented field trip. Local county park systems, the Northern Virginia Regional Park Authority, the Virginia Department of Conservation and Recreation, Division of State Parks and the National Park Service all operate nature centers or visitor centers with interpretive natural programs within the greater market area. None focus specifically on forest resources. While adjacent states provide a number of facilities devoted to explaining forest history and forest ecology to the public, Virginia offers no similar opportunity (Fahl 1983). The ability of the Conway Robinson Memorial State Forest to offer a specialized and identifiable program will make it a strong candidate to attract visitation by school groups, particularly in the grades K through 8.

Table 1:

Age Class	Short-leaf Pine	Loblolly Pine	Virginia Pine	White Pine	Mixed Pine	Pine Hard-wood	Upland Hard-wood	Bottom-land Hard-wood	Bald-cypress	Total
1-19	1.3	8.3		2.4		0.8	5.2		2.1	20.1
20-39		10.6		3.5						14.1
40-59		58.0	5.4	13.2	8.5			20.2		105.3
60-79			6.1			30.5		11.6		48.2
80+			16.8				221.7	5.0		243.5
Total Acres	1.3	76.9	28.3	19.1	8.5	31.3	226.9	36.8	2.1	431.2

Interpretive program

Creating an informative, enjoyable program which encourages repeat visitation requires that it focus on a specific and well defined message. The recommended interpretive mission for the CRMSF is based upon forest stewardship, and designed to inform visitors of all ages about forest stewardship and the sustainable use of forest resources. Stewardship requires knowledge of forest ecology, forest history, and forest management. These three interrelated themes reflect the important characteristics of the CRMSF and provide an opportunity to utilize the Forest's unique resources as interpretive settings.

Natural and cultural features deliver ecological and historical messages. Extent forest stands illustrate different stages of forest succession and the implications of forest management. Interpretive stations emphasize history, ecology, or management, but always contain related secondary/tertiary messages. In some cases landscape and forest management techniques will be used to communicate important ideas regarding stewardship.

Like many Piedmont forests, the CRMSF provides ample evidence of sustained human influence. Interpretive messages on forest history will highlight the effects of subsistence, indigenous people, colonists, homesteading, plantations, Civil War, reversion, donation to the Department of Forestry and urbanization.

The ecology of the CRMSF reflects different forms of continuing human influence such as clearing, harvesting, changes to soils and hydrology. The message of forest ecology will illustrate that forests have basic biophysical requirements and that forest organisms are interrelated. Cyclical forest processes such as succession, evapotranspiration, and nutrient transfer will be illustrated through interpretive signage and programs. The message will stress that the diversity at the CRMSF forest depends upon both biophysical and human factors.

The management message of the CRMSF will stress that forests provide useful products and services, and that humans have used forest resources for a long time. Forestry is the scientific practice of managing these forest resources. The CRMSF and all forests can be managed for various objectives and multiple uses with sustainability as an important goal of stewardship.

Interpretive facilities

The Visitor Center serves as the starting point and terminus for a system of paths linking interpretive stations located throughout the forest. Thirteen interpretive stations will be linked by existing and proposed forest roads and trails. A one-third mile loop near the Visitor Center, the Growing Forest Trail, provides an easily understandable introductory presentation of forest stewardship, touching upon history, ecology and management (including forestry and forest product) themes, expressed through three interpretive stations. This path, which will be paved and fully accessible, is particularly suited to school groups of younger children and to those with limited mobility, or

limited time to spend in the Forest. Figure 1, the Visitor Center Site Plan, illustrates these facilities.

From the Visitor Center and introductory trail, visitors will select from three additional self guiding trails focusing on forest history, forest ecology or forest management. A series of outdoor interpretive stations linked together by paths provide the key interpretive messages. Interpretive messages target visitors of diverse age and education levels, but primary school age children will be a major audience. Interpretive settings are designed for compatibility with existing environmental education curricula such as Project Learning Tree, Project Wet, and Project Wild.

An interpretive station is a natural or cultural setting within the forest possessing interesting physical characteristics. It may be an existing stand of timber of a particular age and type, or a habitat, such as a wetland, or a cultural site, such as a former homestead. In some cases, it may be a manipulated area, such as a field, or plantation site, used to describe aspects of forest ecology, history, or management. The three major trail loops group stations with the similar major themes of forest history, forest ecology and forest management. Table 2 describes each of the interpretive stations on site.

Conclusion

The creation of a Forest Stewardship Center on the Conway Robinson site will be accomplished specifically to preserve the site's important physical, historic and cultural resources because they constitute its interpretive program. Development of the center and integral on-site management provides an opportunity to protect and monitor the Forest's resources. The creation of the Forest Stewardship Center provides a structured and scientific response to potential impacts to the site's forest and other resources caused by encroaching off-site development. All education center facilities will be located to minimize impacts to known rare plants, important wildflower groups, very old trees, wetlands, and other special features while providing for their interpretation under appropriate management or oversight, including limiting access. Similarly, old homesites, the historic Manassas Gap Railroad roadbed, and prehistoric encampment sites will be protected from disturbance. The program of self-guided walks through historic sites, wildflower stands, and all types and ages of forest stands will appeal to a growing interest in nature appreciation and nostalgia for attributes of Prince William County since passed.

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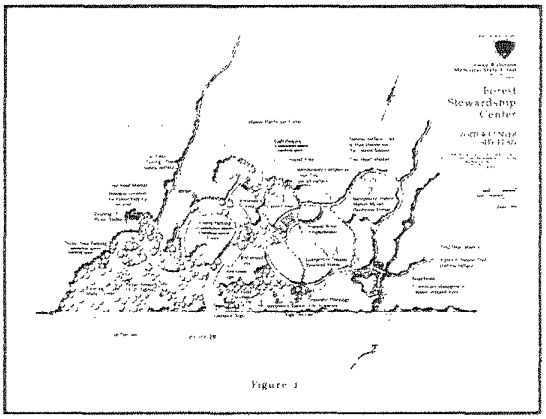

Table 2:

Station Number and Name	History Theme and Content	Ecology Theme and Content	Management Theme and Content	Landscape Management Required
1. Visitor Center	history introduction hands-on learning	ecology introduction hands-on learning	forestry introduction hands-on learning	optimize viewing opportunity of diverse habitats
2. Mature Mixed Hardwood Forest	presettlement norm	succession natural history of forest gypsy moths and chestnut blight	timber value wildlife value non-consumptive use	little management necessary-locate in reserve area
3. Renewed Forest	pine plantations in modern era naturally regenerated pine stands in past	single species ecology ecological benefits	modern forestry fast rotations sustainability	intensive silviculture keep 1, 2, 5, 10 year and older plots
4. Old Homesite	homestead life in Piedmont reversion to forest urbanization trends	diverse, introduced domestic plants wildlife early succession short lived plants	historic management by homesteaders incidental cedars, Virginia pines	manage historic site - plant domestic species keep small plot in arrested succession
5. Fernstrom Forest	acquisition of CRMSF Civil War history	horticultural use of native plants exotic plants	cooperative agreements for forest management	restore ornamental plantings
6. Exposed Bedrock	Native American shelter	geology, soils species adaptation	none	archaeological study - protect from damage
7. Abandoned Manassas Gap Railroad	pre Civil War life Battles of Manassas Reconstruction	barriers and corridors for wildlife, drainage	reuse of railroad corridors	maintain as trail
8. Forest Clearing	Native American and early settler cultivation	clearing formation and regeneration	early native management	create clearing native food plants
9. Pine-Hardwood Succession	history of succession from farm field to pine forest to hardwoods	send transport successional species	natural and artificial pine regeneration releasing hardwoods by harvesting pines	planting pines release and thinning
10. Forested Wetland	role of railroad in creation of wetland	characteristic plants and wildlife	management for wildlife habitat aesthetics water quality	boardwalk
11. Little Bull Run	old mill across stream	stream ecology Chesapeake Bay watershed	beavers as managers Chesapeake Bay preservation	boardwalk
12. Loblolly Pine Plantation	history of forestry in Virginia	maturation change in species diversity	superior tree seed improvement modern forestry	continuing silviculture
13. White Pine Plantation	pine's historical usefulness	site characteristics favoring species	modern forestry aesthetics forest products	thinning as necessary
14. Hardwood Management	history of hardwood lumbering and wood uses	habitat and mast species diversity	hardwood improvement cuts disease/pest control	continuing silviculture

THE MARYLAND FOREST CONSERVATION ACT

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Abstract

The Maryland Forest Conservation Act, enacted 1991, requires that forest resource issues be addressed as an integral part of the land development process. The Act emphasizes retention of existing forests, mandates ratios for replacement of forests cleared during land development, and requires certain minimum percentages for afforestation on land that has little or no forest cover. Forests retained or planted under the Act must be protected by long term covenants.

This Act has resulted in a demand for professionals with the technical expertise to delineate and evaluate forests, to develop forest conservation plans, and to review plans submitted for approval to state and local authorities. In addition there is an increasing demand for industries that will grow, install and monitor required forest plantings.

The technical presentation is an overview of the Act and the regulatory requirements of the program. The graphic exhibits are based on figures prepared for the second edition of the Forest Conservation Manual, Guidance for the Conservation of Maryland Forests During Land Use Changes, Under the 1991 Forest Conservation Act.

The act and the manual

To reduce the loss of forest resources during the increasing urbanization of the state, the Maryland legislature enacted the Forest Conservation Act on July 1, 1991, the first such statewide program in the national. The Forest Conservation Act provides for local jurisdictions to establish forest conservation programs to enforce controls on the disturbance of forests as part of the overall development review process. The Forest Service, Department of Natural Resources administers the state program.

Forest conservation issues now must be considered under any public or private application for a grading or sediment control permit on areas 40,000 square feet or greater. Most development that occurred prior to July 1, 1991 is exempt; provisions also are made for numerous other exemptions.

The primary objective of the Act is to ensure that as much forest as possible is retained during the land development process. If forest clearing is unavoidable, the Act requires reforestation at mandated ratios. On sites with limited or no forest resources, new forest stands (afforestation) must be established at minimum levels.

Although the Act provides for conservation of certain specimen trees, it is not a tree preservation act. Similarly, although the Act may require new plantings to replace forests lost to clearing and development, it is not a landscaping ordinance. The emphasis is on conserving forests as ecological communities. A forest is defined as an area 10,000 square feet or greater with a minimum of 100 trees per acre.

The Act requires publication of a companion document, Forest Conservation Manual: Guidance for the Conservation of Maryland's Forests During Land Use Changes, Under the 1991 Forest Conservation Act. The first edition was published December 31, 1991. A Forest Conservation Manual Task Force was convened by the Department of Natural Resources in 1993 to recommend changes to the Manual. The expected publication date for the second edition is December, 1994.

Forest conservation documents

The Manual outlines standards and recommends procedures for the preparation of required plans using a case study approach. Two major submissions in the process are the Forest Stand Delineation and the Forest Conservation Plan.

The Forest Stand Delineation (FSD) inventories existing forest resources and sensitive environmental areas on the site. Field reconnaissance and forest sampling procedures are required. Worksheets are provided in the Manual for recording forest structure and conditions. FSD information is summarized on maps and in a narrative describing each stand and evaluating its potential for retention, management, or development. The FSD provides guidance for decision making during the development of site plans and forest conservation plans.

A Forest Conservation Plan (FCP) is a compendium of documents that may include maps, specifications, implementation details, worksheets for computing forest conservation obligations, construction timetables, legal instruments, post-construction maintenance agreements and long-term protective agreements. Maps in the FCP package may include plans showing forest retention areas, forest protection plans (with protective devices), and planting plans for reforestation and afforestation areas (if required).

Forest Stand Delineations and Forest Conservation Plans must be prepared by a state licensed Forester, a state licensed Landscape Architect, or other qualified professionals as defined in the Act. The state offers courses through local colleges to train professionals and to assist them in obtaining the qualifications that are needed to prepare FSD and FCP documents.

