BUILDING A STATE PRESCRIBED FIRE PROGRAM: EXPERIENCES AND LESSONS LEARNED IN OHIO

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Abstract.—Science continues to show the need for the use of prescribed fire in oak-dominated forests of the eastern United States. Fire is necessary to reduce competition by thin-barked species, allowing for the development of oak advance regeneration. Many agencies are beginning to apply this science by using prescribed fire to manage their oak forests. This paper examines the development of the Ohio Division of Forestry's prescribed fire management program. It outlines the experiences of the Division as it increased use of fire and began burning at the landscape level. Problems, challenges, and lessons learned during the growth of Ohio's prescribed fire program are addressed as well. Although this paper does not provide all of the answers for how to develop a prescribed fire program, it does use the experiences the Ohio Division of Forestry faced over the past 10 years to provide some idea of what expect.

FIRE AND OHIO'S STATE FORESTS

Ohio's forests, like many in the eastern United States, are made up various species of deciduous trees; oaks are the most abundant, especially in the southern and eastern portions of the state (Griffith et al. 1993). At time of settlement (ca. 1800) the state was estimated to be more than 95 percent forested. Settlement and western expansion during the 19th century resulted in a deforestation that lasted nearly 100 years. During the first decade of the 20th century only 10 percent of Ohio was forested. This rapid and significant deforestation spurred the state government to create a State forest agency in 1885.

One of the primary missions assigned to the newly created Division of Forestry was to address the deforestation and prevent a "timber famine." The Division worked on ways to increase forest lands in the State. In 1912 the state legislature amended the Ohio Constitution to allow for the creation of a forest reserve system. Shortly thereafter, the State began to purchase lands which became the first State forests. The lands the Division acquired had been heavily cut over, burned, grazed, and farmed during the late 1800s and early 1900s. These newly obtained lands were then protected from fire and grazing, which resulted in rapid regrowth to mostly oak-dominated stands.

Wildland fires continued to burn occasionally through these forests, but by the mid-1930s the Division's fire control efforts had dramatically decreased the acreage of forest land burned annually (Leete 1938). The decrease in wildfires allowed fire-intolerant species such as red maple and yellow poplar to move out of their traditional locations in the coves and bottomlands and begin to establish in the uplands (Hutchinson et al. 2008). Prior to the development of an effective fire suppression program, these species would be killed during wildfire events that occurred, on average, once every 3-10 years (McEwan et al. 2007). Without fire burning through these stands during the past 70 years, red maple and yellow poplar have developed into saplings and pole-sized stems, creating dense, shaded conditions in the understory, which prevents the development of oak advance regeneration (Dey and Fan, this volume).

In addition to maintaining forest reserves, or State Forests, the Division has a mandate to "take such measures as are necessary to bring about a profitable growth of timber." The Division utilizes many "measures" to address this charge, including harvesting and timber stand improvement practices. The high density of red maple and lack of oak advance regeneration (large seedlings and saplings) has created problems for foresters trying to regenerate oak and sustain its dominance in our State forests. Without

Figure 1.—Ohio Division of Forestry crew conducting a burn in 2005 on the Fire and Fire Surrogates Study.

advance oak regeneration present, harvests or significant disturbances (e.g., tornadoes, ice storms, or insect outbreaks) result in stands that regenerate with an oak component greatly reduced from the previous stand.

Studies throughout the eastern United States have brought to light the changes that are occurring in oak-dominated forests due to the lack of fire; this research stresses the important role that fire plays in maintaining the oak component in these ecosystems (Abrams 1992, Brose and Van Lear 1998, Dey and Fan, this volume). The Ohio Division of Forestry has been involved with this research through its partnership with the U.S. Forest Service, Northern Research Station. Northern Research Station scientists based in Delaware, OH, have led the efforts to study the interaction of fire and fire surrogates (i.e., thinning and harvesting) on the oak-dominated forests in Ohio (Yaussy and Waldrop, this volume). Two of the three replications of this long-term national study are located on Ohio State Forests, Tar Hollow in Ross County and Zaleski in Vinton County (Fig. 1).

