

CHAPTER 9

ECOLOGICAL EFFECTS

OBJECTIVES

- 1) Identify fire's primary effects on the basic physical ecosystem components of water and soils.
- 2) Identify fire's primary effects on floral (plants) and faunal (animal) components of ecosystems.
- 3) Identify common Florida fire-dependent ecosystems and frequency of fire return intervals that sustain them.
- 4) Understand the relationship between season or timing of fire applications and certain ecosystem responses.
- 5) Understand the connection between burn prescription parameters and ecological effects.

INTRODUCTION

No natural force is so misunderstood or such a ready catalyst for heated debate as fire. A student of its literature finds much contradiction, many anecdotal offerings and results of poorly designed research projects. Few long term studies have been conducted to weigh and document fire's ecological effects and in this culturally altered landscape of ours it is often difficult to sort out ecological consequences in systems that human disturbances have made unnatural.

Fire is a global phenomenon, not something confined to Florida, although we can claim to be the lightning capitol of our continent. Florida possesses many ecological systems which require frequent fire to maintain their appearance, function and diversity. Although it is now a much changed landscape, the systems recognized in Florida today have existed for at least 20,000 years (except for the Everglades which is less than 10,000 years old). Lightning has been a primary force in maintenance of biodiversity and we, the human animal, have never been adverse to setting landscapes ablaze to achieve a variety of objectives.

As resource managers we are charged with meeting a wide array of resource management needs. This discussion of ecological effects is designed to provide fire managers with an understanding of basic ecological principles and how they may be incorporated into each fire management program and how burn prescription parameters can be crafted to produce certain desired ecological effects that reflect resource management objectives.

Fire ecology or ecological effects is the study of the effect of fire on the physical environment (soil and water) as well as on the living organisms (flora and fauna). This discussion will focus on how fire may affect soils, water, flora (plants), and fauna (animals).

These four components of the environment and interactions between them account for the majority of fire's ecological impacts. Certain things occur as a result of every fire regardless of the fire's origin or the time of year in which the fire occurs.

ECOLOGICAL EFFECTS ON ECOSYSTEM COMPONENTS

Water/Hydrology

Fire affects hydrology in Florida's systems through a variety of both short and long term processes. There is also a reverse effect in that changes of hydrological regimes also cause changes in fire regimes for Florida's ecosystems. There is a much entwined relationship between water and fire for Florida's fire dependent communities. In this section, the focus is strictly on effects of water or hydrology on the ecosystem.

Some short term hydrological effects are:

Infiltration and percolation rates can be slowed, especially in dry, sandy soils that have good grass cover due to the clogging of the soil's pores from the input of ash.

Soil surface evaporation rates can be hastened immediately post-burn due to higher soil temperatures that occur due to a reduced canopy cover and the presence of blackened surfaces which absorb more heat than an unburned surface. This is usually minor since plant transpiration rates are usually decreased due to loss of plant biomass. As plants grow back and ground shading increases, the loss of soil moisture will decrease.

Evapo-transpiration (transpiration from the plants) rates may be temporarily reduced due to reduction in vegetation and due to the possible conversion from a woody (trees and shrubs) canopy to a more herbaceous (grasses, forbs) groundcover.

Surface runoff can be accelerated when fires remove most of the fuels/plants that capture water and impede flow and when ash clogs soil pores and reduces water penetration. In Florida, our relatively flat landscape generally minimizes runoff. In areas with a more pronounced slope, erosion may occur but plants with well developed and undamaged root systems will continue to bind and protect soils. The rapid rate of plant growth after spring and summer burns reduces chances of erosion while soils that are exposed for longer periods after fall and winter burns could be subject to more erosion.

Post burn rainfall may act as a major recovery aid or as a hindrance. In wetlands, flooding immediately after a fire may eliminate some emergent species such as sawgrass. These newly created open areas may be relatively permanent if subsequent water levels remain high. Less pronounced plant responses are governed by the duration and degree of soil saturation or inundation.

There are also more lasting effects of fire on hydrology:

Fire in wetlands may prevent organic buildup, impede succession, and enhance water storage.

Heavy removal of organic soils (especially when their drying has been anthropogenically influenced) can re-create wetlands. Under natural conditions these peat or 'muck' fires were far less frequent than today because wetlands were not drained by canals and other human activities.