Calculating obligations

A series of formulas (thresholds), based on land use type, have been established to calculate reforestation and afforestation requirements when forest clearing is unavoidable. Conservation thresholds range from 15% in commercial, industrial, mixed use, and planned unit development areas to 50% in low density residential and resource areas. Afforestation thresholds are in the 15% to 20% range. Thus, high density residential development and high intensity commercial land use areas have lower requirements, with low density residential development or resource protection areas having higher expectations for forest conservation.

Clearing below the threshold levels is not prohibited; however, it results in significant reforestation penalties. Forest cleared down to the level of the conservation threshold must be reforested at a ratio of 1/4 acre planted for every acre removed. Clearing below the conservation or afforestation threshold must be reforested at a ratio of 2 acres for every acre removed. As an incentive for forest retention, forests saved above the threshold can be credited to reforestation requirements at a ratio of 1 acre credit for every acre saved above the threshold. There exists a break-even point for every site: for every 5 acres of forest above the threshold, 1 acre may be cleared without incurring a reforestation obligation. A worksheet is provided in the Manual for computing forest conservation obligations.

Site planning guidelines for forest conservation

The Manual provides extensive site planning guidance so that forests, particularly those in high

priority environmentally sensitive areas, may be retained. Site planning practices that limit clearing and grading of forest areas are encouraged. The Manual promotes the use of creative site planning techniques such as clustering to protect sensitive areas. Innovative approaches to issues such as stormwater management are encouraged when they reduce forest clearing. Forest conservation planning also requires that the relationship of on-site forests to nearby adjacent forest resources be taken into account.

Forest retention, reforestation, and afforestation

Retention of forests in high priority areas is promoted in the Manual. Typical high priority areas include critical habitats of rare, threatened, or endangered species; streams and their buffers, steep slopes with easily erodible soils; 100-year flood plains; forests with high diversity and large contiguous forest corridors. Individual trees that are part of an historic site or that have a diameter of 30" or greater are high retention priorities. Priority forest retention areas often coincide with sensitive environmental areas required to be protected under the Maryland Economic Growth, Resource Protection, and Planning Act of 19922. A goal of reforestation and afforestation is to provide new forest planting to enhance sensitive areas, establish forest corridors, and create buffers to adjacent properties. In general, priority areas for reforestation and afforestation are similar to high priority retention areas.

Reforestation and afforestation requirements can be satisfied in various ways, such as (in order of preference) selective clearing and supplemental planting, installation of transplanted or nursery stock, use of whip and seedling stock, landscaping, and natural regeneration. Reforestation and afforestation plantings should be located on-site. If off-site planting is permitted, preferred locations are within the same watershed or local jurisdiction.

The Manual encourages planting patterns that replicate natural groupings with mixes of species and sizes for both aesthetic and ecological reasons. Specifications for plant size, quantity, and survival rates are included in the Manual.

Opportunities and needs

The Act has resulted in new opportunities for forestry professionals with the technical expertise to delineate and evaluate forests, to develop forest conservation plans, to review plans, and to grow, install and monitor required forest plantings. Education and training is needed to help these professional perfect and develop the skills and expertise they will need.

There is little research on the subject of reforestation and afforestation in urban and suburban settings. Much of the current forestry research is related to silviculture focusing on timber primarily as an economic rather than an environmental resource. Areas of needed research include techniques for preparing a disturbed site for reforestation, plant installation methods, plant species lists and planting patterns for establishing native forests, management techniques to aid survival of new forest plantings, the use of production techniques for growing stock, methods for encouraging natural regeneration, techniques for selective clearing and supplemental planting, and post-construction evaluation.

Conclusions

Although the Forest Conservation Act has been in existence for three years, it is still too early to evaluate its effect. Required annual reports from local jurisdictions and the state will show the number of acres that have been retained under long term protective agreements and the number of acres of new forests planted. It may take decades to determine whether the program will slow the rate of loss of forests and improve environmental quality in new developments.

The Act and the regulations for implementation of its provisions are continuing to evolve. For example, recent amendments addressed the particular needs of densely developed urban jurisdiction. The second edition of the Manual will include streamlined procedures for sites where there are no forests or where priority forests are retained and protected, clearing is limited so that no afforestation or reforestation is needed. For further information about the state program or to voice concerns, contact Ginger Page Howell, Forest Conservation Manager, Forest Service, Department of Natural Resources, Tawes State Office Building, 580 Taylor Avenue, Annapolis, Maryland 20401.

References

1. The major provisions of the Forest Conservation Act are found in the Code of Maryland (COMAR), Title 08, Department of Natural Resources, Subtitle 16 Forest Conservation, 5-1601 through 5-1613.

2. COMAR, Article 66B, Sec.3.05 (a)(1)(viii)

3. Senate Bill 915, enacted June 1, 1993 and incorporated into COMAR, Natural Resources Article, 5-1607 (b)(2)(i)(ii).

Plant Species Richness Following Chemical or Mechanical Site Preparation in Mississippi

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Abstract

Clear-cutting pine-hardwood forests, followed by site preparation affects plant community characteristics. Effects of mechanical or chemical site preparation on plant species richness are an important forest management issue. Therefore, we compared plant species richness on replicated four-acre plots by site preparation method: roll-chop and burn (n=5), Imazapyr (Arsenal) at 1 lb./acre and burn (n=5), Imazapyr and no burn (n=4), and two 50-year-old pine-hardwood forests in Noxubee county, Mississippi. A 100% inventory of plant species on the plots was conducted during May-June 1991 and May 1992; one and two years post site preparation and planting of loblolly pine (Pinus taeda) seedlings. Mean number of plant species did not differ ($P > 0.05$) among the following treatments: roll-chop and burn 152 (1991) and 129 (1992), Imazapyr and burn 140 and 119, Imazapyr no burn 135 and 119, and pine-hardwood 123 and 137. A total of 427 plant species was found on the plots and ranged from a high of 178 on roll-chop and burn in 1991 to a low of 101 on roll-chop and burn in 1992. Most plants, 74% or 327 species in 1991 and 79% or 360 species in 1992 were perennials. Forbs were the most abundant plant category, averaging 56% in 1991 and 51% in 1992 of all plant species found on site prepared plots, followed by woody plants, grasses, then vines.

Introduction

Pine (Pinus spp.) plantations are a major forest and habitat type in the southeastern United States. There are nearly two million acres of plantations in Mississippi. Often, intensive site preparation is performed to enhance planting conditions, and subsequent seedling survival and growth. Mechanical site preparation was prevalent for several decades, but chemical (i.e., herbicide) site preparation has recently become dominant (Miller et al. 1990). Chemical site preparation reduces soil disturbance, lowers erosion rates, can be performed on steep slopes or wet soils, and achieves more complete control of competing vegetation.

Plant species richness refers to number of plant species encountered in a given area. Plant community characteristics, including species richness, determine habitat conditions for wildlife. Mechanical or chemical site preparation alter forest habitat conditions. Our objective was to determine plant species richness on areas site prepared by mechanical or chemical methods.

Methods

The study area was located near Macon, (Noxubee county), Mississippi, USA. Site index for loblolly pine (P. taeda), at age 50 years, ranged from 76 to 83 feet. All merchantable sawtimber and pulpwood were removed (i.e., clearcut) from the area in fall 1989. Fourteen rectangular plots, four acres in size were installed on the area and the following site preparation treatments were performed: roll-chop and burn (D-8 bulldozer pulled a drum roller, 1 pass, broadcast burn 14 days later), herbicide and burn (Imazapyr, aerial application at 1 lb. a.i./acre, burned 6 weeks later), herbicide but no burn (Imazapyr, 1 lb./acre), no treatment (50-year-old

pine-hardwood forests). Number of plots by treatment was five for roll-chop and burn and herbicide and burn, four for herbicide but no burn, and two for pine-hardwood forests. Genetically improved loblolly pine seedlings were planted in February 1991, and spacing was 8 x 9 feet (605 seedlings/acre).

The relatively small size of the plots allowed for a complete inventory of plant species. Treatment plots were systematically traversed to observe the entire plot. Two people walked parallel lines approximately 5 - 10 feet apart, depending on vegetative density. Each new species encountered was identified. Inventories were conducted in May and June, 1991, and May 1992 (Wilson 1993).

Number of plant species was compared between treatments within years using analysis of variance (Steele and Torrie 1980). Comparisons between years were not conducted due to marked differences in weather conditions in winter and spring.

Results

A total of 427 plant species was found on the plots. Mean number of plant species varied from 123 on pine-hardwood forests to 152 on roll-chop plots in 1991 and 119 on herbicide treated plots (burned and not burned) to 137 on pine-hardwood forests in 1992 (Table 1). The greatest range in number of species was found on roll-chop plots in both years. There were no significant ($P > 0.05$) differences in number of plant species, richness, among treatments or pine-hardwood forests in 1991 and 1992.

Most plants, 74% or 327 species in 1991 and 79% or 360 species in 1992 were perennials. Forbs were the most abundant plant category, averaging 56% in 1991 and 51% in 1992 of all species observed, followed by woody plants, grasses, then vines.

Discussion

Plant species richness was similar on mechanical and chemical site prepared plots, and also was similar to richness on pine-hardwood forests. Blake et al. (1987) and Hurst and Blake (1987) reported no difference between number of plant species found on chemically (Hexazinone) and mechanically site prepared (shear, rake, disk, bed) areas in east-central Mississippi. Likewise, Hurst and Perkins (1987) found 99 species of plants on mature pine-hardwood forests and 95-99 species on loblolly pine plantations, age 1 - 4 years that had been chemically (sprayed 2-4-5-T, injected 2-4-D) site prepared in east-central Mississippi.

Because there were no significant differences in plant species richness between mechanical and chemical site preparation methods, other factors, such as effects or impacts on soil, economics, efficacy in controlling vegetative competition, and application restraints, must be considered. Plant community characteristics, other than plant species richness, must be determined before assessing effects of site preparation method on wildlife habitat or populations. Vegetative conditions in pine plantations change rapidly, with pine canopy closure occurring at age 5 - 6 years. At this age, abundance and diversity of herbaceous plants are greatly reduced; however, woody and vine types persist.

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Table 1. Mean number (range in parentheses) of plant species by site preparation treatment and year, Noxubee County, Mississippi.

Year	Roll-chop and burn	Imazapyr and burn	Imazapyr not burn	Pine-hardwood forest
1991	152 (137-178)	140 (130-155)	135 (128-141)	123 (101-144)
1992	129 (101-157)	119 (103-130)	119 (106-134)	137 (129-144)

No significant ($P > 0.05$) differences found among treatments by year.

Acknowledgements

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Wood Works™

Cinda Hartman Jones, Director of Marketing, American Wood Council, American Forest & Paper Association, 1111 19th Street, NW, Suite 800, Washington, D.C. 20036

Wood Works™ is a comprehensive environmental communications program of the wood products industry. It was developed to meet the growing need for accurate information regarding the environmental benefits of wood products. Current supporters of Wood Works include the American Forest & Paper Association, American Plywood Association, Canadian Wood Council, Southern Forest Products Association, West Coast Lumber Inspection Bureau, and founder of the Wood Works program, the Western Wood Products Association.

Traditionally, building product selection has been determined by price, availability, quality, and performance. Now customers throughout the chain of distribution are considering the environmental impact of using our natural resources, manufacturing efficiency, energy consumption, and recyclability of materials before making a purchase decision.

The Wood Works™ initiative demonstrates that wood is a solution to environmental issues and concerns because wood products are made from an infinitely renewable, reusable, and recyclable resource, require less energy to produce than competing products, and are for many other reasons, the environmentally sound choice.

Regardless of the temporary price competitiveness of alternative building materials, wood continues to account for 95% of residential framing in the United States. The only reason why steel is being considered as an alternative to wood is because over-regulation, and lawsuits by environmental extremists have tied up available supplies of timber which has caused the price of lumber to rise.

