Panel Discussion: Silviculture Effects on Groundcover Plant Communities in Longleaf Pine Forests

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Note: The panel discussion consisted of an introduction by the facilitator followed by an unstructured interchange of comments moderated by the facilitator. The introduction and most of the unstructured discussion are reproduced below; these comments have been edited and somewhat rewritten for clarity and brevity (also for this reason we have not reproduced the introductory comments made by the facilitator about each panel member; the reader is referred to the appropriate footnote for the institutional affiliation of each panelist) but we have tried our best to leave intact the ideas and as much of the original language as possible. Subsequent to the discussion, panelist Ken Outcalt submitted some additional comments in writing which were intended to clarify and amplify on his verbal statements. Ken's written comments are appended. Written comments were also solicited from the audience. Dale Wade (U.S. Forest Service Southeast Forest Experiment Station at Dry Branch, Georgia), submitted comments in response to this request and his comments are appended.

INTRODUCTION

Jeff Glitzenstein:

If I may have everyone's attention, we will try to get started. I must say that I am gratified to see such a large audience this early on a Saturday morning, and I think this attests to the importance of the topic we will be discussing. Thank you all for attending.

As you have already heard from several speakers at this conference, longleaf pine forests are distinguished by diverse herbaceous dominated understory plant communities and associated animal communities which are very difficult to replace once they have been eliminated. You have also heard several speakers refer to the fact that pine silviculture the way it is now widely practiced throughout the southeastern United States appears to constitute a serious threat to remaining intact understory plant and animal communities. The following quotation from Noss (1989) succinctly summarizes the concerns felt by many ecologists. Reed says, "Today scientific silviculture creates smaller, cleaner clearcuts, which are intensively site-prepared through chopping, discing and often bedding. Pines are artificially regenerated, and the ground, now largely devoid of wiregrass and other plants native to the site is taken over by weeds."

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Now, Noss' statement may speak to the concerns of many ecologists, but it is certainly not a viewpoint which is universally held among scientists. In fact, many wildlife biologists and foresters have quite a different opinion about the effect of intensive silviculture on groundcover plant and animal communities. For example, Lewis et al. (1988a) state that "it appears that neither site preparation, burning nor proper grazing has an extremely harmful or longlasting effect on woody and herbaceous species". And in a companion paper they conclude, "These results show that common timber management and grazing practices do not decrease species diversity. This knowledge alleviates much of the concern about environmental degradation" (Lewis et al. 1988b).

In organizing this panel discussion, my purpose is not to promote further divisiveness between ecologists and foresters. Rather, my intention is to promote a fair and open-minded discussion with the following three goals in mind. First, to see if we can at least agree on what precisely the effects of intensive silviculture really are on understory plant and animal communities. I think such agreement is critical for foresters whose job it is to regenerate pine trees, but who would like to do so while doing as little damage as possible to other components of the ecosystem. Secondly, it is a high priority to indicate where our current knowledge is inadequate to help make informed judgements about effects of timber management, and to motivate some of you in the audience to go out and collect the data we need. And finally, we need to take the information we now have and to make the best recommendations that we can about how we can properly manage the longleaf pine ecosystem for maintenance of natural species diversity, while possibly also continuing to grow and harvest timber.

Before I introduce our panel and begin the discussion, I would like to take a few more minutes to review what exactly we mean when we talk about conventional silviculture in the southeastern United States. This review will probably bore most of you foresters in the audience who know a lot more about this topic than I do. However, I think it is important for ecologists and conservationists to understand what silviculture consists of if they are to fully understand the issues that we are dealing with.

A good place to start is with cutting of the pine canopy. Typically, this is done in relatively large blocks, 30 to 100 acre clearcuts. Undoubtedly, this pattern of cutting is unnatural and may pose serious problems for red-cockaded woodpeckers and other animals. However, I think that from the perspective of understory plant communities clearcutting is one of the least serious of the various threats that may be posed by silvicultural activities.

After the canopy trees are cut, the next step is to reduce competition from the groundcover vegetation before planting the next crop of pine seedlings. There are three major ways this can be accomplished. First of all, there is of course fire, which is the most natural form of site preparation. The other two methods are mechanical site preparation and chemical site preparation. Mechanical site preparation involves the use of heavy machinery to physically disrupt the ground cover and roots of ground cover vegetation. An important thing for ecologists to realize is that not all forms of mechanical site preparation are equivalent. There are quite a number of different methods, many of which vary rather substantially in the severity of the disturbance that is administered to the understory. George Bengston, in his talk yesterday, mentioned bracke-mounding, which is one of the least severe forms of site preparation. Roller chopping is a more severe treatment, and discing, bedding and windrowing constitute disturbances even more severe than roller chopping. Ken Outcalt, one of our panelists who is a professional forester, may want to discuss these treatments in more detail, but the major take home message I want to leave you with is that these treatments vary substantially and may have very different effects on plant and animal communities.

As you might imagine, the effects of chemical site preparation are probably very different from those of mechanical site preparation. I have to admit that I do not know very much about these effects, but we are very lucky to have on our panel Neal Wilkins, a graduate student at the University of Florida, who is working on a doctoral dissertation on this subject, and he will be able to contribute a good deal more to our discussion of this subject.

After the use of site preparation to reduce competing vegetation, the next step is to plant the seedlings. This can be done by hand, a technique which obviously involves a minimum of disturbance. However, often the seedlings are planted mechanically using devices such as the V-blade planter which can cause a certain amount of additional soil disturbance. However, I think that disturbance caused by planting is generally rather minor when compared to the disturbance associated with, at least, mechanical site preparation.