Soils

Effects on soil vary depending on the intensity of the fire, fuel types, soils, topography and residence time, with fire intensity and residence time having the greatest impacts on soils. The most observable or measurable effects to soils are:

A release of nutrients into the ecosystem, followed by a possible leaching of nutrients from ecosystems due to fire consuming the surface fuels (plants). Some of these nutrients may be leached from the system if they are not taken back up by micro-organisms in the soil or by plants. Less leaching may occur after spring and summer burns when plants grow quickly post-burn and take up the released nutrients before they can leach from the system.

Due to the generally short-term loss of forest floor organic layers there is greater mineral soil exposure in the short-term.

Fire will accelerate rates of oxidation and decay which means leaves and other organic litter decompose and oxidize more rapidly. Nutrients and minerals released by this process enhance plant growth.

Concentration and mobility of potassium, calcium and magnesium are increased, and there is a short term transfer of phosphorous, potassium, calcium, magnesium and nitrogen from the litter to the soil.

Increased soil temperatures after fires enhance nitrification of remaining organics (however, fire also volatilizes nitrogen).

Soil bacteria and insect populations decline immediately after a fire but can increase 3 -10 times within a month. Bacteria act to break down organics making nutrients available to plants.

Slight elevations in pH may occur for up to two years after some burns. This may influence the types of plants that will grow in the area.

The above factors when combined with soil moisture will greatly enhance soil fertility and plant growth.

Flora

The major factors which effect post-fire plant recovery and growth are intensity of the burn, season of burn, post-fire plant competition, weather and biological characteristics.

Fire has some immediate and sometimes lethal effects on living plant tissues. These effects will vary based on the temperature and amount of time it takes for the fire to pass over an area, the fire's residence time. For most plants, mortality of plant cells will occur if temperatures from 122-131°F are sustained for 10 minutes. Instantaneous tissue death occurs at 145°F. The time and temperature required to kill a plant varies, depending on moisture content of the tissue. The heating of swollen cells bursts cell walls.

Many different environmental conditions and various plant characteristics will influence the impact that fire will have on vegetation. There is usually a good correlation between fire behavior and its effect on trees, but much less correlation between fire behavior and its impact on understory vegetation (shrubs, grasses and forbs). The longer term ecological effects from fire are also very dependent on post burn weather conditions. The same type of fire application can produce very different effects depending on weather after the burn – did it rain soon after the fire; was there any extended dry period post burn that added additional stress to the vegetation. These post burn variations contribute to and can exacerbate the interactions between fire intensity and fire severity as discussed in Chapter 6, Fire Behavior.

Plants have different abilities to recover after a fire. If you understand the basic principles that determine how plants are affected by fire and the factors that control plant response after a fire, you can understand why various studies often present apparently different results even on the same plant species. You can also realize why there is so much variation after different fires or even in different locations of the same fire.

Once you grasp the causes of variation in fire effects, then, given a certain plant community and a certain set of burning conditions, you can better predict what post fire effects are likely to occur. You should also be able to explain departures from what you predicted. This process must also take into consideration the conditions that existed prior to and following the burn.

With the exception of some communities that naturally burn catastrophically (Peninsula sand pine scrub, oak scrubs), most “killing fires” are a result of abnormally high fuel loads created by infrequent fires resulting from an interruption of the natural fire cycle due to fire exclusion.

Fire Effects On Pine Species

Pine tree species make up much of the overstory in many of Florida's fire-type ecological communities as well as being a resource managed by the forest products industry. Due to the significant focus of many resource management programs on managing pine canopy, effects on individual pine species are described.

In wooded areas the forest stand characteristics can alter the impact of a fire. These include factors such as the distance between crowns, the shape of the crown, the ratio of live to dead trees and the amount of litter accumulation beneath the trees. Under some conditions special prescription precautions must be taken to prevent intense or severe fires.

Pines have thick bark that does not conduct heat well. Studies have shown that although temperatures may reach 1500°F on the bark surface, the temperature at the cambium is only 180°F. This can still be a lethal temperature for plant tissue when sustained long enough which is an impact of fire residence time. The highest temperatures are experienced on the leeward side of the tree where it can be twice as hot as the windward side. Even a low intensity fire with low flame lengths can kill trees due to extended residence time where the fire effectively girdles the base of the tree. When leaf litter, pine needles and other types of duff accumulate at the base of trees, fires may burn into the roots or lower trunk, causing stress or mortality. This is especially prevalent in old-growth pines that have experienced fire exclusion. Burn prescription parameters and burn site preparations can address this undesired effect.