Annual forest growth exceeds harvests by 33%, therefore there is no danger of "running out of trees." Conversely, in utilizing non-renewable, finite resources that make up concrete, steel, and aluminum, natural resources are being depleted.

While producing some building materials generates CO2 and other air pollutants, forest growth produces oxygen and stores carbon, which lessens the impact of global warming.

Concrete requires nearly three times as much energy to produce as wood. Even more environmentally damaging than concrete's natural resource depletion and energy-intensive production is this building material's emission of extraordinarily high amounts of nitrous oxide, sulfur, and carbon dioxide during its manufacture. Producing one ton of concrete releases more than one ton of carbon dioxide into the atmosphere while wood manufacturing produces far fewer toxic emissions and wood's production actually improves air quality because growing one ton of wood absorbs more than one ton of carbon dioxide and generates over a ton of oxygen. Young, well-managed forests are more efficient at taking in carbon dioxide and emitting oxygen than are older, untended forests. Steel is even more energy intensive than concrete.

Wood is the best insulator of all structural building materials. A wood-frame house keeps you cooler in the summer, warmer in the winter, and can save you a small fortune on your heating and cooling bills. An inch of wood is 16 times as efficient an insulator than concrete, 415 times as efficient as steel, and 2,000 times as efficient as aluminum.

When designed and built in compliance to local building codes, homes of wood, steel and concrete perform equally well in hurricanes and earthquakes -- and insurance rates do not vary because of framing material used.

Alternative building materials such as steel, plastic, and aluminum boast about their recyclability.

Wood is recyclable too, and the rate of wood recycling is on the rise. An estimated 400,000 tons of wood waste were recovered in 1990. This waste included barrels, boxes, Christmas trees, construction & demolition waste, crates, pallets, posts, poles, prunings, railroad ties, sawdust, slab wood, and yard trimmings.

Recycled and reused wood products are currently being utilized as animal bedding, boiler fuel, carbon and fiber composite materials, cellulose (batts, blankets), cement-bonded particle and fiber boards, chip boards, composite boards, erosion control material, fuel, gypsum-bonded wood fiber panels, humus, landfill cover, landscaping material, mulch, oriented strand board, panel products, particle board, plastic wood, pulp and paper, resin material for automobile doors and interiors, spaceboard, structural material for buildings and furniture, wet-formed fiber products, wood/inorganic composite (w/ cement/gypsum), and wood stove pellets.

An independent newsletter on environmentally Sustainable Design and Construction compared the attributes of wood and steel and concluded that:

> *"The extraction of raw materials used to make steel can have serious environmental impacts, and the manufacturing process, even from recycled steel, is extremely energy intensive. Wood, on the other hand, is naturally renewable, requires less processing energy, and is ultimately biodegradable."*
>
> *"Where wood is available from a certified, well-managed forest, it's probably the best choice environmentally."*
>
> **Environmental Building News**
> **July/August, 1994**

Beauty, value, longevity, durability environmental soundness -- wood has it all. Wood is reusable, recyclable, biodegradable, and it's renewable. No wonder it's the primary material in more than 9 out of 10 American and Canadian homes. From floors, paneling, decorative moldings, and structural framing, to siding, roofing, decks, and windows -- wood is the natural choice. Wood Works.

The American Forest & Paper Association (AF&PA) is the national trade association of the forest, paper, and wood products industry, representing member companies engaged in growing, harvesting, and processing wood and wood fiber, manufacturing pulp, paper, and paperboard products from both virgin and recycled fiber, and producing solid wood products. AF&PA represents a segment of industry which accounts for over 7% of the total U.S. manufacturing output.

Lessening Demand on Eastern Forests Through Timber-Frame Construction

Jonathan Orpin, Timber Framers Guild of North America, President, New Energy Works of Rochester, Inc., Rochester, NY

Introduction

Amory Lovins, co-founder of the Rocky Mountain Institute, an energy conservation think-tank, proved that utility companies could actually earn a profit from managing and conserving energy rather than promoting energy use and thereby having to build the required production capacity. His concept was dubbed "negawatts", and is now a widely accepted understanding.

Similar thinking is required in the forest products industries, for until demand on forest resources is lessened, no management plan can hope to stem the loss and over-harvesting of eastern forest ecosystems. Today's residential building technologies, which employ large amounts of wood products in new structures with short life spans are an important part of the problem. Replacing wood with other material, such as steel or structural plastic that consume large amounts of energy in the raw material and manufacturing stages is not the answer. Trees are indeed a valuable and renewable resource. Our goal should be their better utilization.

If we were to add 50% to the life of new homes, we would need that many fewer trees over the longer time period; homes that lasted twice as long would save half the trees, and so on. Timber-frame construction, with its emphasis on securely connected heavy timbers, has proven through the centuries to create a much longer lasting structural frame than today's light framed housing, while using only slightly more board footage of lumber per cubic foot of enclosure.

This greater efficiency of timber utilization due to the longer lasting construction methodology will be examined.

Historical overview of light and heavy framing

For definition, light framing refers to the use of 2"x4", 2"x6" and other dimension lumber and plywood to work together as studs, trusses, and sheathing in the "rough framing" of the structure. This creates a platform framed home, and is so called because the loads that result from usage and the environment (i.e. snow, wind, people, furniture) are spread out more or less evenly. The entire length of walls, and the total area of roof, etc. using plywood or other sheathing as the outside membrane, work as a unit to spread these loads and limit racking. This method allows the use of many smaller structural members that are fastened with great quantities of nails and plates, to achieve what was once thought to be the realm of large and heavy timber members.

Platform framing techniques allowed more homes to be built in shorter amounts of time with less skilled help. Beginning in Chicago in the 1880's as "balloon" framing, and further developed through the first half of this century, this style is best exemplified by Levittown (Gans, 1967), on New York State's Long Island. This huge development-turned-community was built right after World War Two to accommodate the incredible demand for housing by returning veterans. Coupled with the almost unbridled economic growth and little regard for forest or other natural resources, the Levittowns of that era would have been less possible without the mass-production capacity of light framing.

Heavy timber framing is the concentration of the loads on a structure to a few large, well-joined and secured members that do most of the work. Also known as post and beam, and timber-frame construction, it is a point-loaded, rather than

platform loaded, building technique. Where the primary economic advantage of light framing as stated above is its capacities in mass production, the primary economic advantage of timber-framing is in its longer life-spans.

There is a great deal of literature available to support the suggestion that timber-framed buildings last a long time. Many examples exist, particularly in the pre-twentieth century homes and barns in the eastern states. But to really appreciate the long view of timber-framed buildings, one must go back further than our own country's settlement by European emigrants to Europe itself, where homes built after 1776 are often the new kids on the block.

A large body of work exists on the history of timber-framed buildings in Europe. A particular standout is English Historic Carpentry, by Cecil Hewitt, (1980). This definitive work explores numerous examples of buildings standing today dating back as far as the twelfth century. The barley barn at Cressing Temple, Essex, which was carbon-dated to 1200 A. D. +/- 60 years is a good example of an 800 year old heavy timber building.

Extremely old structures should be considered only to emphasize timber-framing's potential for longevity. If, however, the assumption rested just on the basis of a few buildings still in use from a particular era, then it could be credited to exception, and therefore have limited value. Of greater value is the review of timber-framed structures built between 1600 and 1850 in this continent, and easily seen today in the thousands of old barns that dot the country side. One can clearly see all the structural members of these buildings by simply walking inside and looking around. The huge timbers (posts if vertical, beams if horizontal), often connected with traditional mortise and tenon joinery and held in place with wood dowels called pegs are not only interesting, but extremely functional. These barns, well described by Fink (1987), and Hubka (1984), have often survived heroically through adverse conditions of poor upkeep and hard use.

Timber-frame homes, too, abound as examples from previous centuries. The Framed Houses of Massachusetts Bay, 1625-1725, by Abbott Lowell Cummings ((1979), and Early Domestic Architecture of Connecticut by J. Frederick Kelly (1924) chronicle many homes of that era, examining their construction styles and techniques by studying many of the homes as they stand today.

This author maintains that the use of heavy timber construction is largely responsible for these long life spans; that had they been light framed (or log built, for that matter), they would not still be of value, and that heavy timber-framing should be re-examined as a viable building technique in light of today's demands on our forests and our need to limit that demand.

Heavy Timber's Role in Today's Construction

No one can point to a specific study or experiment to prove that light framing can not compete with the longevity of timber-framing. The use of small dimension lumber has not been around long enough for a full review of its potential. And as stated, light framing techniques have some clear advantages over its more labor intensive predecessor. Light framing has a place in our time. There are, however, many old (and new) timber-framed buildings that can be studied and documented.

Given identical use, wear and tear, and environmental conditions, it is suggested that a home built with a heavy timber structural method with outlast a light-framed home by a factor of two or more. Specifically, if the usable life of a stud-framed home is 100 years, the usable life of a timber-framed home is 200 years, and so on. (Note that this figure was chosen simply because it is used by the insurance industry for depreciating the framing component of light framed homes.) This conclusion is reached with a variety of inputs. Discussions with firemen, insurance adjustors, historical architects and contemporary timber

engineers have been pieced together to paint a picture that can support an intuitive understanding.

A heavy timber-framed home is more likely to survive a natural disaster than a light-framed home. Wil Wilkins (1991), a timber-framer from Hamilton, Montana, found that a recently completed timber frame of his was the only intact home in a neighborhood near the epicenter of the San Francisco earthquake. Good foundation attachment of the post bottoms was an important component, but could not by itself explain this sole survivor.

Merle Adams (1993), another Montana timber-framer, reports on a fire that started inside a timber frame home he had built. Due both to the tightness of the house and propensity of heavy timber to resist burning, a fire that would have burned most homes to the ground smoldered and sputtered for a long enough time to require drywall replacement and sandblasting of timbers, but no structural damage. More than one fireman has told this author that he would rather be on the roof of a burning heavy timbered structure than any other, due to the mentioned ability of a timber to char over on the outside and insulate itself.

A favorite story is that of Toni and Bob Donahoe, whose timber-framed home in western Pennsylvania was in the middle of a tornado's path. Toni hid under the kitchen table as her roof was sucked off overhead. To get it, the tornado had to split the oak rafters in half longitudinally, leaving an otherwise messy but intact home behind. The rest of the tornado's pathway had no standing homes, and very few trees.

Normal wear and tear, and the general ravages of aging, can also be addressed. In a perfect world, both light framed and timber-framed buildings rest on strong foundations, have fully maintained roofs, and have complete control of interior and exterior moisture relationships. In that same world, all homes would be built by precise, committed craftspeople using the highest quality materials available and installing them not only to the building code specification, but beyond. Because that is not the case, timber-framing holds some practical advantages. These include a fully exposed structural system for closer monitoring, and, in traditional timber-framing, a minimal use of ferrous fasteners.

Finally, with the structural system exposed and the work requiring a greater degree of craftsmanship, it would be hoped that a more consistent and better grade of attention to detail and care would be a result. One of the lessons of Hurricane Andrew and Homestead, Florida goes beyond questions of whether the construction style was sufficient. It was obvious that even the minimum standards of workmanship were ignored in too many cases. Pride of craft, and pride of ownership go hand in hand to ensure that a product is up to its own standard.

Conclusions and implications for further study

The building of high quality, heavy timber-framed homes will ultimately lower the demand on forest resources by requiring fewer replacements of required housing stock. (See accompanying chart "200 Years of Serviceable Life.) The benefit to the forest products industries will be felt as longer rotation harvesting cycles create a better grade of log, thereby yielding higher value timber and grade boards. Mark Wiggs (Levin, 1988) a forest economist from Salem, Oregon proved that 180 year rotations of western forest harvests could yield greater profit than 60 or 90 year rotations. While this work has not been extrapolated to eastern forests, it flew in the face of recent west coast business practices, and may well apply here.