After the seedlings are planted they of course begin to grow and within ten years or so they begin to form a relatively closed canopy where light reaching the ground is substantially reduced. An advantage to planting longleaf pine over other species of pines is that, even as a sapling, longleaf has a more open canopy, permitting more light to reach the understory. Perhaps even more importantly, longleaf can be burned at a younger age, which results in some thinning of the pines and also helps to check the development of hardwood trees and other woody plants. If burning does not occur soon enough, a dense stand will develop, after which there is probably not too much hope for the continued persistence of a natural ground cover plant community.

This brief review of silvicultural methods is meant to convince you that understanding how and especially why natural communities are altered by silvicultural methods is not a simple question. Since there are several stages in the silvicultural process which may potentially have an important effect, I have tried to divide up the potential discussion topics into a number of questions related to these different stages in the silvicultural process (Table 1). The first question is: "How does mechanical site preparation affect plant and animal communities in the longleaf pine understory? Are there differences in effects of different kinds of treatments?". I know that Dennis Hardin is eager to start the discussion on this question. Dennis?

OPEN DISCUSSION

Dennis Hardin:

I would like to make three points at the outset. The first is that whatever the estimate is for remaining acreage of longleaf pine forests in the Southeast (A number of conference participants noted that the area occupied by longleaf pine at present is only a small fraction, probably about 5% or less, of the original range of this forest type.), the estimate for such forests with intact groundcover is probably substantially less than that. My second point is that there is a difference in how public and private longleaf pine land is managed. Management of most public land, and I am speaking here in particular about National Forests, State Forests, Wildlife Management Areas, Department of Defense lands, and other lands managed under the concept of multiple use, is perhaps driven less by biology, or ecology, or an orientation to ecosystem management, than it is by politics, economics and social policy. This is perhaps shifting a bit, but it is the kind of reality we have to remember.

I would like to spend a little more time talking about my third point than I have about the other two. First, I want to read a quote, and then talk about it for a minute or two.

Table 1.

DISCUSSION TOPICS

1. **How does mechanical site preparation affect plant and animal communities in the longleaf pine understory?**
   a) **Are there differences in effects of different kinds of treatments?**
2. **What are the effects of chemical site preparation on plant and animal communities?**
3. **How does mechanical or chemical site preparation affect populations of rare, local, or threatened species.**
4. **Do plant and animal communities recover from site preparation with time after disturbance?**
5. **What are the effects of different densities of planted pines on understory plant and animal communities?**
6. **How does management of the planted pine stand influence recovery of the original vegetation and persistence of rare species?**
7. **Can or should silviculture coexist with understory plant and animal communities in the longleaf pine forest? If so, can we devise silvicultural methods to achieve this goal, and what are they?**

"Both plant species richness and diversity were increased by forest operations, and both remained at a level above that of the natural stand for two years following the planting" (Conde et al. 1983).

I am just going to say a few things about the first few years of this study, and then Ken or Neal is going to say something about later studies. The study was conducted by IMPAC, which stands for the Intensive Management Practices Assessment Center, which is located in Gainesville, FL. and is a cooperative effort between the University of Florida, the Forest Service and the forest industry. The Center is evaluating the effects of intensive forest management practices, such as clearcut harvesting, site preparation and planting on an array of forest resources including water, understory vegetation, soil and wildlife, for the major site types of slash pine forests. The objective of the work is to provide information to land managers for improving the forest resource and to assist regulatory agencies in preventing environmental degradation. I am discussing this particular study because the study site was a longleaf pine-slash pine site with a representative longleaf pine understory. I want first to briefly review the study and then examine the conclusion and what it really means.

The study site is a 67 ha watershed in Bradford County, Fl, containing Coastal Plain flatwoods, pinelands and swamps. The area was frequently burned and heavily grazed until 1938 when it was bought by Container Corporation of America. The canopy vegetation in the pine forest is predominantly slash pine, with occasional longleaf and laurel oak. The understory is dominated by gallberry and saw palmetto. The rest of the site is a mixed pine-hardwood swamp with slash pine, cypress, loblolly bay, blackgum and sweetbay. Prior to treatment in 1977, vegetation cover and frequency were sampled by line intercept methods. Biomass was also sampled. Between December of 1978 and November of 1979 the pinelands were clearcut, harvested, site prepared and machine planted. Site preparation involved double roller-chopping and harrowing, methods which were considered relatively non-destructive to the residual vegetation and soil. Vegetation was resampled in the summers of 1980 and 1981.

A few results from the study are as follows: Woody cover was reduced from 151% of surface area to 26% two years after planting and woody biomass was also reduced an order of magnitude. Herbaceous cover increased from 47% to 50% (I'm not sure if this was statistically significant) and herbaceous biomass increased an order of magnitude. Prior to treatment 69 species were found on the transects, and afterwards there were 74. The conclusion seemed to be that both plant species richness and diversity were increased by forest operations and remained above pretreatment levels for at least the next two years. The reason I want to highlight this conclusion is that it has been shown to me on numerous occasions to illustrate how this method of silviculture benefits the groundcover by increasing species diversity.

What I would like to present to you now is my attempt to take a closer look at some of the results of this study. This is not really rigorous research, but what I did was to go through my plant manuals and floras to find out what I could about the species encountered in the study. In doing this survey, I was particularly interested in comparing characteristics of those species which decreased or disappeared as a result of the treatment and those which increased greatly. If you look at the numbers, there were 13 species that were eliminated by the treatment and were still gone from the site two years afterwards. Some of these were trees (for example *Gordonia, Magnolia*) and shrubs (*Rhododendron, Befaria racemosa, Itea virginica*); others were herbaceous species such as *Lycopodium, Ctenium, Sorghastrum, Lillium, Sabatia, Euphorbia,* and *Viola.* Of this list of 13 species, only one of the species was associated with disturbed sites. On the other hand, of the 50 new species (that is, species sampled for the first time after the treatment) 24 (these included species like *Hypericums, Asters, Eupatoriums,* and *Rhus radicans*) are described in manuals and floras as characteristic of disturbed sites such as ditches, spoil mounds, old fields and borrow pits. In other words, many of these newly invading species could best be described as weeds. This brings up another problem with studies of groundcover vegetation, in addition to those discussed by Donna Streng yesterday, and that is the problem of coming to conclusions that are perhaps not warranted by the data, or of leaving it to the reader to look carefully at the conclusions to see what exactly they mean. The Bradford Watershed study is a good example of this particular problem. Though the conclusion that intensive silviculture increased species diversity was correct from a limited technical viewpoint, this conclusion did not tell the whole story about the kinds of changes which were going on in these plant communities.