Needle scorch alone in longleaf and south Florida slash pines is not an indicator that the affected trees will die. However, total needle scorch of north Florida slash, loblolly, shortleaf and sand pine may result in tree death. Actual consumption of pine tree needles generally leads to death of all pines except pond pines which resprout from the trunk.

Longleaf Pine – seedlings remain in the grass stage for 3-5 years and are very fire tolerant; the tree's long needles dissipate heat and aid in cooling the growing buds; large buds have a high heat capacity due to their high moisture content; thick twigs and bark insulate the tree trunk. Young trees are vulnerable during their sapling stage as they are bolting, rapidly gaining height and have thinner bark due to rapid growth.

Slash Pine – North Florida slash pine has thick bark and fairly long needles but otherwise it is not very fire tolerant. It reseeds well. South Florida slash pine mimics longleaf pine and has a pseudo-grass stage and other characteristics similar to longleaf pine. It takes the ecological place of longleaf pine in South Florida.

Sand Pine – not fire tolerant, but has serotinous cones which release a large volume of seeds in response to the heat of a fire; it forms single age stands due to this reproductive strategy.

Pond Pine – can sprout from the trunk or the root collar even when tree is apparently consumed by fire; it has thick bark and serotinous cones.

Loblolly Pine – not very fire tolerant when it is young but gets a thick, insulating bark as it matures; highly susceptible to scorch; frequently an invader of high pine, flatwoods and old fields, especially in North Florida.

Spruce Pine – grows in hammocks and is not very fire tolerant.

Shortleaf Pine – if burned as a seedling or a sapling, it will resprout from the root collar; it has

thick bark but does not tolerate intense fires; tolerates frequent surface fires.

Fire Effects on Understory and Groundcover

A high percentage of understory plants are usually top-killed by fire. Those without fire adaptation qualities may be killed by a single fire or eventually eliminated by subsequent fires that follow at close intervals. Those which are fire adapted recover quickly. They usually have specially adapted parts that resprout and grow vigorously after a burn (rhizomes, stolons, bulbs or corms, dormant buds, root crowns, etc). Some plants also have a double adaptation to fire by both sprouting and producing or releasing seed.

Fire alters plant composition and productivity in a variety of ways. The overall number of plants may increase or decrease; some species may increase while others decrease; and the density of plant growth (amount of cover) may be altered. These factors interact and determine the species composition of the burn unit (ratio of various types of plants and total plant biomass).

Fuel and moisture characteristics affect the amount of heat generated in a grass fire. Factors determining temperature are stem coarseness, fine vegetative culms, bunchgrass diameter, amount of surface litter, fuel moisture content, soil moisture and wind speed. Slow moving (long residence time), hot burns can weaken grasses, especially those approaching senescence (older growth). Delayed sprouting or heavy mortality can occur but mortality can be managed by appropriate burn prescription parameters.

Saw palmetto now dominates many fire-type communities. It is important for wildlife food and cover, but where it has gained dominance due to fire exclusion, it shades much of the groundcover components of these communities. Saw palmetto responds to fire with rapid regrowth and heavy flowering and fruiting. Shorter fire frequencies (1-2 years) as compared to longer fire frequencies (4-5 years) limit cumulative fruit production and plant growth of saw palmetto.

Reproduction by seeding can be influenced and managed with fire in a number of ways:

1. Knowing the seed ecology of the target species; not all species produce seed every year (ex. longleaf pine) and many tree species must reach a certain age before producing seed;
2. Selecting burn sites where optimal seed production will occur;
3. Sizing the burn to promote dispersal based on the species seed dispersal mechanism (wind, animals, ants);
4. Timing the burn to take advantage of seasonal responses which will favor seed production and germination;
5. Utilizing fire to stimulate seed banked seeds to germinate or to open serotinous cones;
6. By removing parent plants which produce alleopathic chemicals to inhibit seed germination (ex. rosemary) thereby promoting seed establishment once released from chemical impacts.