The rapid increase in number of scientific publications suggesting the need for fire to sustain oak-dominated ecosystems was a catalyst for the Division of Forestry to expand its use of prescribed fire during the late 1990s and early 21st century, from small sites to larger landscape applications (Fig. 2). This increase in the use of prescribed fire has pointed out issues that fire managers need to be ready to address when building or increasing a prescribed fire program.

The Division of Forestry had been involved with fire suppression for more than 70 years and had been using prescribed fire for nearly 20 years prior to its expansion to the landscape level. Differences between the Division's traditional practice of fire suppression and the larger-scale application of prescribed fire quickly became apparent. The goal of this paper is to share the experiences of the Division of Forestry during the expansion of its prescribed fire program.

GROWING A PRESCRIBED FIRE PROGRAM

Preliminary Considerations

When beginning to grow a prescribed fire program, the natural resource manager should consider several things before taking action. You should identify the goals of using prescribed fire. Burning for ecosystem process restoration is different from burning to reduce hazardous fuels and will require different tools, training, and application. In addition, you need to consider how much land you envision treating annually and compare

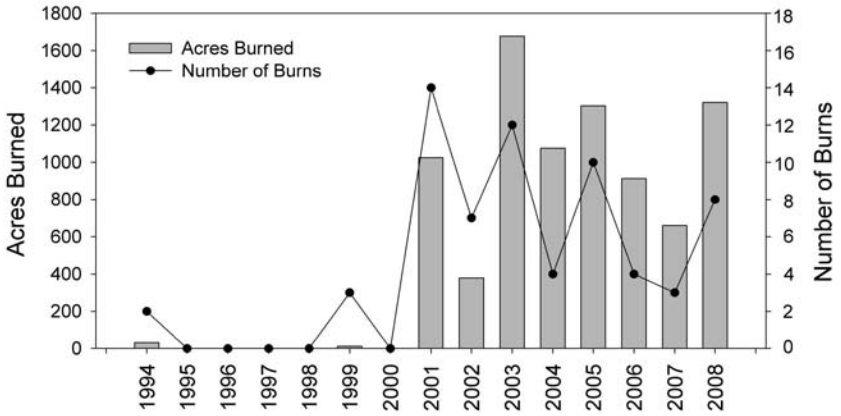

Figure 2.—Prescribed fire application by the Ohio Division of Forestry, 1994 - 2008.

that amount with your current levels of treatment. You should identify the situations, such as weather conditions, season of burning, and fuel moistures, in which you can treat the landscape with prescribed fire. What barriers may impact your implementation of prescribed burning? Can these barriers be mitigated or overcome? Finally, do you have opportunities to establish partnerships with other agencies or organizations to increase capacity to burn more acreage? Serious consideration of these issues can reduce "growing pains" and speed the growth of the program.

During the growth of our prescribed fire program, we have realized the importance of making sure that all involved, from leadership to firefighters, understand its goals. A lack of understanding results in application of fire that does not meet the objectives. Additionally, a workforce with a long history of fire suppression may not understand the goals of prescribed burning, will not fully embrace the management technique, and will be less willing to implement it.

As a program is being expanded, I recommend starting small and gradually increasing capacity. This stepwise implementation allows workers to increase their skills gradually, gives all participants an opportunity to identify practices that are efficient and effective, and prevents workers from landing in situations they are not prepared for or able to deal with. This approach will result in a more effective prescribed fire program in the long run, as recovery from a "misstep" when growing too fast is a difficult process.

Public Perception and Education

Public perception of prescribed fire will be an issue when your organization is developing and growing a prescribed fire program. It is critical to recognize the public's role and to be proactive in sharing information about the program. Educational materials such as Websites, handouts, and displays explaining what and why you are conducting burns are important tools to prepare in advance of program growth. You should plan on spending time talking with local, state, and federal elected officials about the importance and need for prescribed fire, as constituents will contact their elected representatives about your burning efforts.

As prescribed fire programs grow, they often encounter vocal minority groups that oppose the use of fire as a management tool. These opposition groups can provide a serious challenge to a program. They may base arguments on emotion rather than science, and will utilize websites, letters to the editor, and petitions to promote their viewpoint. Many of the opposing arguments focus on potential short-term impacts to plants and animals and do not consider the long-term benefits to habitat that result from the application of prescribed fire.

