PRESCRIBED FIRE ON THE APALACHICOLA RANGER DISTRICT: THE SHIFT FROM DORMANT SEASON TO GROWING SEASON AND EFFECTS ON WILDFIRE SUPPRESSION

Joseph P. Ferguson
U.S. Department of Agriculture, Forest Service, National Forests in Florida, 325 John Knox Rd., Suite F-100, Tallahassee, FL 32303

ABSTRACT

Although prescribed fire has been an important management tool in the southeastern United States for over fifty years, recent changes in the application of prescribed fire on the Apalachicola Ranger District (ARD) of the Apalachicola National Forest, are bringing about significant changes in vegetation that are benefitting wildfire suppression efforts. The ARD has increased the frequency of fire to a level approaching a 3- to 4-year cycle. Almost 50% of the acreage burned annually is now completed in the growing season, the time of year when lightning fires occur in Florida. District managers have also shifted methods of applying prescribed fire to increase intensities and more accurately represent burning conditions within the range of natural variability. These changes in the prescribed fire program have significantly improved firefighter safety and lowered wildfire suppression costs. Prescribed fire effects on the behavior of three recent wildfires are discussed. In a recent administrative study, all wildfires on the Apalachicola Ranger District were suppressed without the use of tractor-plow units. The lessons learned from this progressive prescribed fire program can serve as a model to managers of other short fire-return interval ecosystems.

Citation: Ferguson, Joseph P. 1998. Prescribed fire on the Apalachicola Ranger District: the shift from dormant season to growing season and effects on wildfire suppression. Pages 120–126 *in* Teresa L. Pruden and Leonard A. Brennan (eds.). Fire in ecosystem management: shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, FL.

INTRODUCTION

The Apalachicola Ranger District (ARD) of the U.S. Department of Agriculture, Forest Service, has one of the oldest and largest prescribed fire programs in the country. Located in the panhandle of Florida, the district contains 117,000 hectares of intermixed pine uplands and hardwood swamp. The flat terrain, with elevations from 10 to 24 meters above sea level, is marked by considerable change in vegetation over gradients of only a few inches of elevation. Prescribed fire has played an important role in maintaining and restoring the cutover lands that were designated as the Apalachicola National Forest in 1936. Approximately 61,000 hectares are within ecosystems considered to have a short (2 to 8 years) fire-return interval. Although prescribed fire has been a key management tool on the district for over 50 years, within the last 15 years managers have shifted to a more aggressive, year-round burning program. The results of this shift are paying big dividends in terms of both ecosystem management and wildfire suppression.

PRESCRIBED FIRE HISTORY

Like most national forests in the South, prescribed burning on the ARD began soon after the land was acquired. The first prescribed burn on the ARD was completed in the winter of 1943–44. The district has sketchy prescribed burn records from 1943 through 1958, and very solid records since that time. The program averaged roughly 6,000 hectares yearly the first two decades, expanded to about 9,300 hectares yearly during the 1960's, and remained at that level through the 1970's (Figure 1). The first three decades were marked by cool dormant-season fires that minimized crown scorch. Most burns were conducted in the cool weather that prevails in late December, January, and early February. Control lines were plowed east-west every 400 meters to allow burners to use the steady north winds after a cold front passed to back fires through the understory from one plowed line to another over the course of a day. Preparing and igniting the blocks to be burned was very labor intensive under this strategy.

During the 1980's, the area treated by prescription fires averaged 11,300 hectares per year, a rate approaching a 5-year fire-return interval. To date in the 1990's, the district has averaged 13,150 hectares per year, with 1995 accomplishments reaching a new high of 17,254 hectares.

GROWING-SEASON PRESCRIBED FIRE

The Shifting Program

In the early 1980's, district prescribed burners began to experiment on a small scale with burns outside the traditional winter season. Most of these early burns were conducted in late summer for site preparation or to increase forage for cattle grazing. The year 1985

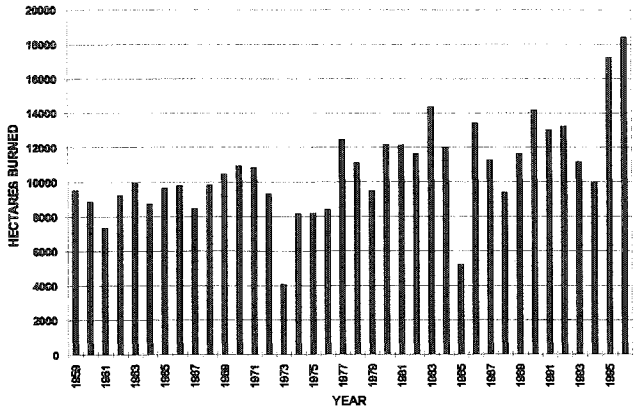

Figure 1. Total annual prescribed burning on Apalachicola District, 1959–1996.