General wisdom holds that the greater the quality of construction the higher the initial cost. Specifically, timber-framing is assumed to be more expensive than light framed homes. In fact, most timber-frame homes cost more than their stud framed cousins. When factoring in the generally higher insulation values and resulting lower utility expenses, larger interior volume to square foot ratios, and typically

higher quality components throughout the project, the difference in cost is greatly reduced.

In sum:

1) Each home requires natural resources not only to be built, and then to be maintained and operated. Few people think that there are unlimited resources to be used without foresight. As stated, the longer life spans of these homes result in less replacement material over the life of the home. The higher initial costs per square foot often results in a somewhat smaller home, necessarily using fewer materials for its completion. The generally high insulation and low infiltration rates found in these homes translates to lower costs in heating and cooling.

But beyond the benefit of reducing forest resource demands, there is compelling rationale to re-examine our attitudes towards home building. The housing stock of the country represents enormous collective investment. We all hold a stake in these homes because their construction affects us so dramatically. Therefore:

2) The construction of each home represents jobs and the socio-economic sustenance that jobs create. The increased labor intensiveness and greater skill requirements typically experienced in timber-frame construction should be celebrated. In a time when class after class of lawyers and stock brokers graduate into bloated ranks, the crafting of high quality buildings offers an exciting manufacturing alternative for our young people.

3) Each home adds to or detracts from the quality of life for its inhabitants and the neighborhood in which it stands. The lack of a national consciousness on the effect of space on family and neighborhood continues to be reviewed. High quality homes play an important role in this issue, and some great thinkers on the subject refer specifically to timber-framing in their discussions (Alexander, 1979; Brand, 1994.)

Heavy timber construction and timber-framing should be reviewed as an alternative to light framed structures in light of this discussion.

The two homes above are identical in plan and size, with construction method the only difference. Represented is a one-and-a-half story cape-style home with 2,200 square feet of usable floor space. Based on data collected by New Energy Works of Rochester, Inc. the timber-framed home would require 8,000 board feet of wood in the 8"x8" posts and beams, and 5"x7" floor joists and roof rafters required to form the structural skeleton. The light framed structure would require 6,250 board feet in 2"x6" studs, 2"x6" joists and rafters, and miscellaneous other dimensional stock for the same structural result. Components that are identical to both construction methods have been factored out for clarity. These include: first floor joists; sub and finish flooring; interior non-load bearing partitions, and; sidewall and roof sheathing.

The projected serviceable life for the timber frame structure is projected as 200 years, while the light framed structure is projected to be 100 years. Please refer to text for further information.

d, only wood construction techniques are reviewed here: There may well be other materials, including steel and masonry that should be continually reviewed for their applicability from a resource and life-cycle cost perspective. At present, the large energy requirements of steel manufacturing, the higher cost and lower thermal efficiencies of masonry, and the still-emerging potential of recycled plastic building material leave wood the clear front-runner in residential buildings. Our goal here is to examine the difference between light framing and heavy timber-framing.

Environmentally Motivated Consumer Behavior: Implications for the Household Furniture Industry

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Abstract

Recently a new influence is impacting the marketing planning and implementation process of modern business - the environment. Specifically, the environmental impacts of the raw materials procurement, manufacturing, distribution, product use, and disposal issues as measured by regulators, environmental organizations, investors, and the consuming public. Of particular interest, consumers who are concerned about the environmental impacts of the products they purchase and use have created a demand for more environmentally friendly products, referred to as green or environmental consumerism. Several researchers have suggested that what lies at the heart of these environmental concerns are different beliefs and values concerning human relationships to and uses of the natural environment, especially the forest environment. A major impact of these new environmental values on the practice of forestry and the wood products industry has been to restrict the harvesting of timber in many areas. However, it is believed that not only will the publics' beliefs and values impact policy issues, but they will also impact consumer demands for "environmentally friendly" wood products.

This paper will examine many of these issues, and will also review a study that is being conducted by the authors. This study attempts to determine for which consumers environmental impact is an important purchase criteria for household furniture. The study also examines consumer environmental beliefs and values for their effects on the perceptions of the environmental friendliness of wooden household furniture as compared to current and potential non-wood substitutes.

Introduction

After declining somewhat in the 1980's, consumer environmental concerns are again rising to the surface in the 1990's. Numerous environmental events and disasters in the late 1980's have alerted consumers to the consequences of industrialization and their own consumption decisions. The Valdez oil spill, loss of endangered species and biodiversity, global warming, the Chernobyl nuclear accident, and the solid waste crisis are just a few of the images that indicate to consumers the extent of the environmental crisis and make our world seem out of control.

Both Ottman (1992) and Coddington (1993) suggest that a significant implication of this trend in environmental concern for marketers of consumer products and services is that individuals will act upon their environmental beliefs through the poser of their purchasing decisions. Consumers, it is suggested, are voicing their concerns in the marketplace by evaluating products not only on performance and price, but also on the environmental and social responsibility of manufacturers.

The implications of consumer environmental concerns are far-reaching for the wood products industry. Consumer demands for more environmentally friendly products are growing, as is pressure for legislation requiring the industry to deal with environmental problems. This combined opportunity and threat may lead wood products marketers to acknowledge that the green challenge will force the industry to change dramatically. Corporate environmentalism is defined by Banerjee (1993) as "an organization wide recognition of the legitimacy and importance of the biophysical

environment in the formulation of organizational strategy." When practiced successfully, it can lead to increased market share and profitability, enhanced corporate and brand image, consumer goodwill, and access to new market segments.

Although the current environmental movement has often been seen as a threat to the wood products industry, with those associated having to defend the harvesting of trees and the use of wood, it now appears there is an opportunity for the industry to take advantage of consumers demands for "greener" products. In their efforts to protect themselves and their world, consumers are scrutinizing products for environmental safety and friendliness. This environmental scrutiny should lead consumers to find that, when grown and harvested in a sustainable fashion, wood has many environmental advantages. One study being conducted to assess the total environmental impact of wood has found that among wood's advantages are the renewability of the resource, the removal of carbon dioxide from the air by actively growing forests, low energy use in the manufacturing process, as well as biodegradability, reusability and excellent insulation qualities (Anon. 1993).

Although there are many environmental advantages of using wood compared to other substitute materials, that message does not seem to have reached the majority of the consuming public. For instance, Winterhalter and Cassens (1993) found that a majority of consumers believe North American forest are under threat and that few forests in the U.S. are managed for sustainability. Also, Michael and Smith (1993) found a "green gap," or no available product which matched the "ideal" for a convenient, green product, in parents' diapering decisions. This previous work suggests there is a need to further explore consumers environmental beliefs and values in order to determine the most effective marketing strategies to enhance the competitiveness of wood products on the green dimension.

Profiling the environmentally concerned consumer

If a manufacturer of wooden household furniture decides to market to environmentally concerned consumers, a major consideration for marketing segmentation purposes will be to identify and profile these environmentally concerned consumers. In other words, which consumers constitute the market segments for wood products which are marketed and promoted based on their environmental advantages. As explained by Webster (1975), management must have a clear understanding of the characteristics of those consumers most likely to respond to appeals to their environmental consciousness. Marketing researchers have looked at demographic, socioeconomic, personality variables as well as values and attitudes to identify the environmentally concerned consumer. We will briefly review some of the most important findings from this literature.

Demographics and socioeconomic variables

Previous research in this area has suggested that demographic and socioeconomic variables alone have not been adequate descriptors of the environmentally concerned consumer. Although previous findings have been somewhat inconsistent, the environmentally concerned consumer has been found to be: young, better educated, white, politically liberal, higher in income, occupational and socioeconomic status, not employed in a resource extractive/dependent industry, and lives in an urban area.

Personality variables

Several studies have found personality variables to be better predictors of environmentally concerned consumers than demographics. On such variable which has received a great deal of attention and shown consistently positive results is perceived consumer effectiveness (PCE). PCE represents an individual's perception of whether or not they have the ability to bring about change through their own

behavior. In this case, a consumer's perception of their ability to have an impact on environmental problems through their purchase behavior.

Values

A value is a mental construct with both cognitive and affective elements. In other words, a value is composed of two dimensions: an emotional dimension involving feelings; and a cognitive aspect which refers to dispassionate facts. Values are central in a person's belief system, and thus they form the basis for evaluative beliefs or attitudes. Rokeach (1973) describes the concept of value as "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode."

Several researchers have suggested the debate over forests and the proper use of forest resources is a result of the different values concerning forests and human relationships to forests (Shands 1988; Kennedy 1985). Shindler et. al. (1993) found evidence of broad support for a more environmentally oriented, multiple valued, and publicly influenced approach to federal forest management. They refer to this as a more "biocentric" value orientation as opposed to an "anthropocentric" value orientation.

An anthropocentric orientation is defined as a human centered orientation toward the non-human world. In effect, the non-human world is reduced to a storehouse of resources and is considered to have instrumental value only, that is, it is valuable only as a means to human ends (Eckersley 1992). A biocentric value orientation recognizes the full range of human interests in the human world for both this generation and future generations; recognizes the interest of the non-human community; and adopts a holistic rather than a reductionist perspective insofar as it values populations, species, ecosystems as well as individual organisms.

Environmental attitudes

An attitude is a hypothetical mental construct which is inferred form verbal reports and behavioral observation (Heberlein 1981). Like values attitudes are conceptualized as being composed of beliefs and affect toward an object (Fishbein and Ajzen 1975). As Heberlein (1981) shows in his review of the environmental attitudes literature, values, beliefs and affect function to form an attitude toward some aspect of the environment. Thus, concern for the environment has usually been conceptualized as an attitude.

A model of the environmentally concerned wood products consumer

Based on our review of the literature and work done by Balderjahn (1988), we hypothesize the following model or profile of the environmentally concerned wood product consumer. A consumer that will consider environmental impact when purchasing wood products: 1) will have a higher educational level, income, occupation, and socioeconomic status, they will be younger, and more politically liberal; 2) they live in an urban area and be employed in a non-resource dependent occupation; 3) they will believe they have the ability to impact natural resource problems through their own purchase behavior; 4) they will have more biocentric values towards forest resources; 5) they will be concerned regarding the environmental welfare of forest resources; and 6) they will support forest management practices they perceive to be less damaging to forest resources. Figure 1 gives a graphic representation of these relationships.

The current study

A study is being conducted by the authors, to determine the profile of those consumers for which environmental impact is an important purchase attribute for household furniture products, or to test the accuracy of our proposed model. The study will also determine the consumer perceptions of the

environmental impact of solid wood compared to current or potential solid wood substitutes for household furniture. In order to investigate the consuming public on environmental beliefs and values, and how they may impact the perceptions and subsequent purchase of wooden household furniture, a mail survey is being sent to 3,000 potential consumers of household furniture. A marketing research firm has provided a list of residential consumers who have lived in their home for less than one year. It is believed that recent home purchasers are likely to also have made a new home furniture purchase, and thus will serve as an adequate sample frame for possible home furnishings purchasers. The sampling, survey procedures, follow-up efforts and data analysis have all been conducted in accordance with the well documented and verified techniques of Dillman's (1978) Total Design Method. In analyzing the data extensive use will be made of Classical Multidimensional Scaling Techniques.