The majority of the general public will remain silent on the issue, even if these individuals support your efforts. However, you should expect people to speak up if a burn impacts them or others they care about, as in the case of a close-to-home fire or one that creates a smoke problem. When addressing these concerns, make sure you take time to listen and understand the concern. Frame your response to address the concern and stress the importance of the prescribed fire as a management tool. If there are ways to mitigate the concern in the future, be sure to acknowledge that you will change your practice to accommodate the concern. Not addressing an individual concern may result in the formation of a new vocal minority group that opposes prescribed fire.

As a prescribed fire program grows, it is important to recognize that just because there had been no public opposition to burning in one or more areas, this silent acquiescence may not hold true as burning begins in new areas. Additionally, as the use of fire increases, there will be a corresponding need for increasing efforts to reach out and educate the public.

Questions will also come from the public, as well as within agencies, on the question of why there is a shift from fire suppression to prescribed fire. When addressing these questions, as well as other questions on the use of fire, be sure that if you say something is "science-based," you have the support of science and scientists. If you are using adaptive management to make your decisions, say that as well. Finally, when dealing with the public and

media, you or other fire management personnel may say something that can be taken out of context, portraying your agency in a bad light. It's important to think how something you might say could be used in a story or on a website.

IMPLEMENTATION: METHODS AND CHALLENGES

As a prescribed fire program grows, the complexity of burns will increase, as will the need for additional resources. Along with these changes comes the challenge of positioning personnel to perform successfully through training. Training of prescribed fire personnel should focus on both the operational level and the "state of the science." Understanding the science will better enable your personnel to meet the burning objectives because they will understand the benefits of prescribed fire more fully.

It is important to recognize that a workforce that has extensive fire suppression training and experience may lack the knowledge, skills, and abilities to perform prescribed burns that meet land management objectives. Tactically, the application of fire, or "burning out," during fire suppression is commonly the approach that experienced firefighters utilize when implementing prescribed burns. In most cases, burning out is rapidly performed in order to secure the control lines by removing the fuel ahead of the main fire. Many times use of the standard burning-out methods results in too much heat and negative fire effects (e.g., damage to the stand). Training on firing methods such as flanking fire, dot firing, and chevron patterns is helpful in addressing this issue.

A key point to emphasize to the workforce is that prescribed burns are conducted to achieve management objectives, not to achieve black acres. To achieve management objectives, prescribed fire programs may need to look at using different burning practices, methods, and tools.

Equipment needs are different for prescribed fire than for fire suppression. Instead of emphasis on equipment that can put out fire, large-scale prescribed fires require emphasis on equipment that can light fire. Efficient and effective ignition of prescribed burns requires the need for more and specialized equipment. Drip torches are the workhorse of any prescribed fire program. It is important to have a lot of these in your equipment cache. Prepositioning a large stock of torches throughout your burn unit will reduce the time spent waiting for torches to be refilled. Having more drip torches available also increases the number of igniters you can use on a burn. Having too few torches often is the limiting factor for completing the burn efficiently. In addition to drip torches, standard operating procedures should require all igniters to carry several fusees, which can be used to keep the operation moving when refueling is not possible.

Other useful firing devices are flare guns, Terra Torch®, torches mounted on all-terrain vehicles (ATVs), and plastic sphere dispensers. Flare guns and plastic sphere dispensers are used to facilitate interior ignition. Flare guns can launch a highly flammable flare approximately 100 yards to ignite inaccessible areas. Ground-based plastic sphere launchers are also used to facilitate interior ignition. These handheld launchers perform the same function as aerial-mounted plastic sphere dispensers (see below), injecting spheres filled with potassium permanganate with ethylene glycol to create an exothermic chemical reaction; instead of the ball falling from the aircraft to the ground, the ball is launched into the fuel bed. These devices are very useful when using the spot ignition technique on smaller units and when igniting areas that are difficult to reach with other ground-based tools (e.g., locations across waterways, areas of dense fuel concentrations).

ATV-mounted torches are great tools to use when firing on flat ground or where there are roads and trails that are ATV-accessible. These torches expedite blacklining and lighting from roads and trails. If the burn unit has gentle terrain and is fairly open, these devices can be used to perform interior ignition as well. The operator using an ATV to perform interior ignition needs to be an experienced ATV operator as well as an experienced igniter. In many incidents during the past several years, ATV torch operators have been trapped inside burn units because of ATV operation error or lack of good judgment on fire behavior.