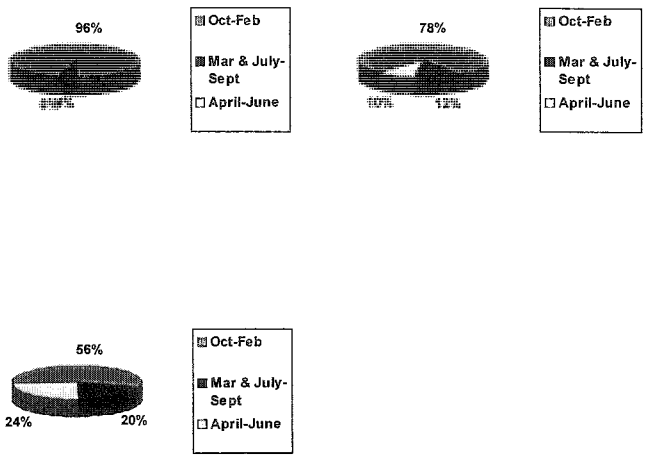

Figure 2a. (top left) Percent of area prescribed burned on the Apalachicola District by season of year 1981–1985.

Figure 2b. (top right) Percent of area prescribed burned on the Apalachicola District by season of year 1986–1990.

Figure 2c. (bottom left) Percent of area prescribed burned on the Apalachicola District by season of year 1991–1995.

was pivotal for the prescribed fire program on the Apalachicola. A winter-long drought drastically reduced the hectares prescribed burned in January and February. After an intense spring wildfire season, the district conducted several late summer prescribed burns in an attempt to make up some targets missed the previous winter. The results were so promising that the growing-season burn program was rapidly expanded over the next few years.

By 1990, the district had significantly increased the amount of growing-season burn area and was using prescribed fire not only in March and late summer, but also during the traditional lightning season of April to June (Figures 2a and 2b). Although north Florida experiences lightning fires from April through September, the majority of the area historically burned from April through June (Komarek 1964). With Florida having one of the highest frequencies of lightning strikes of any region in the United States (Abrahamson et al. 1984) and more thunderstorm days per year than anywhere else in the country (Wade 1983), replication of lightning-caused fires by prescribed burns during the lightning season has had very positive effects on the native vegetation.

In addition to being the time of year when lightning fires historically burned, April through June are also the months when the most damaging human-caused and lightning-caused wildfires occur in north Florida. This means that prescribed fires during this period of the year carry a greater than normal risk. Nonetheless, ARD prescribed fire managers have been committed to managing this risk and increasing the area prescribed burned during this "natural" time of year to roughly half of the total program (Ferguson and Hart 1994) (Figure 2c). The primary growing season risks faced by burners on the Apalachicola have been timber mortality and a greater chance of a burn escaping. It is much easier to scorch southern pines on days when the ambient air temperature is already high. Occasional small pockets of mortality are almost a given with a large scale growing-season burning program, particularly if the burns extend into August and September. The chance of an escaped burn increases in the growing season for several reasons. First, April and May are generally drier than other months. Wetland fuels that act as barriers to fire in the winter will readily ignite in late spring. Secondly, the weather, particularly wind direction and speed, is not as predictable and reliable as it is during other times of the year. During winter cold front passage, winds in Florida are very predictable. In the growing season, winds are more variable and there is always the chance of development of an isolated thunderstorm with high winds. The presence or absence of a sea breeze can also cause unexpected problems. Other burners looking to move their program toward the growing season need to be aware of these risks.