In concluding, I would like to briefly comment on Ken's poster at this conference, and he will have a chance to straighten me out if I get this wrong. In brief, Ken's poster describes a study where the conclusion was that site preparation, properly ap-

plied, will not cause a significant long term reduction in wiregrass on sandhill sites. This is a study that was started many years ago that Ken is following up on, so that he did not participate in the design of the experiment. Thus, we can't blame him for a serious problem in the design of this study, which is that the control for the experiment was long-term winter burning, a treatment which may itself cause unnatural changes in vegetation composition.

Jeff Glitzenstein:

Ken, would you like to say something further about the Bradford study?

Ken Outcalt:

I would like to say first of all that although I am a member of IMPAC, and have been for approximately ten years, I have never really been significantly involved with the study that Dennis was referring to, although I have looked at the data and have raised questions very much like the ones Dennis was asking.

It is true, as Dennis says, that although species diversity, as measured by diversity indices, was greater following the silvicultural treatments, that they did not get back the same kind of community that was there before the site was treated. However, when I tried to communicate this idea to resource managers I got these blank stares. I don't think they really understand what we are talking about, and maybe we need to do a better job of explaining to them what exactly we mean when we talk about maintaining the biological diversity of a community. I agree that we need to talk about more than the number of species out there, and this is especially true of bedded sites because you can permanently change the complex of species. I know Neal has been working on this study, so I will let him make some comments if he wants to.

Neal Wilkins:

I think everyone agrees that the scientific literature can be misused and anyone can take a set of numbers and just about turn it into anything they want to. I must say, however, that there seems to be some confusion about the Bradford Watershed study and what it was trying to accomplish. The intent was to examine the ecological processes following extreme site disturbance including a number of different mechanical site preparation treatments stacked one on top of the other. The study was not intended as a restoration study and I think arguing about whether alpha diversity went down or alpha diversity went up is not constructive at this point in time. I think it would be more fruitful if we could learn something from these studies about the techniques that were used and how we can make use of them to practice our craft as ecologists to restore longleaf pine ecosystems.

Now I would like to say something else that I have been waiting to say for two days. Foresters, in the true and pure sense of the profession, are ecologists and they are conservationists. I would hope that those of us who call ourselves foresters and those of us who call ourselves ecologists and conservationists would all realize this and then possibly we would have a better chance of finding some common ground.

As far as the Bradford Watershed study, I think it can be put to rest, because upon rigorous examination we will find that it doesn't really have many implications for management of native longleaf pine ecosystems.

Bruce Means:

I have a couple of points to make about some of the things that were said by Jeff. One is that Jeff said something about clearcuts being no larger than 100 acres. Let's keep in mind that we are talking about private lands as well as public lands. On private lands I think we all know of examples where clearcuts have exceeded hundreds of acres. In fact, in north Florida if you take I-10 all the way over to Fort Walton Beach you will find that there are literally tens of thousands of acres of sandhill habitat that have been altered in this way. Another problem, and this brings me to my second point, is that many of these forests which were originally longleaf forests have been replanted to "off-site" species. At first it was slash pine, and it is true that slash pine does have more canopy closure than longleaf. Here in the Florida panhandle, however, it has recently become the practice to plant sand pine. Now sand pine inland from the coast more than five miles is certainly not the natural condition and sand pine is much worse even than slash pine in restricting light from reaching the understory. We now have tens of thousands of acres in which the canopy will shortly be so tightly closed that there will be virtually no diversity to the ground cover of either plants or animals.

Next I'd like to speak generally about the different types of diversity and try to consider what has been done and what should be done about maintaining diversity on several different scales. Ecologists have basically thought of biodiversity in three ways: First is within habitat diversity, which is what we have been talking about so far in this discussion. That is, we have been considering the question of what happens to species richness on a site which is badly disturbed, and we can refer to several papers on this question pro and con. One old paper which I would like us all to remember was published by Poole and Plummer (1961). This paper was cited extensively by Clewell when he studied the Apalachicola National Forest. Essentially, what Poole and Plummer (1961) did was to resample a site which had been surveyed by Roland Harper in 1906. This was in a wet savanna situation, probably including longleaf and slash in a seepage savanna environment. They found that by 1961 approximately 100 species which had not been found by Harper had invaded the site, probably as a result of changes in drainage or grazing. Furthermore, there were about 50 species that Harper had recorded which had been totally eliminated, things like pitcher plants (*Sarracenia* spp.), sundews (*Drosera* spp.), *Gerardias, Asters, Coreopsis* and others. This is another example of what we have talked about already, that is, the alteration of within habitat diversity, but intensive silviculture can also influence two other types of diversity which I would also like to mention briefly.