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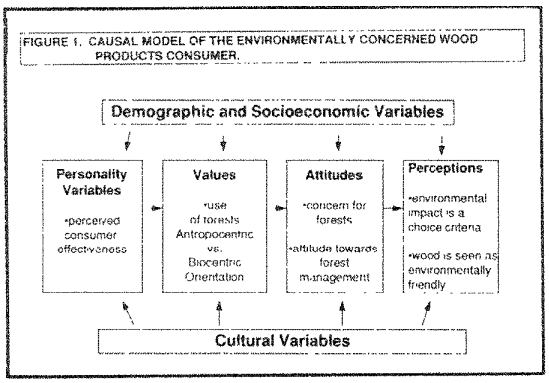
FIGURE 1. CAUSAL MODEL OF THE ENVIRONMENTALLY CONCERNED WOOD PRODUCTS CONSUMER.
Demographic and Socioeconomic Variables
Personality Variables
•perceived consumer effectiveness
Values
•use of forests
Antropocentric vs. Biocentric Orientation
Attitudes
•concern for forests
•attitude towards forest management
Perceptions
•environmental impact is a choice criteria
•wood is seen as environmentally friendly
Cultural Variables

1994 Issues for Forestry Professionals

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Abstract

Who's Fooling Whom? Are "environmental" groups and the legislation they have encouraged really having a desirable societal and environmental impact?

Forestry and forest products are sustainable activities and products.

American lifestyle is on a collision course with the unacknowledged impacts of our profligate consumption.

Global trade is based on massive use of fossil fuels.

American transportation and use of low cost energy has displaced local sustainable agriculture.

Substitution of steel, masonry, plastic for wood in the name of environmental quality is a lie.

What are Forests For?

Sanctuary?
Protection of biodiversity?
Benign source of renewable products and energy?
Supplier of materials as the market requires?
Investment opportunity for long term sources of capital?
Participant in the global market?

Where do People Belong in the Broad Scheme of Things?

Major predators?
Disinterested bystanders?
Protectors of the genome of the planet?
Major consumer of all energy resources available on the planet?
As a species isolated from the normal competitive battle for global resources?

What Part Should Forestry Play?

Source of local energy and materials to be used primarily within stable communities?
Prime mover for social change?

Suggested basis for dialogue:

There are 3 kinds of "environmentalists" - "protectionists", "preservationists", & "sustainable solution seekers."

Forests and forestry are being converted from sustainable providers of energy and materials because of a lack of a global energy policy.

The extent to which U.S. financial problems are exacerbated by purchases of foreign oil.

Current energy consumption is supplied from sources that damage both our community structures and our environmental stability.

Consumption is facilitated by promotion of unsustainable life styles based on energy costs that do not reflect the full costs of the energy use.

Preservation & Environmental Protection" at home must not result in the displacement of pollution and environmental damage to other countries.

Proposed actions:

Proactively describe the position of forests and US economics

Forests produce real wealth from water, CO2, land, (human care), and time

Describe the degree of vulnerability faced by the oil based consumption patterns being encouraged by our economic model

Describe wood as a local resource that should get modified for its highest use close to the point of growth

Develop a national CO2 recovery certificate program that funnels the revenues from CO2 liberators to CO2 recoverers.

Advocate for responsibility by the financial community to develop local sustainable business plans that wean the region from reliance on imports for energy and exports for cash.

Encourage all corporations to rewrite their charters with sustainable energy systems as the base for all operations.

For our own benefit and as a role model we could advocate:

Refusal to create impediments to forest use without total energy cost analysis of alternatives necessitated by these impediments.

Education of all students in what a sustainable life style entails and educate all students in biology and ecology.

Research funding for local small-scale cogeneration systems that use locally available renewable fuels.

Exposure of the "global market place" as the fossil energy-dependent system that it is.

Efforts to develop intraregional trade as the norm (with barter between regions).

Exposure of the sources of funding for the massive "Environmental Organizations" that dominate the "preservation/protection" discussions today.

Issues for forestry professionals in 1994:

Who's Fooling Whom? Are "environmental" groups and the legislation they have encouraged really having a desirable societal and environmental impact?

Environmental regulation is causing shifts from sustainable activity toward the consumption of non-solar energy sources. This happens because it appears that there is a collective surplus of funds and a need for protection of various facets of our lives from our consumption. This appearance of surplus develops from the largess associated with the use of energy that is priced at less than the total economic and environmental cost of the commodity. Thus, American lifestyle is on a collision course with the unacknowledged impacts of our profligate consumption. In 1990 a sustainable level of CO2 emission per person for the earth was 1.69tons/year. The average 1990 US CO2 emission per person was 19 tons or more than ten times what an acceptable level was. The UN CO2 Information Analysis Center predicts that by 2025 the global sustainable emission level may be down to 1.05 tons per person per year. This consumption gap is being encouraged by the regulations that seek to protect us from the impacts of consumption. The impact of governmental regulations must be weighed by comparing the value of the protection against the environmental cost of the regulation. Today too often regulation is targeted at sustainable activities by using fossil fuels to fund the protection efforts.

Forestry and forest products are sustainable activities and products. Trees are made of a major waste product of our society, carbon dioxide (CO2). Products made from wood are carbon storage items even if they were not designed that way. Even landfilled organic material is a carbon storage mechanism as long as it doesn't rot. Removing old trees makes room for young vigorous trees to grow. Young forests are much better CO2 accumulators than are older forests. Old forests are unreliable storage vehicles for the carbon tied up in the wood because there are many risk factors that are more effective on trees that are tall, out of balance

physiologically, stressed by environmental factors, etc., and older trees are more likely to share all of these factors and hold very large amounts of carbon in each individual. Recent research in high elevation forests of the southeast indicate that mortality of old trees is 3 times previously observed levels. It is speculated that this problem is caused by pollution coming from the west.

Forests provide real wealth for people of communities to modify and use for their benefit. The long distance transport of wood with fossil fuels to a plant that runs on fossil fuels is an example of an industry that uses significant amounts of fossil fuels. The forestry community needs to encourage the research community to develop ways of using our wood waste, mortality, and small thinnings in small quantities to power local energy production and manufacturing. Research is also needed to develop ways of adding as much value as possible close to where the trees grow.

Let us not also fool ourselves while others are trying to fool us. "Environmental" regulations must balance the need for a reasonable quality of life with the need to drastically reduce our dependence on imports of all kinds, including fossil fuels. The forested areas of our country must come to be an integral part of the energy and material supply system as we are weaned from these other sources. All ecosystems are energy transfer systems from an energy source (producer) of some sort through several to many species with an eventual increase in entropy -- waste heat or disorder. Ecosystem management must start with the high end predators or it is doomed to failure. Our lives today are lived as if this were not the case. The compromises by the forestry and forest products community have been made as if good forestry was part of the problem rather than a significant ameliorator of human resource consumption.

Global trade is an example of economics based on false assumptions. Global and interregional trade is based on massive use of fossil fuels that are currently priced at less than their full economic and environmental cost. The subsidization of the most common modes of transport, truck and air has enabled the development of unsustainable agriculture in very distant regions and has reduced the rail and barge transport to fractions of their potential. The use of low cost fossil fuel has displaced local sustainable agriculture. These forces have destroyed communities throughout this nation by requiring the choice between products that are cheap but with long term side effects and local sustainable products that were more expensive. These choices have become even harder to make as the information about the process of production becomes harder to gather and comprehend. The cheap energy and long distance transport has forced farmers who practiced sustainable agriculture to either use fossil fuels and get bigger or to move out. Substitution of aluminum, steel, masonry, or plastic for wood in the name of environmental quality is frequently a deception. These materials all have fossil fuels used in their production and the volume of energy used is significantly higher than the energy needed to produce the same item from wood.

What are forests for?

What are forests for: Sanctuary? Protection of biodiversity? Supplier of materials as the market requires? Investment opportunity for long term sources of capital? Participant in the global market? Our "environmental" leaders today would have us believe that forests are most important for the aesthetics, diversity, and genetics that they embody. If one accepts the notion that humans are above the normal ecosystems that inhabit forests, that may seem plausible. But it is not true. Humans are little different from ants except that we can see the impact of our actions better. Human economic activities operate within the same envelope of air and on the same resources as the ant community. Humans have come to occupy a very significant portion of the total ecological space available on earth. They are likely to attempt to acquire more. This tension for more resources does not negate the value of the other members of the eco-community in which we reside. It does place the responsibility of our energy decisions squarely where they belong, on

our own shoulders. Each of us should use no more energy than is ecologically sustainable within the community we choose to frequent. Forests are benign sources of renewable products and energy. Forests that are not declared preserves for very good reasons must become much more significant providers of real resources for local communities.

Where do People Belong in the Broad Scheme of Things?

Should people be: Major predators? Disinterested bystanders? Protectors of the genome of the planet? Major consumer of all energy resources available on the planet? As a species isolated from the normal competitive battle for global resources? All these positions are now taken for granted. Each special interest group chooses one of these as the penultimate "good". Some of these we can balance. For instance, we can choose what we eat and where it comes from. Our communities will always consume a quantity of energy that is affected by the numbers of people in the community and the amount of non human assistance and environmental modification we require. Minimizing local impact is not enough to say that impact of humans has been mitigated. The "NIMBY" syndrome merely exports negative impacts. Today the atmospheric impact of all the things that humans demand is pervasive and potentially massively upsetting to areas that have never even had any physical presence of a single human. Although decisions of individuals drive the global impact, these decisions are largely based on economics; economic policies are set or encouraged by governments. Tinkering with individual ecosystems, in ways that seek to maintain them, without addressing the impact of our life style on the global scene is like counting grains of sand.

What part should forestry play?

The potential of forestry is to be something that can be done forever. It can continue as is until the impact of the fossil energy use therein (transportation and processing) catches up with it. As part of the global economy it is also part of the problem of negative cash flow, pollution, and CO2 accumulation. As part of a society that wants to use fossil and nuclear fuel "servants" because of their low present cost, it is still part of the problem. The long-distance transport of unprocessed wood is an example of "economies of scale" that are completely dependent on fossil fuel use. Forests can become a source of local energy and materials to be used primarily within stable communities as a means to stabilize these communities and to ameliorate fossil CO2 release. For this to happen it must be realized that we have been protecting both ourselves and our children from life. This protection has been bought with the largess from cheap fossil and nuclear energy. The choice of an energy source must be made very carefully because it may eventually come to devalue parts of the ecosystem that have lower energy concentrations or lower flow rates (such as biomass). This devaluation then results in the elimination of the possibility of sustenance from these lower-value sources or occupations connected to them. Recognition of the value of renewable energy (solar) as well as materials that come from forests can make forestry a prime mover for social change.

Suggested basis for dialogue:

There are 3 kinds of "environmentalists" - "protectionists", "preservationists", & "sustainable solution seekers."

The dialogue from the first two of the above advocates for "environmental" solutions has been dominated by either poorly informed individuals and groups or those that have very limited agendas, including maintenance of their own financial positions. The activities of these two groups has not sought to direct humanity into sustainable pathways. Forestry and the use of nonpreserve forests can integrate of all three facets of environmental action.

Forests and forestry are being converted, to uses other than sustainable provision of energy and materials, due to a lack of a national and international energy policy.

Forests are the only long term natural terrestrial solar collectors that we have. They are relatively easy to manage. It is quite likely that directed research would find ways to use the mortality of nonpreserve forests for efficient local energy production. The lack of an "environmentally" sound national and international energy policy is resulting in the development of a group of roving transnational resource and labor manipulators that prey on forests as they do any other resource. They then sell the products to whatever country has the liquidity to pay for their wares. The U.S. is in the process of being stripped of its industrial productive capacity and its forests are being used as a raw material in the export cash market. Even third world countries have learned that they must not sell unprocessed timber for cash. Such sales eliminate the value-added multiplier from conversion to finished products. The lack of a coherent energy policy allows the promulgation of uncoordinated regulations in the name of "environmental" action which do not target total energy use nor the type of energy used. Frequently these regulations require the use of revenues from fossil fuel use in order to be implemented and destroy sustainable solutions in the process.

The extent to which U.S. financial problems are exacerbated by purchases of foreign oil.

Today the Northeastern U.S. has a fiscal hemorrhage that no one talks about. It is as if it is normal for us to send 85% of the price of every purchase completely out of the country. This can not continue for very long. At some point either the fiscal reality of this drain on this region will surface or the impact of the use of the atmosphere and rural landscape as an unending dump will create inescapable dilemmas. Then there may be little that can be done to change the conditions. Today we could recognize that we are on the wrong path and take steps to move toward less damaging energy sources.