Effects on Vegetation

Several authors (e.g., Robbins and Myers 1992, Glitzenstein et al. 1995, Grelen 1975) have discussed the effects of growing-season prescribed fire on southern coastal plains vegetation. Such fires have had dramatic effects on the flora of the Apalachicola. Growing-season fire has proven very beneficial in promoting the flowering and spread of wiregrass (*Aristida stricta*). The visual impact of thousands of hectares of wiregrass putting out a tall seed head after a growing season burn is particularly impressive. Growing-season fire also appears to reduce the frequency and also the size of saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*) plants. In many parts of the district, these two species dominate the understory, shading out grasses and forbs. Growing-season fire has also been credited with promoting flowering of many of the dozens of threatened, endangered, and sensitive plant species that occur on the district. In one area a preburn survey found only 3 individual Florida skullcap (*Scutelleria floridana*) plants, while a postburn survey along the same transects after a May burn found over 100 individuals (Carr, personal communication, 1990).

Perhaps the most important effect for fire manag-

ers is the relegation of titi (*Cliftonia monophylla, Cyrilla racemiflora,* and *Cyrilla parvifolia*) to its historical habitat. These three species of brushy wetland trees that are collectively referred to as titi have invaded thousands of hectares of uplands on the ARD over the past 60 to 80 years. Titi burns ferociously during drought periods, with total crown consumption being the norm. The small waxy leaves are particularly prone to becoming firebrands that travel long distances. Spot fires from titi can occur over two and one half kilometers in front of wildfires during extreme conditions. By pushing titi back into the wetter habitats, fire control is enhanced.

WILDFIRE SUPPRESSION

Changes in Suppression Tactics

Understory vegetation responses to the changes in our prescribed fire program have resulted in concomitant changes in wildfire suppression. Reduced fuel accumulation, particularly of ladder fuels, results in shorter flames and lower fireline intensities which in turn allows incident commanders a larger number of tactical options. For 50 years the tractor-plow unit (a bulldozer pulling a plow with wing disks that open up a wide trough of bare soil) has been the staple of fire suppression in the South. Rank fuels and wet swampy terrain make most other methods of line building, including handline construction, too dangerous and very inefficient. Tractor-plow units can be used by a single firefighter and are very effective and efficient. A single tractor-plow operator with the Florida Division of Forestry can plow out four or five wildfires in a single day during an active fire season. However, we can now use more ecologically sensitive suppression methods so that tractor-plow lines are no longer distributed throughout the landscape from suppression efforts. The use of roads and natural barriers for fire breaks, and alternative methods of attack, are more likely to be successful. In fact, attack with engines and burnout to natural barriers are becoming the primary methods of suppression. In many cases, there are fewer critical decisions to be made. The choice of when and where to put a tractor-plow line is not as critical today as it was in past years. Commercial timber loss from wildfire is not as likely. Tradeoffs involving protection of endangered species do not arise as often. When critical decisions are required, they can now usually be made by the incident commander, where once they were often forced on the tractor-plow operator.

Firefighter Safety

Changes in fuels, fire behavior, and suppression tactics have not only improved ecosystem conditions, but have also markedly increased firefighter safety. Firefighters have better visibility in the field. The open, parklike appearance of the landscapes that greeted the Spanish explorers 500 years ago is being returned to parts of the district. Along with increased visibility, recognition of escape routes and movement to safety zones is enhanced. Perhaps most important of all, we are reducing the need for tractor-plow attack. Despite their efficiency, tractor-plows have a very big downside; they are one of the most dangerous fire suppression methods in use (National Wildfire Coordinating Group 1994). Year after year, tractor-plow burnovers continue to occur in the South, the Northeast, and the Lake States.

Economic Benefits

Economic benefits have also accrued in the form of reduced suppression costs. Tractor-plow units cost on average $40.00 per hour excluding operators salary in this part of the state. Engine operating costs are roughly $0.75 per mile. The use of natural barriers and roads as suppression lines are also resulting in less of a need for mopup. Firebrands are much less likely to be carried across barriers such as cypress stringers, swamp areas or roads than across a 1- to 2-meter wide plowed line. As will be discussed in the next section, the prescribed fire program is certainly preventing some major project fires. Along with the direct economic benefits from less expensive suppression, the district is seeing substantial savings from reduced rehabilitation costs. Over the last few years, rehabilitating plowed lines has proven to be more expensive than the actual suppression. And finally, the forest is seeing reduced resource loss. As plant community composition and structure change, instances of pine mortality from wildfires are less and less frequent, particularly in diameters above 15 centimeters.