Let's start with between habitat diversity. In North Florida, we have many examples of where the xeric turkey-oak dominated, gopher tortoise type of longleaf pine habitat grades very quickly into a mesic type of longleaf pine forest which is very different in its plant species composition. At lower elevations, the mesic pine forest may then grade into a seepage savanna with a natural slash pine canopy and then into an evergreen shrub bog or a cypress-tupelo swamp. Here in panhandle Florida, particularly in the coastal lowlands, it is not uncommon for this entire transect, from the highest sandhill habitat to the wetlands, to occur over a change in elevation of five to ten feet and over a horizontal transect of a couple of hundred feet. Locally, examples of this sort of vegetation gradient can be found in the St. Marks National Wildlife Refuge and in the Apalachicola National Forest, and throughout panhandle Florida. This high turnover of different plant and associated animal communities along a short elevational gradient is what ecologists refer to as high between habitat or beta diversity.

In my opinion, intensive silviculture is as much of a threat to this high between-habitat diversity as it is to high within-habitat diversity. I know of many examples where mechanical site preparation has proceeded from the turkey oak community right down through the transect of different habitat types so that even the upper parts of wetland habitats have been bedded. There are also examples on the National Forest where some low lying, but never-the-less oak dominated, communities have been grossly altered by bedding or discing. After the pines are planted what has essentially happened is that what was formerly a rich gradient with a large amount of between-habitat diversity has been converted into a monoculture of planted pines with very little difference in species composition from one end of the elevational gradient to the other. I don't think this practice of eliminating the whole gradient is as frequent now as it used to be, and I hope that in the future we can do away with it entirely.

Finally, there is one more type of diversity that can and should be considered. I should say first that I know of no studies that have considered the effects of site preparation on the sort of between-habitat diversity that we have just been talking about, and there are only a few studies that have looked at effects on within habitat diversity. As far as I am aware, there are also no studies on the effects of silviculture on region-wide or gamma diversity, which is the last type of biological diversity I wanted to mention. As many people are aware, and this has been emphasized again at this conference, there is a large difference in ground cover vegetation composition from different parts of the range of longleaf pine. For example, perhaps only 50% of the species that occur in the western Gulf Coast, that is, in Texas and parts of Louisiana west of the Mississippi River, also occur this far to the east. My point is that by converting longleaf pinelands from Texas and longleaf pinelands from North Florida and longleaf pinelands from the Carolinas to intensively site prepared stands we are losing not only the local within habitat and between habitat diversity from those areas, but also the diversity of different types of species and communities found in different parts of the longleaf pine forest from throughout the Coastal Plain. Rather than a rich mosaic of different types of longleaf pine groundcover communities, each characteristic of a different region as well as a different local habitat, we may be left with a homogenized flora composed mostly of widely dispersed weedy species.

Joan Walker:

I would like to make some mention of the Bradford Watershed study just one more time, and I know why Dennis mentioned it, because when I started working with the Forest Service I had three different silviculturalists come into my office to show me a copy of this study and to tell me that mechanical site preparation was OK. This was at a time when biodiversity was just becoming a big issue and very few people really understood what it meant. And I just want to say that if you are in a position as a forester or an ecologist or a conservationist, don't show that paper to the person who succeeds me and use it to defend mechanical site preparation.

I guess what I would like to do is to return to the question that Jeff posed about the differences in effects of different kinds of site preparation methods and the factors that may influence the impacts that these methods may have on plant communities. I think Bruce did a nice job of expanding a little on the kinds of effects that might be measured, especially in his comments about how our concerns about effects on the community level may apply also to the landscape and regional levels. I think that one strategy for maintaining regional and higher-order levels of diversity is to maintain local levels of diversity at something like the pretreatment level.

When we consider the effects of site preparation, I think we need to get back to basics and remember what site preparation was designed to do, and that is to control the abundance of competing plant species. For example, it clearly states in the vegetation management EIS written for region 8, that is, the National Forest Service's southern region, that "herbicides were made to kill plants". That is a very straightforward sentence. In a similar sense, mechanical forms of site preparation were also devised to control competing vegetation to a certain extent. The actual impact that these methods can have on plants varies not only with the site preparation method itself, but also with the characteristics of each plant species. Characteristics such as plant longevity, growth-form, habitat, ease of seedling establishment, and whether the plant reproduces sexually or asexually by rhizomes or tillers can all help to determine how a plant species will respond to a particular type of site preparation. And it is also important to remember that, just as effects of a particular site preparation treatment may vary among plant species, the effects of that treatment may also differ greatly depending on the habitat in which the treatment is applied. For example, I have observed that roller-chopping may be less destructive on dry sites than on wet sites. And I think this may be one criteria we can use when making decisions about whether or not to allow the use of site preparation under certain conditions.

Jeff Glitzenstein:

Before we entirely leave the subject of mechanical site preparation, I would like to make just a couple of additional points. With respect to the Bradford Watershed study, I would like to point out that the "control" used in the study was the pretreatment vegetation, and the pretreatment vegetation was a slash-longleaf pine stand that had not been burned in something like 50 years. It is obvious that under these conditions the understory species diversity would be much lower than it would be in a longleaf pine forest properly managed with frequent low-intensity burning. Thus the increase in species diversity shown by this study following mechanical site-prep probably would have been much less obvious if the comparison had been with a frequently burned forest with truly intact ground cover vegetation.

The other point I wanted to make is to emphasize that there really is an important effect of mechanical site preparation, in addition to just increasing weedy species, and that is the effect of mechanical site-prep on the composition of the dominant grasses. Ken has suggested that in some of the studies he has looked at that some of the less intensive treatments may not substantially impact wiregrass in the long run. I think that the jury is still out on that, but I also think we have to remember that if I am correct none of these studies involved repeated disturbances to the ground cover. Even though wiregrass may recover somewhat following a single disturbance, probably as a result of regrowth of the surviving plants, it will inevitably be eliminated by repeated disturbances unless it is capable of reproducing and establishing new plants. And I think that growing season burning may be the key to sexual reproduction and long-term ability of wiregrass to recover following repeated mechanical site preparation treatments.