Fauna

Although many people worry a great deal about the effects of fire on animal life, animals are a product of the habitat or natural community, and the natural community is frequently a product of fire. Animals are adapted to survive the patterns of fire frequency, season, size, severity and uniformity that occurred in their habitats in pre-settlement times. In considering effects of fire on animal life, the most often overlooked issues revolve around the impacts associated with fire exclusion and reduced fire frequencies. Florida wildlife evolved and thrived in an environment shaped and maintained by frequent fires across much of the landscape. It is not surprising that under most circumstances direct mortality of wildlife is rarely a problem even when heavy fuel loads are burned during wildfire events.

Burns conducted for ecological purposes should incorporate the entire faunal component of the region, vegetation types, stages of succession, weather patterns and intensity of burns. Often, a mosaic of successional stages of vegetation created by a series of fires, over time, is the preferred habitat for the optimal diversity and abundance of wildlife.

Animals can also influence the probability of fire. For instance, heavy grazing reduces ground fuels and the likelihood of fire, while heavy insect damage which kills trees may increase the potential for severe high intensity burns. Rooting by feral hogs is a significant problem in many natural areas because the rootings are so extensive that they stop the spread of fire in fuels where fire spread is typically not a concern. Hogs also have a significant impact on wetland systems, not only impeding the spread of surface fires into the wetlands but also disrupting the hydrology of the impacted wetlands.

The principle way that fire affects fauna is by altering habitat. Direct wildlife mortality is rare but depending on the type and frequency of fire the altered habitats may support higher or lower densities of a particular wildlife species. Ecological prescribed fires in Florida should be designed to maintain or restore wildlife densities to levels consistent with historical pyrogenic (fire maintained) conditions. Burn prescription objectives should include desired habitat responses.

Wildland fires can kill wildlife but mortality is usually limited to a few individuals representing a small fraction of the population. In contrast, lack of fire can result in the loss of entire suites of fire-adapted animal species as the habitat becomes unsuitable for their needs. With careful planning and with attention to potential impact to individual species, the prescribed burner can minimize the risks of direct mortality. In Florida this can be especially important when dealing with species that are threatened, endangered or of special interest on a particular site. Gopher tortoise, sand skink, red-cockaded woodpecker, Florida grasshopper sparrow, Florida scrub-jay, bald eagle, Florida panther, and Florida black bear are examples of species that receive special attention.

Fire Effects on Fauna

Most effects of fire on animals are indirect effects. Fires make changes in the environment (habitats) in which animals (vertebrate and invertebrate) live, and animals respond to those

changes. The extent of fire effects on animal communities generally depends on the extent of change in habitat structure and plant species composition. Stand-replacement fires usually cause greater faunal changes in forest communities than in grassland communities. Within forests, stand-replacement fires cause more alterations than understory fires.

The primary indirect fire effects on animals may include the following:

Micro-climate changes due to the resultant temperature and moisture level changes which occur as a result of vegetation changes. This may make areas of the habitat unsuitable for certain animal populations.

Pathogens (disease causing organisms) may be killed or controlled by fire (e. g. brown spot which is detrimental to longleaf pine).

Insect populations may be reduced dramatically but these species may rebound quickly. The reduction in insects may have a secondary impact on the animal species using insects as a food source.

Changes in habitat, i.e., cover. Recovery occurs more quickly after a growing season fire; but loss of cover is more protracted after non-growing season fires.

Changes in plant food sources and nutrients levels. Plants regrow at different rates which result in differing amounts of forage, seed and fruit production. Nutrient levels increase in the new sprouts and are beneficial as animals benefit from improved forage quality.

Small mammals often evade a fire by using burrows or moving to unburned areas or wetlands. Fast moving fires burning across heavy continuous fuels may cause significant mortality but short reproductive cycles can quickly compensate for these losses.

Alterations in food quality and abundance as well as cover, nesting and denning sites are more important factors that ultimately determine small mammal populations.

Large and/or severe fires in concentrated nesting or reproductive sites may cause significant mortality or recruitment failure.

FLORIDA ECOSYSTEMS AND FIRE

Fire-Type/Non Fire-Type Communities

The Florida Natural Areas Inventory (FNAI) describes 81 natural communities found in Florida. Fire plays a role in over 26 (32%) of these 81 communities. In some instances, the communities are considered fire dependent, meaning that periodic fire is a vital ecological function for that community. There are other communities, where fire is less common, and combines with other ecological influences, making those communities fire influenced. See Table 9-1.