Current energy consumption is supplied from sources that damage both our community structures and our environmental stability.

If one stands on a street corner today and asks how much of what happens in that vicinity is sustainable (e.g., that does not use the atmosphere as a dump and does not devalue all human labor), there is only one answer - very little. Today our communities are in a meltdown condition because the price we pay for energy is so low that human effort has little value. Fossil and nuclear energy have devalued human labor in our society. Thus farmers and loggers can no longer compete if they are not using a 100+ horsepower tractor or skidder. Neither they nor their industrial counterparts today are real "knowledge" workers as the popular press and the government would have us believe, rather they are energy managers. They are also subject to replacement by computerized energy mangers as the facilities that are used become larger and more centralized. The trend today is to displace these workers with fossil fueled mechanization; rather than systems that are powered from the resource being harvested. Communities of the past were interdependent societies. They bought little from outside their limits because the inhabitants used the local resources to supplement each others' production. Today communities are bedrooms for managers of energy. The layout of the community is designed for privacy and aesthetics. Pleasure and relaxation for an energy manager is all that matters. Every phase of life today requires the use of fossil fuel energy. The food we eat frequently has more energy in the packaging than it does in the food.

Consumption is facilitated by promotion of unsustainable life styles based on energy costs that do not reflect the full costs of the energy use.

The wrong turn that led us to the path that we are now on was taken over 150 years ago. President Lincoln thought that he would preside over a nation of small farms and towns that were designed to service those farms. He was wrong. The marshaling of energy for manufacturing that the North used to win the Civil War changed the fabric

of the country in unexpected ways. The technologies that developed later also contributed to the divergence of the path from one that would be truly sustainable. Today our methods of communication, our financial system, and the marketing community have convinced us that the only good life is one that is dominated by the use of fossil and nuclear fuels. This conviction is so strongly held that the politicians do not have the will to even try to raise badly needed cash from that resource, to say nothing of trying to wean us away from it over a short time period. Thus the demand that energy be kept cheap is a major obstacle to progress away from the current path. How have the Europeans managed to have retail energy costs four times ours and still maintain what most would consider a reasonable standard of living?

"Preservation & Environmental Protection" at home must not result in the displacement of pollution and environmental damage to other countries.

The global economy is a reality. It is driven by low cost fuel and a flexibility in supplying resources and labor to any point in the world at low cost. There is little guarantee that the locations chosen for the combination points will either be permanent homes for the employment of the local residents or be fairly treated by the owners of the mobile facilities. When costs get too high they will move to the next cheapest location. The separation of production and buyer that the global economy allows makes it much less likely that the consumer will be able to choose wisely in terms of pollution abatement, fair labor practices, and the like in the purchase of variously priced goods. One of the best way to avoid untoward consequences is to buy from your neighbor. At that point you know that the pollution is in your own backyard and you can deal with it.

Proposed actions by the forestry and forest products community:

Proactively describe the position of forests and US economics.

- We should not be defensive when describing what forests produce and how they work.
- We should not yield high ground to people who fly around the world telling lies or incomplete truths.
- We should be open about the trap that we all find ourselves in and describe how companies can cope as things change. They will change. You can plan for several eventualities. One can not do it alone, but one can respond in an appropriate manner. The alternative is to fight to maintain the status quo. Luckily most of the forest industry is still community-based and can change appropriately without too much baggage.
- We can illustrate that forests produce real wealth from water, CO2, land, (human care), and time. This is a unique characteristic shared only with farming and fisheries. Our economic system has forced the owners of small amounts of forestland, particularly in populated areas, to neglect or abuse it in the past. The techniques that are being marketed today for harvesting and processing forest products depend almost entirely on fossil fuels. The expense of these systems makes the care needed to leave a healthy forest after harvesting very difficult to provide. The buyout of wood burning power plants in New Hampshire is an example of the coercion applied to force oil and nuclear dependence on this region. The CO2-recovery aspect of forest growth and wood use has received little attention. It should be on top of our list of our activities' positive attributes.
- We can show how the use of wood that is specifically designed as a carbon store can make a difference. This function will be even more important if our society continues to demand that most systems be fueled by fossil fuels.
- We can supply our raw material needs with our wood and power all of our processes on our own energy, and have more to spare, if the rest of society will pay a fair, all costs included, price for the energy source they choose.
- We can describe the degree of vulnerability of our economy from the oil based consumption patterns being encouraged by our economic

model. Use the fact that 85% of every energy dollar is spent outside the region as a lever to pry concessions from environmental groups before an inch is given for compliance with regulations that use cheap energy and discourage renewable energy production.

- We can describe wood as a local resource that should be manufactured for its highest use close to the point of growth. This is a very basic principle. Every third world country understands that shipping raw wood is tantamount to raping and pillaging the forest. There is no infrastructure to help with its maintenance after it is cut and the price paid is always less than what it really takes to grow it.

Develop a national CO2 recovery certificate program that funnels the revenues from CO2 liberators to CO2 recoverers.

A major step to good forestry is for forest owners to be paid for the things that the forest does. CO2 recovery by trees is real. It is needed unless the global climate maintenance system is already out of control. We won't know, if it is out of control or not, until it is too late so action now is appropriate. It would be even better if this were a global program because then the long distance transport of goods and services would be much more costly. It is much more likely that things will be done locally or at least regionally as the cost of transportation increases. In any case the U.S. is looked at as a role model. We need to start doing some sustainable things instead of exporting consumption patterns that should not be repeated.

Advocate for responsibility by the financial community to develop local sustainable business plans that wean the region from reliance on imports for energy and exports for cash.

The financial sector of our society has escaped the environmental reviews that most other sectors have had to struggle with lately. Yet they are primarily responsible for the decisions that most small and medium sized businesses make. If your costs are too high you can't pay the debt service. Banks therefore encourage cost reduction - the use of cheap energy.

For our own benefit and as a role model we could advocate:

- Refusal to create impediments to forest use without total energy cost analysis of alternatives necessitated by these impediments.
- Education of all students in what a sustainable life style entails and educate all students in biology and ecology.
- Research funding for local small-scale cogeneration systems that use locally available renewable fuels. Fuel cells and liquefaction of wood should be included in this effort.
- Exposure of the "global market place" as the fossil energy-dependent system that it is.
- Efforts to develop intraregional trade as the norm (with barter between regions).
- Exposure of the sources of funding for the massive "Environmental Organizations" that dominate the "preservation/protection" discussions today.
- That all corporations rewrite their charters with conversion to sustainable energy and community systems as the goal for all operations.

Early Indicators of Acidification: A Whole-Watershed Approach to Studying Forest Response

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Abstract

A whole-watershed acidification experiment was conducted in which the impacts of additions of nitrogen and sulfur at triple ambient rates were monitored to document ecosystem level biological and chemical responses to acidification. The objective of this study was to develop field techniques to aid forest managers in assessing the health status of forests undergoing acidification stress. Soil and percolating soil water response to acidification involved decreased pH and increased levels of sulfur and the phytotoxic metals aluminum and manganese compared to unacidified control areas. The concentrations of calcium and magnesium increased in percolating soil water collected below the rooting zone. Response of Japanese larch (Larix leptoleptis Sieb. and Zucc.) planted on the watershed included decreased height and diameter of acidified trees compared to control trees. Foliar nutrient calcium and magnesium concentrations in Japanese larch, red maple (Acer rubrum L.), sassafras (Sassafras albidum (Natt.) Nees), mountain laurel (Kalmia latifolia L.) and blackberry (Rubus spp.) were lower in treatments receiving simulated acidification compared to control treatments. Higher concentrations of foliar manganese were evident in trees receiving the acidification treatment. Monitoring of soil, percolating soil water, and foliar chemistry and tree growth under the simulated acidification treatment revealed that all appeared to be pertinent indicators of ecosystem response to acidification.

Introduction

Controversy remains over the impact acidic deposition has on forested ecosystems. Acidification of soils due to additions of nitrogen and sulfur has been well documented (Robarge and Johnson 1992). Net leaching of base cation nutrients has been reported (Robarge and Johnson 1992; Federer et al. 1989) in areas receiving large inputs of atmospheric sulfur and nitrogen. Gradual depletion of base cations and the increased solubility of aluminum and manganese at low soil pH values disrupt nutrient balance and may lead to depressed tree growth. The forest health perspective has broadened on the issue of acid deposition to include effects on forest soils, tree nutrition, accelerated soil base cation leaching and metals toxicity (Tomlinson and Tomlinson 1990).

This study was an attempt to document soil and soil water chemical changes under simulated acidification of a forested watershed in north-central West Virginia. These changes were then related to growth and nutritional status of selected plant species growing on the watershed.

Study design and methods

Clover watershed (11.6 hectares), located in north-central West Virginia, was selected for this study. A general description of the watershed and a history of past land use were provided by Kochenderfer and Helvey (1989). Beginning in 1983, vegetation from the entire watershed, excluding a 1.42 ha buffer zone along the stream, was removed and the watershed was planted with 2-0 stock Japanese larch in the spring of 1984. To simulate inputs of triple the ambient rates of N and S deposition, granular ammonium sulfate fertilizer was applied to Clover watershed by helicopter beginning in April 1987 and continuing through July 1994.. Three applications of ammonium sulfate are applied each year for a yearly addition of

150 kg/ha of N and S. Control plots established on the watershed prior to treatment did not receive treatment.

Soil samples were obtained from hand dug pits in control and treated areas. Calcium, Mg, Al and Mn were determined by atomic absorption spectrophotometry following 0.01 M SrCl2 extraction and preparation as outlined by Joslin and Wolfe (1989). Soil NO3-N and SO4-S analyses were performed by the Agricultural Analytical Services Laboratory, at The Pennsylvania State University based on methods outlined in North Dakota State University (1988). Pan lysimeters were installed at 46 cm in 6 control areas and in 6 corresponding treated areas, and soil water analyses were performed by The Timber and Watershed Laboratory, Parsons, WV. Japanese larch height and diameter were measured on sample control and treatment trees in July of 1992 and 1993. Foliar samples were obtained from Japanese larch, red maple, sassafras, mountain laurel and blackberry in August of 1992 and 1993, and ICP analysis was performed on foliar samples by the Agricultural Analytical Services Laboratory.

Statistical analysis followed a Model I two-treatment ANOVA for a fixed treatment. The SAS statistical package was used for data analysis; all significant differences are reported at ((0.05 (SAS Institute, Inc. 1985).

Results and discussion

Japanese larch trees which received 6 years of increased N and S deposition treatment had significantly reduced growth (height and diameter) compared to control trees (Figure 1). Data for larch height growth on the entire watershed also indicated significantly greater height growth on the control areas compared to larch receiving treatment (J. Kochenderfer, personal comm.). Treated soil had significantly lower levels of nutrient elements Ca and Mg and significantly greater N and S and the toxic metal Al compared to control soil (Figure 2). In 1993, soil Mn (0.01 M SrCl2 exchangeable) was also determined and was significantly greater in the treatment. These soil changes as well as a decrease in soil pH in the treated soil (control pH = 5.38, treatment pH = 4.91) indicate that the treated soil has become more acidic (Schlegel et al. 1992). Because the growth of larch is not stimulated by large N additions and the Ca demand of larch foliage is relatively high, N addition and Ca leaching may be contributing to the observed growth declines of the treatment trees (Tyrrell and Boerner 1987; VanGoor 1953).