Before leaving this question I also wanted to show you the results of some studies other than the one that Ken described in his poster. Here, for example, are some data adapted from an early study by Schultz (1976) showing frequency of occurrence

of various species of dominant grasses along a line transect (Fig. 1). The control was an untreated site, and a variety of treatments were applied to other sites ranging from burning, a low intensity disturbance, to discing, a very severe mechanical disturbance. You can see from the top graph that there was a consistent decline in the frequency of wiregrass following the more high intensity disturbances. From the bottom graph you can also see that this decline in wiregrass was compensated for by an equally striking increase in the low *Panicums*, or *Dichantheliums* as they are usually referred to nowadays. These *Dichanthelium* species do occur frequently in natural wiregrass communities, as Donna and I know from our work at the St. Marks National Wildlife Refuge. But the sort of large increase in dominance shown by these species following mechanical site-prep is wholly different from the situation in any natural longleaf pine savanna.

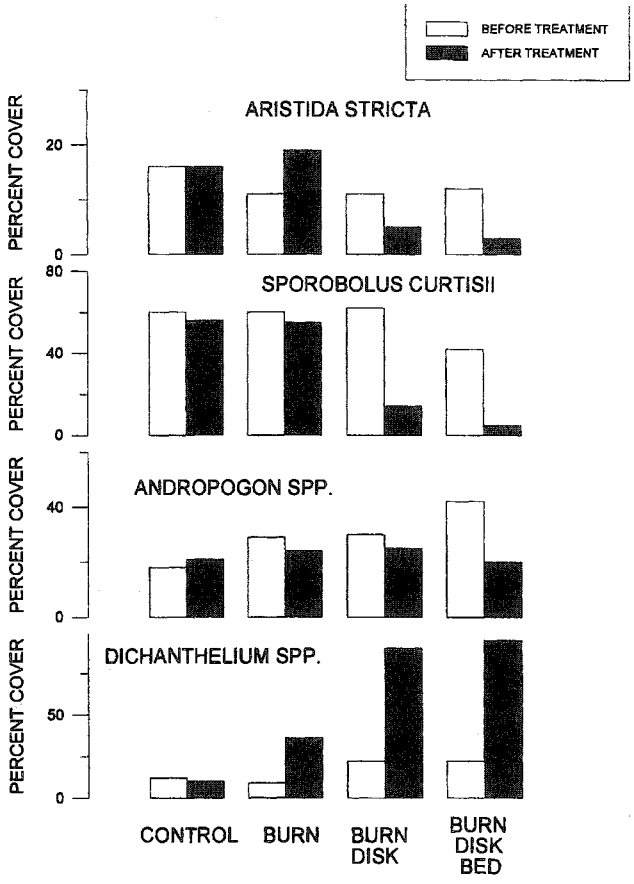

Figure 1. Effects of various silvicultural treatments on cover of dominant grasses along a line transect (adapted from Schultze 1976).

To conclude, let us briefly look at the data Schultz (1976) collected on two other dominant grass species. In the case of the bluestem grasses (i.e. *Andropogon* spp.) Schultz found relatively little difference between the controls and the intensively site-prepared plots. Of course, he did not separate out the different species of bluestems, and we need to remember that this is a large and diverse genus which contains species with a range of characteristics. Nevertheless, the existing data do not indicate a large negative effect of mechanical site preparation on grasses in this genus. However, this was not true of *Sporobolus curtisii*, another dominant grass in the undisturbed savanna. In this case, Schultz's (1976) data indicated a large short-term decline, though perhaps there was some long-term tendency towards recovery of this species. I have some other illustrations that I wanted to show you, but I am not going to be able to do so because we are running out of time (see e.g., Table 2 for another indication of the large negative effect of mechnical site prep on wiregrass). However, I did want to make sure that everyone understood that one of the major effects of mechanical site-preparation is to alter the composition of the dominant understory grasses in longleaf pine forests.

From now on, I would like to ask everyone to be brief in their comments on subsequent issues.

Neal, would you like to tell us something about your work with chemical site preparation treatments and what you have found the major effects of these to be?

Neal Wilkins:

I think a lot of people have phobias about chemical site preparation because it is uglier than mechanical site preparation from the aesthetic point of view, at least to the general public. Some of the public seem to prefer the most destructive mechanical methods, like windrows, because they seem neater and more organized. A site which has been chemically treated often looks like a nuclear winter directly thereafter. But I think this sort of appearance is misleading. Contrary to what Joan told you about the philosophy of chemical site-preparation, most treatments are not designed to kill all plants. They are designed to be selective, and the newest ones are actually designed to be a kind of smart bomb, if I can borrow a term from the recent war. Another way to think about it is that they are designed to funnel site resources into selected plants. Certainly, these include the pine trees that we would like to regenerate, but, some of the

most widely-used chemicals also seem to have some positive attributes for other (i.e. non-timber) species that we are interested in maintaining in longleaf pine ecosystems. I'm sure it was not entirely by design, but chemicals such as Hexazinone (which goes by the trade name of Velpar) seem to control oaks and other woody species on drier sites without harming wiregrass and a number of other common herbaceous plants. Oaks and other susceptible woody species such as sweetgum and grape are of course the same species that are presently overly abundant as a result of fire suppression. In addition to wiregrass, resistant species include *Zamia pumila*, our only native cycad, Carolina jessamine, *Smilax* spp., and all the *Vacciniums*. In some of our work we have found that some of these resistant species appear actually to be released (i.e. to show an increase in growth) following application of hexazinone at certain rates. About five genera of legumes that are native to the longleaf pine ecosystem are also released, including *Cassias, Lespedezas, Galactias* and *Centrosema*. Other species which seem to respond favorably to application of hexazinone include our most common *Baptisia* (I'm not sure about the endangered one), the spurges, the *Tragias*, the *Stillingias*, and a few composites. Unfortunately, most of the rosette forming composites seem to be inhibited by this particular chemical.