Figure 3.—The Terra Torch® in use on a Division of Forestry prescribed fire.

Terra Torches® are very useful when burning larger fuels or for burning during times of higher fuel moistures (Fig 3). These devices can be used to blackline prescribed burn units due to the long residence time of the gelled fuel. These units are also helpful in ignition on roadsides and can blacken edges rapidly. The Terra Torch® requires access to both gasoline and diesel fuel in large quantities, gelling powder, and a means of transportation for the torch.

Aerial mounted plastic sphere dispensers (PSD) should be considered when burning forested areas more than 200 acres in size. The use of a PSD machine allows the prescribed burn manager to spread fire across the unit very quickly. The fire intensity can be managed through the spacing of the ignition flight lines as well as the distance between each sphere within a given line. Each sphere creates a single ignition point and hence an individual fire. The spacing of these individual fires can be used to manipulate how much of the unit is burned with heading, backing, and flanking fire intensity. The use of an aerial PSD machine has specific requirements that may be challenging for some agencies. To use aerial ignition, the prescribed burn manager needs access to a helicopter, a PSD machine, and personnel trained in the operation of the equipment. Although the cost of a helicopter is generally in the range of $400-$1000 per hour, the use of aerial ignition can dramatically reduce prescribed fire costs, especially on larger units, due to the reduction in time and personnel needed to complete the burn.

Other tools include ATVs, water units, and portable water tanks. ATVs are very useful for patrolling, monitoring, and moving supplies throughout your burning area. It is important that you use trained and skilled operators that recognize where the ATVs can travel safely. Prescribed fire managers should not push the limitations of the equipment and operators by asking them to go places that are not safe. Water units such as engines and other utility vehicles with water tanks and pumps are very useful during holding and mop-up operations. When water units are used, portable water tanks strategically placed throughout your burning area will be very helpful in providing refill locations.

As a prescribed fire management program grows, there will be successful days and days that were not as successful. It is critical to document what you did, when you did it, why you did it, and what results you got. Without these data, it will be difficult to determine what works well and more importantly, how to replicate it. When determining the effects of a burn, you need to be patient: It often takes time for those effects to become obvious. When burning, you may need to find out what fire intensity is "too hot" and what is "too cool" for your objectives and try to burn at an appropriate intermediate intensity.

After-action reviews (AAR) should be established as a standard operating procedure. These reviews can be implemented in many ways without taking too much time. The AAR should be done immediately after the burn has finished, while the crew still has the events of the day in mind. Items that come out of these reviews may seem minor, but oftentimes it is the small details that get overlooked in the planning process. Paying attention to these details can greatly improve the overall performance of the burning group. The use of AARs has caused the Division of Forestry to place greater emphasis on logistical support and planning, such as prepositioned drip torches, better communications, and better availability of supplies. Periodic program reviews are also helpful for looking at organizational issues that may need adjustment.

As a prescribed fire program grows, it is important to recognize that your people will need to grow as well.

Utilize the most skilled prescribed fire personnel in the most critical roles and locations during burns. Make sure that they have someone with them who has a mentor and is being nurtured for the future. It is important to establish partnerships with other agencies and organizations that conduct burns. It can be very educational for your personnel to work with these other groups to provide a different training experience. In addition, helping out on others' burns is beneficial as they will be more likely to reciprocate.

As a program burns more acreage, it is important to stay abreast of air quality issues. Air quality regulations are developed nationally and enforced locally. It is also important to get to know your local air quality regulators and to have them observe burns. Once they observe what you are doing with fire and understand that you know what you are doing, they will be more likely to work with you. Many states' air quality regulations are lumped into the general open burning regulations, and showing the regulators how prescribed fire is different from general open burning is important as well. In areas where smoke is a concern, the air quality agency may be able to place monitors in these locations to document background air quality as well as impacts on the air quality from prescribed burns. Smoke management training and research carried out during prescribed burns will be critical to ensure that smoke does not impact the public in undesirable ways and that burning can be allowed to continue.

Most importantly, safe burning practices must be stressed as programs grow. Escaped prescribed fire could result in legislative action that would limit or end the use of this important land management tool.