Table 9-1. Florida natural communities, fire dependency and frequency of fire per Florida Natural Areas Inventory.

Natural Community	Fire Dependent	Fire Influenced	FNAI Fire Frequency/Interval
Hardwood Forested Uplands:			
Mesic Hammock	No	Maybe	Frequent (for prairie variant) to rare depending on surrounding community
Up. Hardwood Forest	No	Maybe	Fire may be important on edges
Xeric Hammock	No	Maybe	Impacts to edges, 30+ yrs
High Pine and Scrub:			
Sandhill	Yes	-	Frequent, 1-3 yrs
Scrub	Yes	-	Variable, 5-30
Up. Mixed Woodland	Yes	-	Fire burns into it, 10-20 yrs
Upland Pine	Yes	Yes	Frequent, 1-3 yrs
Pine Flatwoods and Dry Prairie:			
Dry Prairie	Yes	-	Frequent, 1-2 yrs
Mesic Flatwoods	Yes	-	Frequent, 1- 4 yrs
Pine Rockland	Yes	-	Frequent, 3-7 yrs
Scrubby Flatwoods	Yes	-	Occasional, 5-15 yrs
Wet Flatwoods	Yes	-	Frequent, 3-10 yrs
Coastal Uplands:			
Beach Dune	No	Yes	Occasional – rare
Coastal Grassland	No	Yes	Occasional
Sinkhole and Outcrop Communities:			
Upland Glade	Yes	-	Irregular intervals
Freshwater Non-Forested Wetlands:			
Basin Marsh	Yes	-	Frequency depends on surroundings
Depression Marsh	Yes	-	Burns with surrounding community
Floodplain Marsh	Yes	-	Depends on water levels
Glades Marsh	Yes	-	Tied to surrounding matrix, estimate 2-5 yrs
Marl Prairie	Yes	-	Frequent, 1-6 yrs
Seepage Slope	Yes	-	Frequent to occasional, 2-3 yrs
Shrub Bog	No	Yes	Shrubs, 3-8 yrs; woody, 50-150 yrs
Slough	Yes	-	Tied to surroundings, est. 2-5 yrs
Wet Prairie	Yes	-	Frequent, 2-4 yrs
Freshwater Forested Wetlands:			
Baygall	No	Yes	Fire impacts edge
Basin Swamp	No	Yes	5-150 yrs
Dome Swamp	No	Yes	Light surface fire from nearby community
Hydric Hammock	No	Maybe	Frequent (for prairie variant) to rare depending on surrounding community

Fire Frequency/Fire Return Interval

Fire frequency is a function of pyrogenicity (ease of ignition and ability to carry a fire). Natural communities comprised mainly of herbaceous, fine fuels are usually more easily ignited and carry fire well. Such communities are responsible for carrying fire to less pyrogenic communities adjacent to them or imbedded within the pyrogenic community, such as a cypress dome imbedded in wet flatwoods. The frequency of fire is responsible for the biodiversity and composition of understory plants and presence or absence of overstory trees. Fire frequency also determines the density of the overstory trees and their species composition. Fire frequency of every two to three years has been shown to be critical to several pineland bird species, including bobwhite quail, currently experiencing steep population declines due to a lack of fire frequency which has led to a dominance of hardwoods over grasses and forbs. Frequent fires are paramount to good management of Florida's fire-dependent communities. This frequent re-application of fire is more important than the season of burn unless the land manager can adequately maintain both the frequency and season of burn.

The ecological effects of the lack of fire (fire exclusion) are often long term. Without fire, communities become mono-cultural, grasses grow senescent, trees are crowded, excessive fuels build up and new tree and shrub species invade the site. This 'new' habitat supports fewer individuals of once abundant species and some species disappear. While the actual faunal components may vary by plant community, the decline in abundance and diversity is a predictable consequence of fire exclusion.

The lack of fire frequency also causes fuel loads to accumulate, creating unnatural fuel loading conditions as well as species changes and a loss of biodiversity. When fires do occur in these over-loaded fuel situations, fire effects are much more severe and long-lasting in these poor condition fire-adapted natural communities as the plants and animals are subjected to a type of fire that they are not adapted to.