On wet sites the most commonly used chemical is Imazapyr, which some of you will recognize as Arsenal™. Not enough information is available on this chemical, because it is still quite new. We don't yet know the plant responses and we may not be able to find out because herbicide studies are kind of going out of vogue. Of course, there are lots of other questions we still need answers to, even for well established chemicals. Virtually nothing is known about effects on reptiles, amphibians, arthropods or ecosystem processes like nutrient cycling. I will say, though, that in my opinion chemical treatments do have a potential use in site preparation if we are smart about it, and are not afraid to learn the characteristics of the chemicals and how different species respond to the chemicals. We can already predict with some certainty how a particular chemical will alter the vegetation at a site, and we know that if we apply the chemical at different rates or in different seasons we will get different results. Chemical site preparation is not a natural ecosystem process like fire is, but it is a tool which we can learn to use. In fact, we can even use chemical site preparation along with fire to further stimulate some of the characteristic species of the longleaf pine ecosystem.

Jeff Glitzenstein:

Before we get to the concluding suggestions I wanted to touch just briefly on one other of my discussion topics that I think is particularly important, and that is the effect of current silvicultural practices on rare and endangered species. Maybe all that needs to be done here is to emphasize that not

Table 2. Understory vegetation frequency of occurrence (0-2 meters) in 9-year old site prepared slash pine plantations, Hamilton County, Florida. All differences among treatments are highly significant

	*Site Preparation Intensity**		
Species	Low	Medium	High
	Percent hits		
Wiregrass	80.2	12.2	2.8
Broomsedge	4.5	13.6	8.6
Fringe-leaf paspalum	0.2	3.9	1.0
Dwarf Live oak	8.5	1.2	3.5
Saw-palmetto	68.5	23.4	13.8

*Adapted from White, L.D., L. O. Harris, J.E. Johnston, and D.G. Milchunas. 1976. Impact of site preparation on flatwoods wildlife habitat. Pp. 347-353. *In* Proceedings of the Twenty-ninth Annual Conference, Southeastern Association of Game and Fish Commissioners. Oct. 12-15, 1975, St. Louis, Missouri.

much is known about this topic, and this applies to virtually all types of silvicultural activities. However, to try to get at least a preliminary answer to this question, I attempted more or less systematically to work through the very useful list compiled by Hardin and White (1989) of rare and local plants of the longleaf pine forest to see if any of the published studies provided any information at all about effects of silvicultural practices on these species. As far as I could tell, there wasn't much. The one example that I did find was for *Kalmia hirsuta*, a small shrub which is really not all that rare, but it did make it onto Dennis' and Deborah's list. According to one study (Moore et al. 1982), this shrub declined significantly in abundance following mechanical site preparation. This is really not all that surprising since mechanical site preparation was developed specifically to reduce competition from woody plants and *Kalmia hirsuta* would be expected to respond in much the same way as most other shrubs to these treatments.

Joan, would you like to make some comments on the effects on rare species?

Joan Walker:

Just to say that we don't know very much specifically about the effects on rare plants of either mechanical or chemical treatments. A lot of the information that I have seen has been sort of anecdotal. Fairly recently, we have instituted on the National Forests in Florida a better way of tracking locations of rare plants and the effects of silvicultural treatments on them. For several years now we have visited sites prior to scheduled silvicultural activities, and this year we decided to go back afterwards to see how our measures of abundance had changed as a result of the treatments. Our first year of data collection was not really targeted for monitoring, it was targeted for survey, so we have mostly descriptive population information rather than specific numbers. What we have found out is sort of unsettling to a plant ecologist. I have to say that, yes, in the National Forests in Florida, I have seen *Macbridea* growing and flowering on the top of beds and when we go out and do surveys for *Justicia* we find it thriving on roadsides and on the edges of log-loading platforms. We have a fair number of rare plants that do have characteristics that allow them to take advantage of release from competition or to take advantage of disturbed sites, and I think both factors may be involved.

At this point in time we do not have the information to tell us specifically about how most rare species respond to different silvicultural treatments, but I guess we are in a position on public lands to start collecting that kind of information, and I think we will find out that the effects will be variable. In the interim, we need to decide how to manage the land in the best or most conservative way without all the information we need. I think we need to resist the pressure from those who say: if you really don't know that what I am doing is bad, why don't you let me go on doing it until you find out. That is a really hard position to put a botanist in, and we can't say that something is OK when it may not be OK. In the Forest Service, our specific management requirement is to manage for viable populations of rare plants on the management unit, which in this case is the National Forests in Florida. The definition of a viable population is a very sticky issue, and that is something we need to wrestle with along with the question of how to determine the effects of any management technique, including site preparation.

Bruce Means:

Rare animals usually get short-shrift in discussions of this sort, just because there is not much knowledge available about them. There are certainly a number of species of rare animals throughout the Coastal Plain that could be affected by the sorts of activities we have been talking about; a few which come to mind are the flatwoods salamander, tiger salamander, striped newt, and pine barrens tree frog. All these species are dependent on wiregrass-dominated environments. Around the world, amphibian species are thought to be declining and there have been several international conferences on this subject. However, most of what we know about amphibian populations relates to breeding pond situations and we really know very little about their adult life history and ecology. In the case of those species that live in the very rich ground cover dominated longleaf pine communities, it could well be that some of these animals are declining because their terrestrial habitat is declining. This needs study.