The 1995 Fire Suppression Study

Considering all the information discussed above, in early 1995 the Apalachicola District Ranger and Forest Fire Management Officer decided to conduct an administrative study in which tractor-plows would be the last option considered in suppressing all wildfires on the district (Ferguson and Colaninno 1995). This change in suppression emphasis was intended to: (1) test the feasibility and practicality of such an approach and; (2) to collect information on costs and impacts of suppression efforts without the use of fireplows.

During calendar year 1995, twelve wildfires occurred on the ARD. Eleven of these wildfires were controlled without use of plowed firelines. The only exception was a fire occurring on an inholding. Following preestablished agreements, the fire was controlled at the smallest size possible with tractor-plows. Table 1 displays information on these 1995 wildfires. A relatively mild fire year helped initial attack incident commanders stick to the "no-plow" philosophy, but regardless of weather and burning conditions, these suppression tactics created less resource damage and were a resounding success!

IMPACT OF PRESCRIBED FIRE PROGRAM ON WILDFIRES

Since prescribed burning began on the ARD during the winter of 1943–44 (Clewell 1971), hundreds

Table 1. Comparison of 1995 wildfire size and suppression cost with no plowlines vs. estimated size and cost with plowlines. Area and suppression expenditures were taken from final 1995 records. The estimated area and cost had the fire been plowed were made by the Incident Commander of each fire. Two fires (Pig Island and GFC) were suppressed using a "confine strategy" and would not have been plowed regardless of the district change in suppression policy. The Five Points fire occurred on private land and was plowed.

Fire name	Actual hectares (acres) burned	Actual suppression cost	Estimated hectares (acres) had fire been plowed	Estimated cost had fire been plowed
Smith Creek	165 (407)	$3343	28 (70)	$8000
Five Points	6.5 (16)	2395	6.5 (16)	2395
Savannah	61 (150)	1305	12 (30)	5000
Four Points	4 (10)	67	1.6 (4)	300
Pig Island	18 (45)	0	18 (45)	0
Lunch	7 (18)	1694	3 (8)	3000
Lost	32 (80)	4231	20 (50)	2000
Franklin	17 (41)	3268	12 (30)	4000
Kenny	0.1 (0.3)	558	0.1 (0.3)	700
Night	0.8 (2)	527	0.4 (1)	700
Bear	11 (27)	1475	4 (10)	2000
GFC	18 (45)	0	18 (45)	0
Totals	340.4 (841.3)	$18,863	123.6 (309.3)	$28,095

of wildfires have been impacted by the district prescribed fire program. Many wildfires have ignited in recently burned areas, consequently burning less intensely and with less resource damage and less resistance to control. In dozens of additional instances, wildfires spread into areas that had been recently burned and either went out or changed directions. There has been no attempt to analyze these effects on the district, although the completion of a wildfire and prescribed fire history data layer within the forest Geographical Information System is underway and may soon make this possible. Attempts to find a correlation between the number of acres prescribed burned and wildfire occurrence have not been successful. The test of whether there is such a correlation is made more complex for several reasons. The effects of prescribed fire have a time lag, affecting not just wildfires in the same season, but in several seasons thereafter as well. Second, wildfire occurrences themselves are inherently highly variable (Figure 3), presumably because local weather is so variable. Third, district policy regarding wildfire size has changed over this time. In the early 1980's, the Forest Service instituted policy that allowed wildfires to be confined or contained at a larger acreage and with a less aggressive attack than for immediate control. The average size of wildfires on the

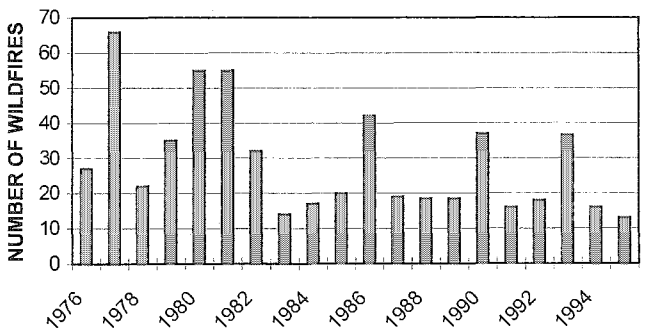

Figure 3. Number of wildfires by year 1976–1995. Apalachicola Ranger District.