In Florida, the combination of depth to the water table and the frequency of fire often will dictate the type of community present, and more than likely the stage of the community, as defined by the height and presence of appropriate plant species. Sites which contain transitions between natural communities often display a degree of slope that corresponds to the soil type present, which also corresponds to the soil's ability to hold ground or rain water for a specific length of time. Historically, fires that were started by lightning burned through the communities that were often the most arid (dry), and stop where lower (wetter) communities occurred. This results in a "mosaic" of habitats that is dictated by the frequency of fire and the depth to the water table. Such knowledge of soils and the historical patterns of fire on your site is essential for restoring and managing fire-dependent habitats. Figure 9-1 illustrates the continuum of natural communities from lower wetlands to higher dry sites. Fire frequency compounds the effect of depth to water table to determine what natural communities occur in a particular area. With changes in the length of fire return interval (possibly due to fire exclusion), the natural community will succeed into another community with no changes to depth of the water table.

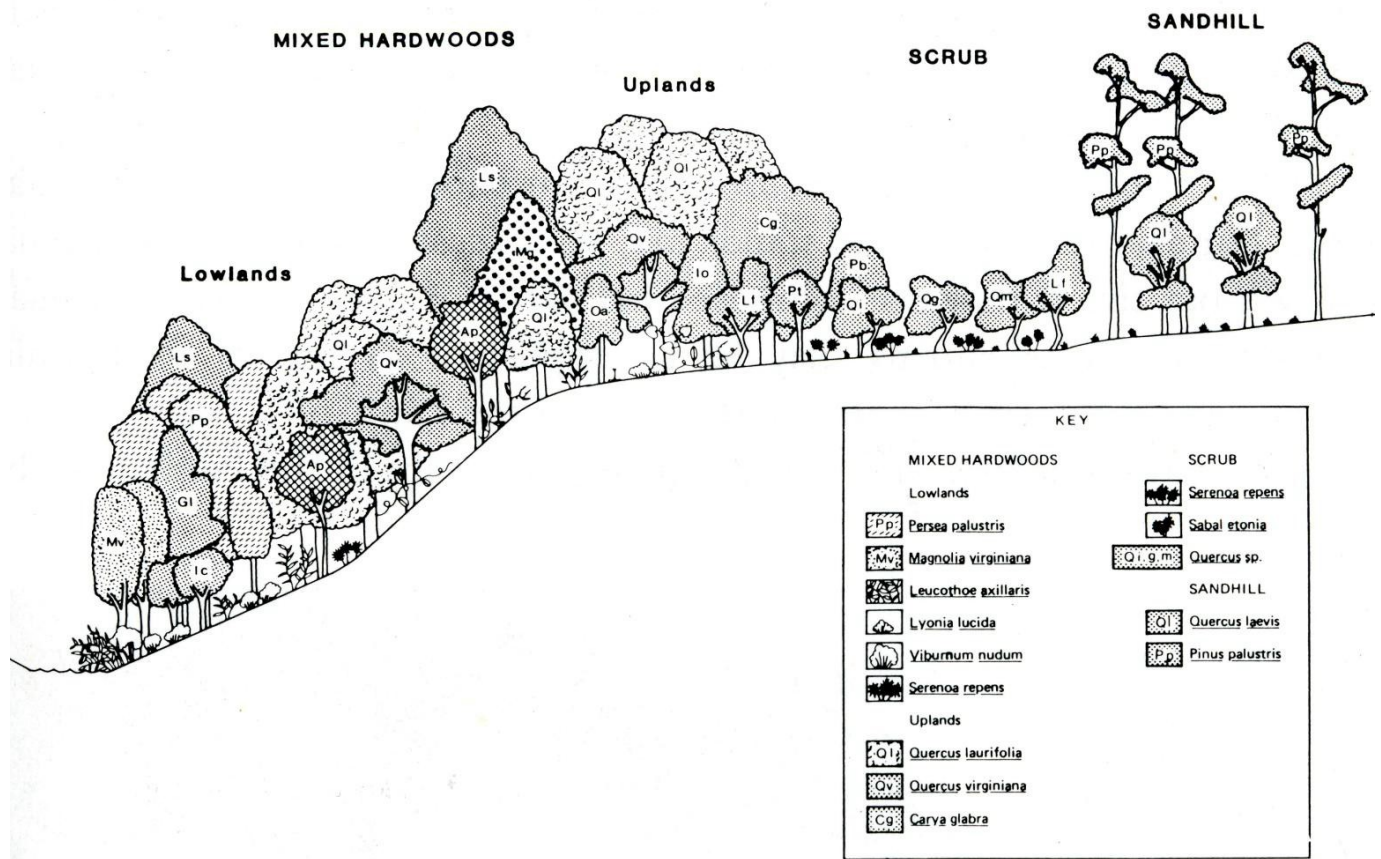


Figure 9-1: Community profile from Mike Roess Gold Head Branch State Park as an illustration of community development and depth to water table. Source: *Ecosystems of Florida*.