LESSONS LEARNED DURING IMPLEMENTATION

Fire Behavior and Fire Season

An early lesson that we learned was that the conditions on days the Division typically thought of as "fire days" are not the most conducive to prescribed burns. The fuel and weather conditions on "fire days" are often too dry, resulting in intense fire behavior and mortality of larger trees, which is not our objective.

The development of burn prescriptions is an art based upon science. When developing prescriptions, you should be careful not to prescribe yourself out of the opportunity to burn. Prescriptions should be developed to allow for burning on almost any day that fire will carry across the landscape.

The number of days since rain is more critical in the early spring than the late spring when vegetation is pulling moisture out of the soil; a longer rain-free period is necessary in early March as compared to mid-April for leaf litter to be dry enough to burn. During the fall, burning is successful under higher relative humidities than in the spring because autumn leaf litter is less compacted. During the spring, when the litter has been compacted over the winter, only the top layer of litter burns unless the site has experienced an extended rain-free period, generally 5 or more days.

In our region, it is very difficult to manage fire behavior on very dry sites that have not had fire exposure in several years, especially those with dense thickets of greenbriar (*Smilax rotundifolia)*. These sites burn with high intensity, regardless of the type of fire (heading, backing, or flanking), and some overstory mortality often occurs. Conversely, fire may carry across mesic sites, but with very low intensity and limited effects. Observations of fire behavior on sites that had a mixture of oak (dry sites) and yellow-poplar/red maple (mesic or wet sites) stands illustrate this difference. Fire behavior in the oak stands was moderately intense (3-ft flame lengths) while the fire behavior in the yellow poplar/red maple areas was minimal and in many places the fire went out (Fig. 4)

Early growing-season burns may be the "wave of the future" and should be considered. Research has indicated that burning during this season can provide the greatest benefit to oak regeneration by having a larger negative impact on competing species such as red maple and yellow-poplar (Brose and Van Lear 1998). Early growing-season fires are much easier to control because they have lower flame lengths, lower rates of spread, and reduced potential for escape due to lower probability of ignition (Fig. 5). Growing-season burning also extends the spring fire season by 3 to 6 weeks. In Ohio, green-up begins in mid-April, the traditional end of the prescribed fire

Figure 4.—Patchy fire coverage on a site dominated by non-oak species.

Figure 5.—An early growing-season burn conducted at the Vinton Furnace Experimental Forest, May 6, 2008.

season; burning throughout the early growing season extends the fire season until mid-May. However, early growing-season burns raise questions and concerns related to potential negative impacts on animals such as turtles, snakes, and ground-nesting birds. More research needs to be conducted to determine whether short-term negative impacts (if any) are outweighed by long-term positive changes to habitat.

Operationally, growing-season burns will be different in several ways. The prescribed fire crew is exposed to more physically taxing conditions due to higher air temperatures. During the typical dormant burning season, it is unusual to experience air temperatures over 75 °F, but higher temperatures will be common during the early growing season. Early growing-season burns will also have reduced visibility across the unit due to the leaves on the vegetation, reducing the ability to see people in the unit and spot fires outside of the unit.

Fire Effects

Many prescribed burns are being conducted in oak-dominated forests to reduce the competition to oak regeneration by red maple and/or other thin-barked trees. A single burn will topkill red maple stems, but abundant resprouting will follow. To reduce this competition, more than one burn will be needed to be successful. Our experience is that fire effects, both desirable and undesirable, take at least 2 years to become evident. It is important to continue to monitor sites for several years after burning to detect these changes.

In general, we observe that burning is reducing the low shade and topkilling the fire-intolerant species. However, if promotion of oak advance regeneration is a management goal, canopy opening will likely be required to provide more light to the oak seedlings. In locations where we have burned and opened the canopy, we are beginning to see the development of vigorous oak advance regeneration (Fig. 6).

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Figure 6.—Abundant white oak advance regeneration on a burned site in southern Ohio. This site had been burned five times from 1996 to 2004, largely eliminating the sapling layer of shade-tolerant species. Here, white oak seedlings are growing rapidly in a gap caused by the death of several dominant and codominant white oaks, part of a regional white oak decline event.

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