ARD has increased significantly over the last ten years with the implementation of this policy change. Together these mean that a good statistical study of the relationship between prescribed fire and wildfire will have to await larger sample sizes than we currently have. Nevertheless, on the ground, local incident commanders and firefighting personnel have been noting and taking advantage of the local effects of prescribed fire when choosing strategies and tactics for suppression. The effects of prescribed burning on three recent wildfires are discussed below. The examples cover a range of fire danger conditions from moderate to extreme.

Smith Creek Fire: 1/18/95 (Moderate Fire Danger)

This fire was discovered in early afternoon, and initially consisted of five separate arson sets in the same general area. The five sets were within a 600-hectare area that had been prescribed burned in January of 1993. Based on the limited fuel accumulation, the cool January temperatures and the absence of any structures or private property, the Incident Commander was able to make the decision to contain the fire within a perimeter of existing barriers of swamps and roads without employing tractor-plow units (Rankin and Kubiak, personal communication, 1995). At that time the largest set was about 12 hectares, with two sets about 6 hectares and two sets about 2 hectares. Drip torches were used to burnout along roads and connect the five fires into one. Holding action consisted of patrolling the roads with engines. Mopup was almost nonexistent due to the previous prescribed burning history of the area.

Final Result: Past prescribed burning allowed a relatively serious situation (five arson sets in a remote location) to be contained as a single 165-hectare fire in one afternoon with a force of only eight personnel and causing very minimal resource damage. Suppression costs for the fire totaled only $3443. By avoiding plowed firelines the cost of the fire was greatly re-

duced. The cost of the two tractor plow units dispatched to the site was about $40.00 per hour each. The original five fires could have been plowed out within two hours, so the savings from not using the two pieces of equipment was minimal. The real savings, estimated at over $4000, came from avoiding rehabilitation of the plowlines. National Forest in Florida policy requires the rehabilitation of all firelines plowed on wildfires to protect sensitive plant species and avoid hydrologic changes. The rehabilitation work involves making at least two and sometimes three passes over the area with a crawler tractor using an angled blade to roll the plowline berm back into its original location. Tractor speed during rehabilitation work is greatly reduced from plowing speed. On a fire such as Smith Creek, plowline rehabilitation costs would have exceeded the total cost of suppressing the fire.

New River Fire: 6/13/93 (High Fire Danger)

Discovered about noon, this lightning-caused fire was located partially within the Mud Swamp-New River Wilderness. Although weather conditions were not extreme that day, the Forest was in the midst of a two-month drought. Only one half hectare in size at initial attack, the portion of the fire outside the wilderness was quickly contained with a tractor plow unit. Two engine crews were unable to contain the portion inside the wilderness with hoselays. Fuels inside the wilderness were very heavy and had last been burned 16 years earlier, prior to wilderness designation. The fuels immediately outside the wilderness at the origin were four years old. The initial attack incident commander felt certain easy containment would have occurred if all the fuels had been less than five years old.

As the fire continued to burn in the afternoon, wind from an approaching thunderstorm produced erratic fire behavior. Flame lengths that had been 2 to 3 meters became 6 to 8 meters and a hurried burnout was conducted to keep the fire within the wilderness. By this time the fire had reached a size of 40 hectares, but was loosely contained on three sides by a river and roads along the wilderness boundary. After the thunderstorm passed by with no rain, four spot fires were discovered in thick swamp fuels about 400 to 800 meters west of the main fire. These spots were each less than one half hectare, but quickly converged and formed a crown fire rolling through titi and other wetland tree species. This spot fire reached twenty hectares in a matter of minutes and direct attack was impossible. Fortunately for the suppression effort, this spot fire moved into an area that had been prescribed burned two years earlier. The crown fire dropped down and the combined efforts of five tractor-plow units and two helicopters quickly contained it.

Final Result: Even though burning on only a high fire danger day, this fire exhibited fairly intense behavior, most likely due to the extreme fuel accumulation. The final fire size, including the crowning spot fire, was 60 hectares. Final suppression cost was about $120,000. With the intensity at which both the main fire and spot fire were burning and considering the distance to the next physical barrier, the Incident Commander estimated the fire would have reached close to 400 hectares had it not run into the recent prescribed burn.