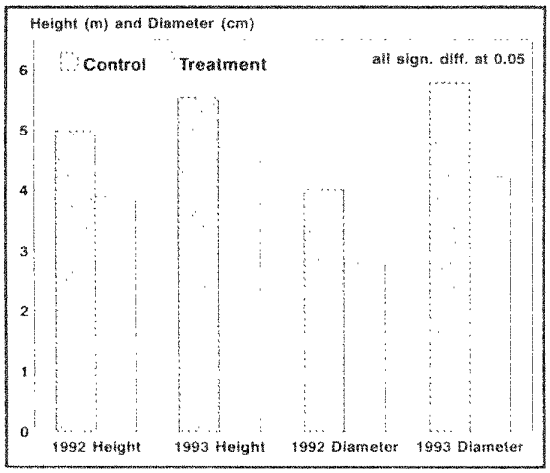

Figure 1. Height and Diameter Comparisons Between Control and Acidification Treated Larch Trees for Sample Dates August 1992 and 1993.

Results of Japanese larch foliar analysis indicated significantly greater Mn and Al and lower Mg and Ca (not significant) in the treated area. Similar results were obtained for red maple, sassafras, mountain laurel and blackberry (Table 1). In general the treatment area had lower foliar and soil Ca and Mg, and higher soil and foliage Al and Mn than the control area.

Reduced uptake of Ca and Mg in response to the treatment may be a consequence of leaching losses with the mobile SO42- and NO3- anions. Soil water data also indicate accelerated loss of Ca and Mg as

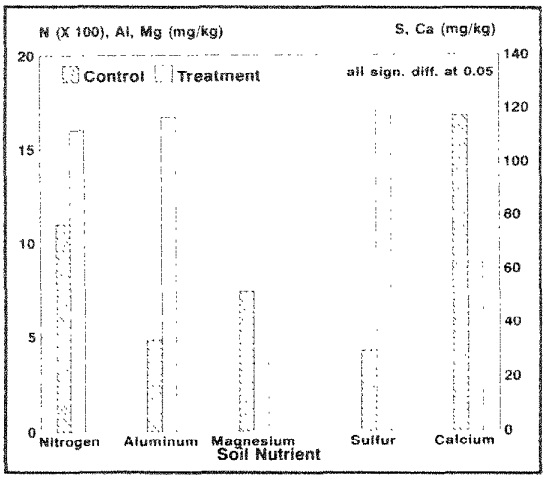

Figure 2. Soil Nutrient Comparisons Between Control and Acidification Treated Soil.

a result of the acidification treatment (Figure 3). Treatment larch height and diameter (r = 0.83 and 0.84 respectively) were positively correlated with foliar Mg, and foliar Mg was significantly reduced in treated larch. Magnesium deficiencies have been reported in declining Norway spruce (Picea abies) throughout Europe (Tomlinson and Tomlinson 1990) and in the eastern US (Ke and Skelly 1994).

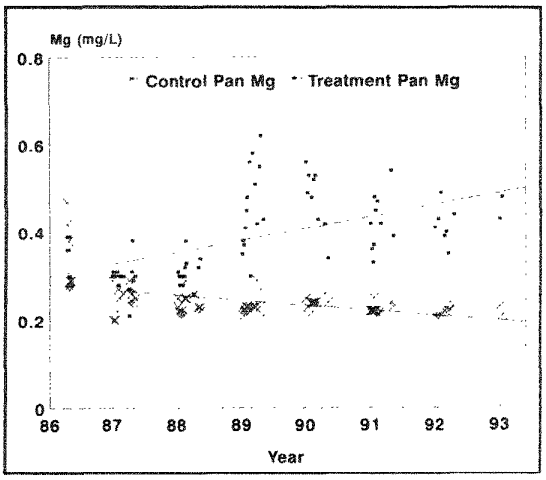

Figure 3. Mean Pan Lysimeter Magnesium for Clover Watershed, 10/1/86-2/18/93.

Conclusions

The chemical changes observed on this watershed, including soil acidification, increased leaching of Ca and Mg, increased foliar Mn concentrations, and decreased tree growth may be used as indicators in the early assessment of forest ecosystem response to acidification.

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Table 1. Foliar Chemistry Comparisons Between Control and Treatment Species. The * indicates significant difference between control and treatment at $\alpha \leq 0.05$.

Foliar Chemical	Exp't Condition	Japanese larch	Red maple	Sassafras	Mountain laurel	Rubus spp.
Ca (%)	Control	0.54	0.93*	1.06	1.07*	1.27*
	Treatment	0.52	0.75	1.05	0.79	0.87
Mg(%)	Control	0.13*	0.16*	0.17*	0.20*	0.35*
	Treatment	0.10	0.09	0.14	0.13	0.28
Al (ppm)	Control	164.6*	18.7*	64.0*	55.6*	82.2
	Treatment	190.8	22.0	86.7	46.0	107.1
Mn (ppm)	Control	193.8*	1788.5*	269.5*	840.5*	1566.1*
	Treatment	2422.6	2206.2	611.0	1488.8	2350.8
S (%)	Control	0.19	0.18	0.40	0.14	0.18
	Treatment	0.19	0.18	0.42	0.14	0.19

Countering the Threat Posed by Invasive Exotic Plant Species; Efforts by the Virginia Native Plant Society

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Invasion of natural ecosystems by introduced or exotic species--including plants, insects, vertebrate animals, and various pathogens--is increasingly considered to be a major threat to ecosystem health and biological diversity. Nor is the problem confined to "island" ecosystems such as Hawaii or the southern portion of Florida. Exotic plants now comprise more than 20% of the species listed in Roger Tory Peterson's *Field Guide to Wildflowers.* At least 88 National Parks have reported problems associated with invasions of exotic plant species. Confirmation of the growing awareness of this threat is the study recently completed by the Office of Technological Assessment at the request of three Congressional subcommittees.

The Virginia Native Plant Society has formed a "partnership" with the Virginia Department of Conservation and Recreation on a project to combat the spread of the more harmful of these plants through citizen education and action.

Project SHARE
Atlantic Salmon Habitat Enhancement for Maine's Down East Rivers

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Champion International Corporation, Greenville, SC

Background

Atlantic salmon (Salmo salar) once inhabited freshwater rivers on both sides of the north Atlantic, and as far south as the Housatonic River in Connecticut, and occurred in at least 33 rivers in Maine (MacCrimmon and Gots 1979, Thorpe and Mitchell 1981, Beland 1984). The species was extirpated throughout most of its range during the late 1800's and early 1900's through over-harvest, habitat loss and destruction, and pollution (ND&T and Ritzi 1994, Netboy 1968). Since the mid-1900's there has been a concerted effort to restore Atlantic salmon to many rivers in its historic range, but with only modest success.

Today, the primary cause for low salmon populations is believed to be commercial over-harvest and at-sea (wintering) habitat (ND&T and Ritzi 1994). The two primary commercial fisheries affecting the Atlantic salmon are the Newfoundland fishery and the West Greenland Fishery. The moratorium on the Newfoundland fishery begun in 1992 and the buy-out of the West Greenland fishery begun in 1993, both continuing today, offer the greatest potential for short-term relief from commercial over-harvest.

Fresh-water (nursery) habitat is also important, and will become increasingly so if limitations on commercial harvest are successful. The down east rivers of Maine (Machias, East-Machias, Dennys, Narraguagus, and Pleasant rivers), in part because of the relative lack of obstruction along these rivers, offer great potential for a successful conservation effort focused on riverine habitat. Such an effort, we believe, would contribute significantly to the restoration of Atlantic salmon. This is the area of initial focus for Project SHARE.

Origin of project SHARE

In early April, 1994, three of the major forest landowners in down east Maine -- Baskahegan Company, Champion International Corporation, and Georgia-Pacific Corporation, with more than 1 million acres combined in the area -- chose to develop a voluntary public/private approach to Atlantic salmon resource conservation and enhancement. On June 27, these three forest product companies joined with 16 other cooperators (including other forestland owners, agricultural landowners, state agencies, research and conservation groups, and local business) as charter members of Project SHARE (Salmon Habitat and River Enhancement). These are:

- Baskahegan Company
- Bangor Hydro-electric
- Champion International Corporation
- Cherryfield Foods Inc.
- Down East Timberlands
- Georgia-Pacific Corporation
- Jasper Wyman & Son
- Machias Savings Bank
- Maine Atlantic Sea Run Salmon Commission
- Maine Conservation Rights Institute
- Maine Council, Atlantic Salmon Federation
- Maine Department of Inland Fisheries and Wildlife
- Maine Forest Service
- Narraguagus Salmon Protective
- National Council of the Paper Industry for Air and Stream Improvement
- National Fish and Wildlife Foundation
- S. D. Warren Company
- Seven Islands Land Company
- The Nature Conservancy

Organizational structure and objectives

Project SHARE was established as a cooperative effort to address the freshwater habitat needs of the Atlantic salmon on the rivers in down east (Washington County), Maine, and indirectly the other fisheries in the area. The objectives of Project SHARE fall into three general areas: habitat management, research, and education. Cooperators plan to identify habitat restoration/enhancement needs in the down east rivers, prioritize them, and bring the necessary resources together to address them. Information gaps in river habitat management and survey techniques, as well as land-use/forestry/fishery relationships, will be identified, and research developed to fill those gaps. Also, a public education program will be instituted to garner understanding of and support for the Project and the conservation of Atlantic salmon. To coordinate these efforts, Project SHARE established three standing committees: habitat management, research, and education (Figure 1).

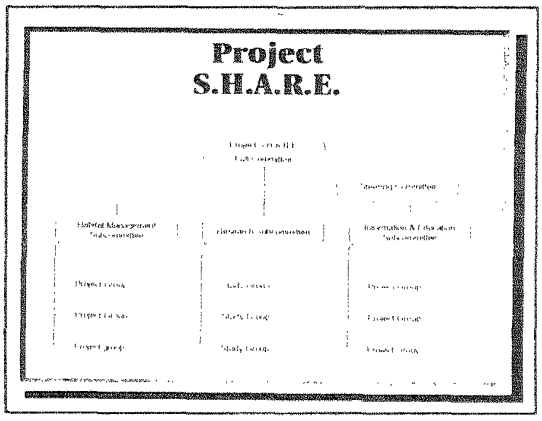

Figure 1. Project SHARE is a cooperative effort to address the freshwater habitat needs of the Atlantic salmon in down east Maine. Projects will be coordinated through three standing committees: Habitat Management, Research, and Education.

Key operating guidelines

Building successful cooperative partnerships, particularly those that include a mix of public agencies, private landowners, and other private organizations, requires mutual respect. Such respect is earned if each member contributes something to the partnership. The "contribution" does not have to be equal in size or dollar value, but should be more than opinion. Simply offering one's opinion of what the others should do, and nothing else, can undermine respect. Such one-sided "help" is often perceived as a demand by a critic not aid by a cooperator. Respect is also built by each member demonstrating an acceptance of the others' objectives, and a willingness to work within those objectives. Recognizing these traits of human nature, the charter members of Project SHARE established a set of key operating guidelines:

- A voluntary, cooperative process that will provide for salmon habitat enhancement.
- Open to all who share a commitment to resource enhancement through cooperative means, and who can bring resources to the table in support of the overall objectives.

- Recognition of and respect for individual landowner, agency, local community, or group objectives.

Results

After only two business meetings, members of Project SHARE have identified five management projects, and subcommittees to coordinate them. These include removal of natural stream blockages (log jams etc.), beaver control (trapping and removal of dams), summary of existing regulations pertaining to salmon streams and associated watersheds, repair/replacement of specific water control facilities, and the installation of temporary population monitoring stations in selected streams. Two research projects were also identified -- review and assessment of irrigation water removals, and review and assessment of stream temperature data -- and teams appointed to draw up the necessary study plans. A number of education projects were also initiated including training sessions for foresters, video tapes on Atlantic salmon, and a logo contest for children.