Jeff Glitzenstein:

Relatively shortly we will need to make some concluding statements and then we will open it up to questions from the audience. It is becoming obvious that we are not going to get around to discussing a number of the questions on my list, but perhaps all we need to do is to reiterate that there is just not much information available about many

of these topics. Joan has reminded me to emphasize again that the later stages in stand development may be just as important for maintaining a high diversity of ground cover species as whatever happens during the site preparation and stand establishment phases. Insuring adequate spacing of planted trees, proper thinning of the canopy, using fire during the process of stand maturation, all of these factors may be critical to maintaining the native ground cover vegetation.

Note: At this point the facilitator requested each panel member to make a brief concluding statement including recommendations for the future. These concluding statements are presented below, beginning with the statement by Dr. Means.

Bruce Means:

I guess we are all realizing that this topic is sort of overwhelming. Each of the subheadings that Jeff has listed would be worthy of an all day conference. I would like to respond to all of these issues but, we really can't in the short time that we have. I would like to say one thing, however, and that is to remind everyone that this is a fire ecology conference and that fire is one of the main themes of this symposium. It is very important to realize that many groundcover plants require fire at certain seasons to stimulate flowering, and, unless they can spread vegetatively, they are simply not going to reproduce unless there is a fire at the proper season. Regardless of the type of site preparation, we might as well forget about re-establishing these plants, even if some are left after the treatment, unless we integrate a proper seasonal burning regime into the silvicultural schedule.

Neal Wilkins:

I think we are ignoring private lands. Eighty five percent of the lands that have potential for restoring at least some of the functions of the longleaf pine ecosystem are privately owned. About 200,000 acres of this land is being regenerated every year, and that means that we are starting over with more or less a clean slate. I think it is very important that we interact with silviculturists who are making decisions about how to regenerate these lands. Forest management for timber extraction will probably continue well into the next century and we can have a positive impact on how these lands are managed. I don't think we can afford to ignore them simply by looking at public lands and the few small tracts that we consider approximately pristine.

Dennis Hardin:

I agree with a lot of what you just said, Neal. I think there are many of us in Florida that would rather see silviculture continue, because if silviculture does become economically not feasible for some reason the alternative could be urban or suburban development, which is much worse. I do think, however, that private timber owners are going to have to begin to realize that just because you own a piece of land does not mean that you can do whatever you want on it. Several local governments are trying to zone out silviculture based on their perception that the air and water is being poisoned by chemicals and the forests are being torn up and replaced with plantations. So I think that there has to be some resolution of these kinds of problems.

On public lands we have the obligation and responsibility to think in terms of decades and centuries, and this is the kind of perspective we really need when we are managing public lands. We owe it to our successors to make sure that all the parts are still there when they get the land, and one way to insure this is to make sure that all the processes, like fire and hydrological processes, remain a part of the system. If you take a species by species approach things become a lot more confusing, and you may wind up having people drag you out into the field through acres and acres of blackberries to show you a clump of wiregrass that survived mechanical site preparation.

Joan Walker:

My experience in National Forest planning has made me really aware of the sort of thought process that goes on and how decisions are made about what management techniques or methods to apply to a particular area. The first step in the process is to envision a desired future condition for each area, and in the past the desired condition for most forest land is to have a sustained economic and timber yield on that land. I think that as long as this remains the primary objective there is not that much we can do in the way of conservation. I think that we need to be up front about the need to identify different goals and agree about them, and until we do that we are going to have conflicts about how and when to apply certain tools on the ground. I think there is a lot of room for using the

tools that have been developed in a silvicultural context to achieve other management goals. We need to get the people who are managing land and the people who are interested in how the land is being managed to agree about objectives and about a desired future condition for the land. If we can do that, it is probably not too difficult to find the methods to achieve those objectives.

Ken Outcalt:

I think one of the things we often forget is that silviculture is still more of an art than a science, and that it is often difficult to find a single simple solution for managing every timber type or habitat. You simply can't say that fire is always the best method, or herbicides, or any other method. I think we all need to keep in mind as resource managers that all prescriptions for silvicultural methods need to be on a site-specific basis, and we need to look at all the factors involved on that particular site and use what is appropriate to that area.

This concludes the panel discussion. The following are questions that were asked by the audience (or statements made in response to a point of view expressed by a panelist) during or after the discussion and the answers provided by the panelists. Due to lack of space, it was necessary to edit these rather severely to focus on the main point of the question and answer.

Question for Neal Wilkins: Did you say that for the most part you don't have data on the effects of herbicides on arthropods and invertebrates?

Answer: Yes, by and large that is true.

Question for Wilkins: I guess this is an ethical question. Do you think it is ethical to use certain chemicals in the absence of any information on how they influence the rest of the biota.

Answer: I think we need to do the experiments to find out what those influences are.

Q: Would you advocate that people not use the chemical until research provides us with more information?

A: I don't think that is very realistic. These chemicals are very actively marketed. Environmental fate and toxicity studies show that direct problems are probably minimized and indirect problems are what we need to be looking at.

Statement: I would like to give you all a quick definition of silviculture. In my opinion, you just talked about intensive silviculture which is a very narrow part of what silviculture is about. My definition is that silviculture is the art or science of reproducing, growing and tending a forest to meet the needs of the landowner. I think if we remember some of the talks from previous days that what Bill Boyer talked about, what Leon Neel talked about, and what Tall Timbers is doing, all of these are different approaches to silviculture which do not involve intensive site preparation. This is not really what silviculture is all about.

Glitzenstein: We wholeheartedly agree with you, but wouldn't you agree that the intensive silvicultural methods are the ones that are presently the most widely used throughout the southeastern United States?

Answer: No, I don't think so, not any more.

Question for Bruce Means: Dr. Means, you criticized the planting of off-site sand pine on what was formerly longleaf pine land. Don't you think the confrontational attitudes of some ecologists have caused private industry to move towards species that won't be restricted in the future?