Post Office Bay Fire: 5/25/92–5/27/92 (Extreme Fire Danger)

This fire began on Memorial Day in 1992 and was the largest fire to burn on the Apalachicola National Forest since its designation as a national forest in 1936. Burning conditions were extreme and mixing heights of over 2,400 meters caused tremendous long-range spotting. Haziness prevented early detection and the fire was discovered at about 1500. When the initial attack Incident Commander arrived over the fire in a helicopter 20 minutes later, the fire was about 200 hectares in size and moving rapidly through grassy savannahs and young pine plantations. The incident commander measured fire progression over the following 15 minutes and estimated rate-of-spread at 3.2 kilometers per hour. Any direct attack at this point was useless and the Incident Commander ordered the responding tractor plow units and engines to standby until more favorable conditions became prevalent. By 1630, the fire was over 480 hectares and proceeded to spot across a paved state highway and a graveled railroad right-of-way. After crossing the railroad track the fire moved into an area that had only a one-year rough. Even in these light fuels the fire burned actively, but equipment was now able to attack the fire and five tractor-plow units began work. Slower spread in the recent prescribed burn area allowed suppression forces to gain a foothold and secure the rear and both flanks of the fire by midnight.

Unfortunately, the advantage gained from the prescribed fire area was lost the next day. The wildfire moved into thick swamp fuels that only burn in extreme drought and thus had not been prescribed burned. Long-range spotting of up to 2.4 kilometers occurred again on the second day. The fire continued to spread, moving into an area of three-year rough. Forces on the second day included 14 tractor-plow units, 4 engines, 2 handcrews, and 5 helicopters. By the end of the second day, the fire had reached a size of 3,000 hectares and a Type II overhead team was in route. Burnout in previously prescribed burned areas was successful the second night, which along with a slight easing of the weather, allowed containment of the fire.

Final Result: The cost to extinguish the 3000-hectare blaze exceeded $600,000, and on the surface this does not appear much of a testimonial to prescribed fire, however, a look at the scenario without the numerous recent prescribed fires shows the true value. The nearby recent prescribed burns not only slowed the wildfire, but also allowed crews the ability to attack the fire safely. Considering the early spread, the fire would have easily reached 1,600 to 2,000 hectares the first day had it not entered the one-year old fuels. With the long-range spotting and extreme intensity on the second day, a fire size of 10,000 hectares and cost

of well over one million dollars could easily have occurred. More importantly, the prescribed burning on national forest land kept the fire from moving into private timberland in Tate's Hell Swamp, a remote tract of land adjacent to the forest and only 1.6 kilometers from the fire's edge. The 30-year accumulation of fuels in Tate's Hell would have made any attempts at suppression very dangerous for crews. In a worst case scenario, 20,000 hectares could have burned with the fire stopped by the Gulf of Mexico, as happened with a fire in Tate's Hell in 1985. Without the prescribed burning, this 3,000 hectare wildfire could have cost millions of dollars in suppression and lost private timber. Remarkably enough, even with the extreme intensities, timber mortality in the previously prescribed-burned areas of the national forest was very limited. Total timber salvage from the fire area was only 4,400 cubic meters of pulpwood and sawtimber, a volume easily obtainable in less than 80 hectares of clear-cut in southern pine.

THE FUTURE

As more area is treated with prescribed fire at a shorter return interval with a larger proportion burned during the growing season, district personnel are seeing dramatic changes in understory vegetation. The dense clumps of saw palmetto and gallberry are thinning. Wiregrass is regularly seeding and beginning to reclaim some of its former territory. Young turkey oaks (*Quercus laevis*) are being pushed back to the higher, drier sites they historically occupied. Perhaps the most spectacular change is occurring in the transition zone between uplands and wetlands. These formerly open zones have been taken over by titi over the last 50–100 years due to fire control and to prescribed burning only during the winter months when the swamps hold moisture better. Growing-season fire is reducing titi at impressive rates. Titi stems up to 15 centimeters in diameter are being top-killed by hot fires along swamp edges.

Stands of longleaf (*Pinus palustris*) and slash pine (*Pinus elliottii*) are regaining an open appearance that many think was the natural state that greeted the early European explorers. Even the areas that have not received growing-season fire yet are looking better due to reduction in the average height of the understory brush species by more frequent fire. Prescribed fire applied on a natural cycle (3 to 5 years), and applied at intensities that represent the range of historic variability are changing the understory vegetation on the Apalachicola National Forest. Although the foremost benefit of this change is the restoration of the natural ecosystem, a very big side benefit is the flexibility fire managers are now incorporating in fire suppression tactics. Plowing out a wildfire in heavy fuels is an inherently dangerous job. Now, changes in understory vegetation along with changes in agency suppression policy, have given ARD fire managers options other than the traditional tractor-plow.