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Short Stream Impacts Associated with Forest Road and Skid Trail Crossings

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Abstract

Forest roads and skid-trail networks often cross headwater streams and associated small riparian wetlands. The environmental impacts of road and trail crossings on stream water quality, especially the relative merits of different types of crossings (bridges, culverts, and fords, etc.) have not been documented. A study was initiated at two sites in Pennsylvania to determine the short-term impacts of several types of commonly used crossings for haul roads and skid trails on stream total suspended solids. Sites chosen were: Penn State's Experimental Forest in Huntingdon County, Pennsylvania and Glatfelter Pulp Wood Company properties in Fulton County, Pennsylvania. Stream water samples were taken before, during, and after installation and use of the crossings. Crossing types used represent conventional as well as innovative technologies, including use of portable steel and treated timber bridges, culverts with clean shale fill and log fill, an unconfined stone ford and a GEOWEB{SYMBOL 210 \f "Symbol"} ford. Preliminary results indicate that increases in suspended solids and turbidity did occur during installation of all crossings. However, the impacts were generally confined to short sections of the stream ({SYMBOL 64 \f "Symbol"} 61 meters) and were reduced to insignificant levels within 24 hours.

Introduction

In Pennsylvania, forest road and skid trail networks constructed for harvesting activities are often located across headwater streams and associated small riparian wetlands. These types of crossings are generally exempt from Federal Regulation (Section 404 of the Clean Water Act), but in Pennsylvania they are regulated by state permits. When a stream crossing can not be avoided, the common crossing methods used in Pennsylvania are culverts with local fill (shale, gravel, or log), or, less commonly, portable bridges and fords.

While the effects of forestry activities on water quality have been documented, research focusing on the impacts of stream crossings is sparse. Miller (1993) evaluated 70 crossings of stream/wetlands which were at least five years old in Pennsylvania to describe the long-term impacts of the crossings on habitat quality and channel stability. Results indicated no significant differences in channel stability and habitat quality when comparing conditions above versus below the crossing (Miller, 1993). However, stream bed fine sediment levels were higher, tree basal area lower, and percent herbaceous cover higher in the immediate vicinity (< 10 meters upstream and downstream) of some crossings (Miller, 1993).

Thompson and Kyker-Snowman (1989) evaluated short- and long-term impacts of non-point source pollution caused by logging equipment entering and crossing streams. During a simulated 'logging' operation, a portable bridge was most effective in reducing crossing water quality impacts (Thompson and Kyker-Snowman, 1989). Thompson and Kyker-Snowman (1989) concluded that the largest impacts to stream water quality occurred as a result of unmitigated crossings, crossings which did not meet best management practice standards, and the approach areas adjacent to the crossings.

The short-term impacts of road and trail crossings on water resources, however, have not been completely documented, especially the relative merits of different types of crossings (e.g. bridges,

culverts, fords, etc.) during construction and use. A study was initiated at two sites in Pennsylvania to determine the short-term impacts of several types of commonly used crossings for haul roads and skid trails on stream total suspended solids. Sites chosen were: Penn State's Experimental Forest in Stone Valley, Huntingdon County, in central Pennsylvania and Glatfelter Pulp Wood Company properties in Fulton County, which is located in southern Pennsylvania. The Stone Valley sites are part of the Susquehanna River watershed and the Fulton County sites are part of the Potomac River watershed, the largest and second largest freshwater contributors to the Chesapeake Bay.

Site description

Four different crossing types were evaluated on the 14.9 hectare (ha) Stone Valley site. They included skid trail crossings using a metal culvert with clean shale fill, a metal culvert with log fill, and a portable steel bridge and a haul road ford constructed of a GEOWEB{SYMBOL 210 \f "Symbol"} plastic confinement system with shale fill underlain by geotextile fabric. All crossings were made across unnamed intermittent tributaries to Shaver's Creek, a high quality trout stream. A shelterwood cut was completed on this site in April, 1994.

In Fulton County three haul road crossings were constructed at three separate locations. A culvert with shale fill was constructed on an unnamed intermittent tributary to Licking Creek on the 14.6 ha Kelso site. The crossing at the 13.8 ha Bailey site consisted of a bedrock-based, gravel ford across an unnamed intermittent tributary to Owl Creek. A wooden bridge constructed of treated railroad ties across the headwaters of Foster Creek was installed on the 20.2 ha Truax site. Logging is scheduled to begin in August, 1994 on all three Fulton County sites.

Methods

Field sampling was initiated in June, 1993 at the Stone Valley site. Sampling upstream, immediately downstream, and 61 meters downstream of each of the crossings was conducted during base flow and storm flow periods before, during, and after installation of the crossings and during and after logging in an attempt to characterize ambient conditions during all levels of activity and flow. Unfortunately, flow was inconsistent and prevented continual monitoring for the culvert with shale fill and ford sites at Stone Valley.

A similar sampling strategy was applied to the installation of the Fulton County crossings but on a delayed time schedule. Due to logistical constraints, only daily samples were collected in Fulton County.

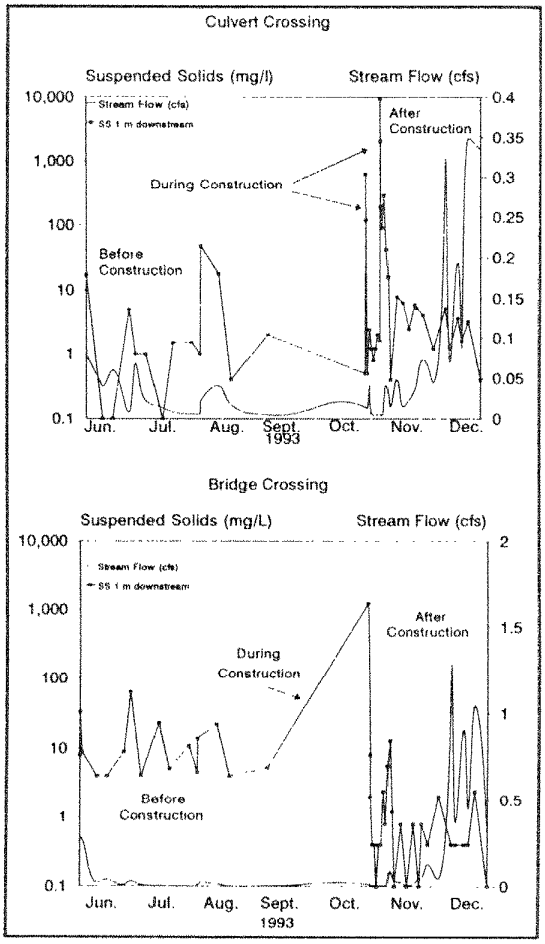
Approximately 1250 water samples were collected for total suspended solids analysis in the laboratory. Stream discharge or stream water level measurements were taken at the time of sampling to provide an indication of flow rates for each sample taken.

Preliminary report on construction and use at stone valley and construction at fulton county

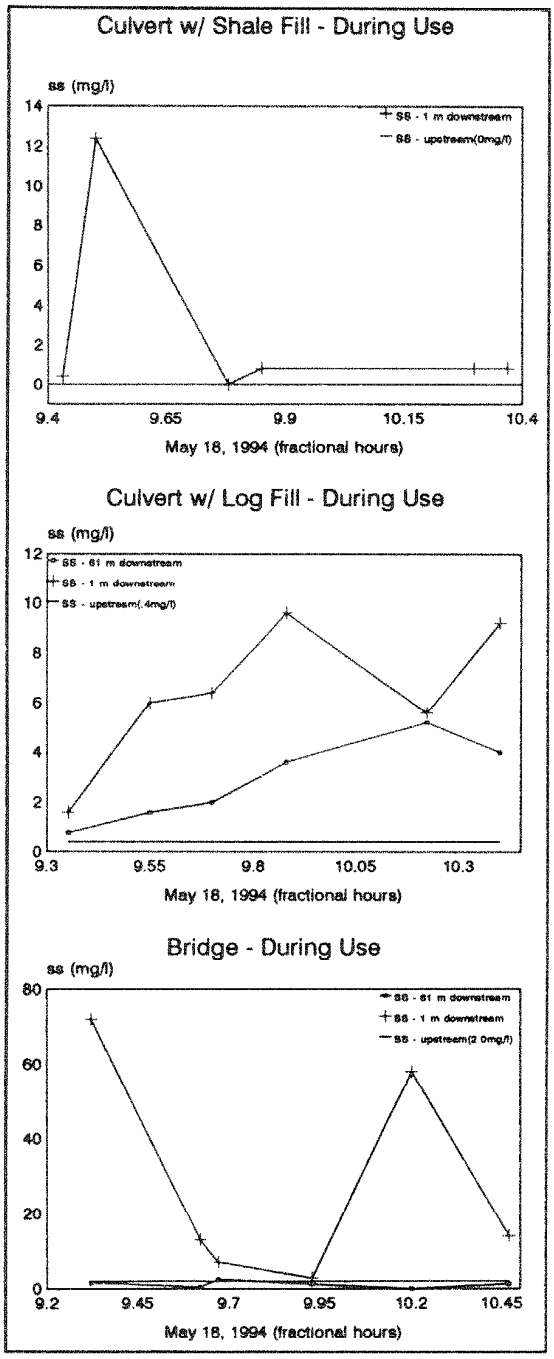
Stone Valley: Baseline data collected prior to the installation of the crossings indicate a natural storm-induced variability in the total suspended solids of the streams but otherwise reflect typical values for headwater, intermittent streams in Pennsylvania. These data are being used as the basis of comparison for the disturbance periods of installation and use.

Installation of the crossings occurred during a period of extremely low flows and this fact should be kept in mind while interpreting the following results. To record installation impacts a series of samples were taken during and following construction. The installation of the bridge required one pass of a bulldozer while culvert installation required back hoe work within the streamed which resulted in significant alteration of the natural stream channel. Preliminary results indicate that increases in total suspended solids did occur during installation of all crossings relative to upstream conditions (Figure 1). However, the impacts were generally confined to short sections of the stream ({SYMBOL 187 \f "Symbol"}61 m) and were reduced to insignificant

levels within 24 hours for the bridge and 96 hours for the culvert with log fill.



Crossing use was simulated by having a bulldozer pull logs across each crossing type six times. During crossing use in Stone Valley increases in total suspended solids occurred at the portable bridge and culvert with log fill crossings while use of the culvert with shale fill seemed to create no increases in the stream's sediment load (Figure 2). The increase at the bridge crossing occurred as a result of organic debris falling through gaps in the bridge planking and was not related to sediment input into the stream although this possibility exists if mud accumulates on the bridge deck during use. The culvert with log fill crossing impacts resulted primarily from increased sediment entering the stream. The stream bank area and the approach to the crossings at this location underwent significant disturbance during use and the authors believe that it was these areas which contributed to the increased sediment load. It should also be noted that there were no increases in total suspended solids 61 m downstream of the bridge during use; however, there was an increase in total suspended solids at this same distance below the culvert with log fill. The natural storm-induced variability observed in the baseline sampling period was also present after the crossings were installed and used. The crossings however did not appear to add to the sediment load of the streams during these higher flow periods.



Fulton County: Installation of the crossings occurred during October, 1993. Each crossing and the associated approach road work required several days to complete. While an analysis of the installation data has not been completed, it appears that there were only minor increases in total suspended solids. The presence or level of increase downstream of the crossings was dependent on the work in progress when the sample was collected.

Conclusions

The results to date indicate increases in total suspended solids during installation of all crossing technologies. For the Stone Valley crossings, the level of impact appeared to be less severe during bridge installation than culvert installation. Installation impacts were reduced to insignificant levels within 24 hours of bridge installation and 96 hours for culvert installation. Crossing use at Stone Valley resulted in different types of impacts for the bridge and culvert with log fill crossings and no impact for the culvert with shale fill crossing. The amount of impact attributed to the bridge crossing appeared to be related to the cleanliness of the bridge deck. Impacts associated with the use of the culvert with log fill crossing appeared to be related to the stability of the approach area and stream bank. Similar results are expected from the use of the Fulton County crossings.

Acknowledgments

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