Answer: My answer is emphatically: no! I don't think that is the main reason why private industry is planting sand pine. I do know of some cases, and I won't name them, where private industry has gotten a little antsy about planting longleaf because of its association with the red-cockaded woodpecker and the possibility that maybe longleaf pine itself would become endangered. Nevertheless this should not keep people who have an interest in conserving longleaf pine and its associated species from speaking out, or, for heavens sake, we will lose it all anyway.

Q: Don't you think it would be better to work with these people (i.e., the timber industry) than just to criticize.

A: If that is directed to me personally, I would be happy to work with anyone in deciding what the best species is to plant on any given site.

The following are written comments submitted by Ken Outcalt and Dale Wade subsequent to the panel discussion.

Ken Outcalt:

The consensus of the conference participants was that management of longleaf communities on public lands should be done in ways which will protect the integrity of the entire community. It was also agreed that this means employing fire to accomplish silvicultural objectives whenever and wherever possible. However, I believe mechanical methods of site preparation are still going to be used, especially on industrial lands. Therefore it is important to know the effects of different silvicultural systems on plant communities. My research has been largely confined to sandhill sites and the following discussion refers to these sites only (Outcalt and Lewis 1990). I have used wiregrass to assess impact, because of its key role in this community type.

Wiregrass mortality from mechanical site preparation is directly tied to soil disturbance. Research plots on the Chipola Experimental Forest in the panhandle of Florida show a large decline in wiregrass from rootraking and other systems where windrows or piles are made. Double chopping or double discing also cause lots of soil disturbance and subsequent wiregrass mortality. A single pass with a double drum chopper will kill about 50% of the wiregrass. I have found this on research plots and on operational level treatments. However, if a smaller single drum chopper weighing approximately 1.5 tons is used, wiregrass mortality can be kept to 0 to 5 percent. This is because the oak stems provide a sort of cushion for the roller which limits its penetration into the soil. The chopping is done to knock down hardwoods and facilitate subsequent burning. The burning is delayed until hardwoods have sprouted to increase overall mortality. This method reduces competition sufficiently to establish longleaf seedlings. Since the wiregrass is maintained, any hardwood sprouts remaining can be controlled by prescribed burning. This system is well-suited to sites that have not been burned for a long period and therefore contain a heavy cover of scrub oaks.

There was some question as to the validity of the conclusions reached by comparing the single drum chop treatment discussed above with a treatment of burning during the first week in October. I do not believe this has any impact. While it is true that a much greater increase in wiregrass cover could have resulted from a growing season burn, this effect would have disappeared after the long period of no burning. It was also suggested this lack of burning since establishment made it difficult to compare treatments. It is true the level of wiregrass is less on all treatments because of fire exclusion, but since all treatments have the same average cover they should respond similarly to fire. As noted by the scientist who installed the study, the chop treatment caused very little if any wiregrass mortality. This is the important point.

Dennis Hardin:

I had no problem with the data or with comparing the treatment and control. I did have problems with the broad, general conclusions.

Dale Wade:

It is important to point out that the U.S.F.S. has recently undergone some important changes in direction with respect to its management of longleaf pine forests. For example, considerable effort was expended to come up with an EIS document for Region 8. This effort involved an in-depth analysis of about seven different alternatives for managing National Forest lands. The decision was made to emphasize fire and decrease the use of mechanical methods when regenerating stands.

There are also some indications that the use of mechanical site prep may decrease on private industrial lands. A lot will depend on equipment costs and tax incentives which help to defer these costs. Aerial methods of applying herbicides and fire may favor these methods over mechanical site prep which is fuel intensive. Due to the past use of intensive site preparation, many stands may already be altered to the point where subsequent rotations may be established without the further use of these intensive methods. Bedding, for example, is not a ubiquitous practice anymore. Less planting of off-site species may also lead to a reduced requirement for intensive site preparation. A number of these factors have already led to a much reduced acreage of mechanical site preparation on some industry lands.

A very emotional issue with many private landowners is the possibility that longleaf pine may be legally designated as an endangered and threatened ecosystem leading to a ban on further cutting. Just the specter of this scenario may be enough to cause industry to plant other species besides longleaf.

LITERATURE CITED

Conde, L.F., B.F. Swindel, and J.E. Smith. 1983. Plant species cover, frequency, and biomass: Early responses to clearcutting, chopping and bedding in Pinus elliottii flatwoods. Forest Ecology and Management 6:307-317.

Hardin, E.D. and D.L White. 1989. Rare vascular plant taxa associated with wiregrass (Aristida stricta) in the Southeastern United States. Natural Areas Journal 9:234-245.

Lewis, C.E., G.W. Tanner and W.S. Terry. 1988a. Plant responses to pine management and deferred-rotation grazing in north Florida. J. Range Manage. 41:460-465.

Lewis, C.E., B.F. Swindell and G.W. Tanner. 1988b. Species diversity and diversity profiles: Concept, measurement, and application to timber and range management. J. Range Manage. 41:466-469.

Moore, W.H., B.F. Swindell, and W.S. Terry. 1982. Vegetative response to clearcutting and chopping in a north Florida flatwoods forest. J. Range Manage. 35(2):214-218.

Noss, R.F. 1989. Longleaf pine and wiregrass: keystone components of an endangered ecosystem. Natural Areas Journal 9(4):211-213.

Outcalt, K.W., and C.E. Lewis. 1990. Response of wiregrass (Aristida stricta) to mechanical site preparation. In: L.C. Duever and R.F. Noss (eds.), Wiregrass biology and management, Symp. Proc., Oct. 13, 1988, Valdosta, GA., KBN Engineering & Applied Sciences, Gainesville, FL 12 pp.

Schultz, Robert P. 1976. Environmental change after site preparation and slash pine planting on a flatwoods site. USDA For. Serv. Res. Pap. SE-156, 20 pp. Southeast. For. Exp. Stn., Asheville, NC