CONCLUSIONS

The recent successes on the Apalachicola National Forest are reason for optimism, but there is still a long way to go. On the ARD we want to continue shifting the paradigm from fire suppression to prescription. We want to tackle the 50% of the district that still has not seen growing-season fire. We want to experiment with larger landscape-scale burns, and we want to move to burning techniques that more closely mimic the lightning fires that once maintained these unique ecosystems. Congress and the land managing agencies must recognize the wisdom of investing dollars up front for prescribed fire, instead of later for fire suppression. For the Apalachicola prescribed fire program to continue the progress made the last few years, funding must be consistent over several years. To monitor and evaluate the changes taking place in the ecosystems of the southern coastal plains, requires long-range planning and commitment. Many opportunities will be missed with a haphazard approach.

Good suppression capability is still very important. Even during an era of frequent prescribed fire, the vast majority of suppression dollars will still be spent on the tiny percentage of wildfires that escape initial attack and become large project fires. Significant savings will occur in suppression expenditures, but big savings will also occur in less resource damage, even though numbers of wildfires may not change.

Land managers all around the country are facing growing concerns about changes in vegetation due to fire exclusion. Prescribed fire is often touted as the "savior." Managers from the southern coastal plains know fire is not the only answer, but it is in many cases the best means to the end. Four to five decades of prescribed fire have taught many lessons to southern prescribed burners, but we are still learning. Managers of short fire-return-interval ecosystems in other areas of the country can speed the process of returning fire to those systems by studying the lessons learned through trial and error in progressive prescribed fire programs such as the Apalachicola Ranger District. The payoffs, both in ecosystem restoration and in less costly wildfire suppression, are potentially very impressive.

ACKNOWLEDGMENTS

Susan Fitzgerald, Gayle Muenchow, Frank Cole, Andy Colaninno, Mike Long, and Dale Wade provided critical review of this manuscript. My thanks also to all the employees of the Apalachicola Ranger District for their willingness to break new ground.

LITERATURE CITED

Abrahamson, W.G., A.F. Johnson, J.N. Layne, and P.A. Peroni. 1984. Vegetation of the Archbold Biological Station, Florida: an example of the southern Lake Wales Ridge. Florida Science 47:209–250.

Clewell, A.F. 1971. The vegetation of the Apalachicola National Forest: an ecological perspective. Publication prepared un-

der contract for the U.S. Department of Agriculture, Forest Service, Tallahassee, FL.

Ferguson, J.P., and A. Colaninno. 1995. No plow study—Apalachicola Ranger District 1995. Unpublished report. U.S. Department of Agriculture, Forest Service, Tallahassee, FL.

Ferguson, J.P., and J. Hart. 1994. Growing season burning on the Apalachicola Ranger District. Pages 24–31 *in* Proceedings—growing season burn seminars. U.S. Department of Agriculture, Forest Service, Atlanta, GA.

Glitzenstein, J.S., D.R. Streng, and W.J. Platt. 1995. Evaluating the effects of season of burn on vegetation in longleaf pine savannas. Florida Game and Freshwater Fish Commission Nongame Wildlife Program Report. Tallahassee, FL.

Grelen, H.E. 1975. Vegetative response to twelve years of seasonal burning on a Louisiana longleaf pine site. Research Note SO-192, U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, New Orleans, LA.

Komarek, E.V., Sr. 1964. The natural history of lightning. Tall Timbers Fire Ecology Conference Proceedings 4:169–220.

National Wildfire Coordinating Group. 1994. Historical wildland fire-fighter fatalities 1910–1993. Boise, ID.

Robbins, L.E., and R.L. Myers. 1992. Seasonal effects of prescribed burning in Florida: a review. Miscellaneous Publication No. 8, Tall Timbers Research, Inc., Tallahassee, FL.

Wade, D.D. 1983. Fire management in the slash pine ecosystem. Pages 203–223 *in* E.L. Stone (ed.). Proceedings of the managed slash pine ecosystem symposium, School of Forest Resource Conservation, University of Florida, Gainesville.