Season of Burn

The time of year a fire occurs, or the season of the burn, has a notable effect on plant responses. For example, an early growing season burn, will produce prolific seeding in wiregrass plants; the same burn done during the dormant season, produces little seeding. Woody plant species (especially deciduous hardwoods) are negatively impacted by early spring burns when they have leafed out and are most actively growing and using up their carbohydrate reserves. Such burns will stress the hardwoods, causing them to draw heavily upon their reserves or kill them outright if the reserves are inadequate to sustain resprouting. A dormant season burn will not have the same impact on hardwoods. Pine trees may be severely impacted by a late summer – fall burn, just prior to the dormant season, if there is major needle scorch. In this scenario, the pines are unable to replace their scorched needles due to the stage of their annual life cycle meaning that they will not have enough needles to sustain sufficient photosynthesis.

Many plants have specific adapted resistances to heat but may be more resistant when dormant and when tissue moisture is very low. During the growing season many green

plants will have high moisture content and may not burn at all. Accumulations of dead fuels and other factors may generate fire intensities or severities that negate these adaptations.

The seeds of some pines and grasses are favored by access to bare mineral soil. Spring and summer fires are appropriately timed to create bare patches of soil to catch the fall drop of pine and wiregrass seeds.

The condition of the site in regards to fuel loading needs to be considered when prescribing the season of burn to produce certain ecological effects. Burns can generally be separated into two types: restoration burning or maintenance burning. In restoration burning the community is not in good condition, typically the fuel loading is high due to fire exclusion, and the community is being gradually restored to some more desirable future condition. Although a certain season, such as the growing season might produce the desired ecological effects, for example an increase in herbaceous groundcover, the community may not be at a fuel loading level to tolerate the stresses of growing season burning. In general, restoration burning is a gradual process beginning with dormant season burning to lower fuel loads and to return the community to a more natural fuel loading scenario. Most areas requiring restoration burning have missed many fire rotations, and those years of missed burn opportunities can not be successfully recovered with just one burn applied at the ecologically most appropriate season of the year.

Seasonal Plant Responses After a Fire

The major factors which affect post fire plant recovery and growth are:

1. The seasonal cycle of carbohydrate reserves: woody species fare better when burned during their dormant season and worse when burned during the growing season when their carbohydrate reserves are lowest.
2. Post fire plant competition: faster growing plants and those that thrive under the specific moisture and temperature conditions existing after a fire compete better for light, space and nutrients. Also, plants with carbohydrate reserves exhibit growth prior to other species. Saw palmetto is an excellent example. With highest carbohydrate reserves in February and March, palmetto experiences rapid re-growth after repeated winter season burns allowing it to expand and replace other plants.

Seasonal Animal Responses After a Fire

Southern wildlife managers historically often avoided burning pine forests during late spring and early summer because of concerns about harming wildlife species. However, the late spring/early summer time of year is also the peak southern historical fire season. Early fire ecologists concluded that southern wildlife must have evolved the means to survive the frequent fires during the spring/summer transitional period.

The impacts of growing season/lightning season burning on pineland birds in southern forests have recently been summarized. There are many concerns over burns done during the nesting season, but studies have found that the threat posed to nesting birds is not as severe as perceived. Many ground-nesting species that might be affected by burns prefer to nest in recently burned areas. Birds also frequently re-nest following nest loss, and the improved habitat conditions created by burning may improve adult and juvenile survivorship and offset the loss of a nest. Late-season burning was also found to not pose a threat to populations as long as it was part of a comprehensive burn program that also included growing season burning. For several pineland bird species experiencing steep population declines, the reduction of hardwoods that typically follows a growing season burn is critical to creating the more open habitat conditions needed by the birds.

A recent (2012) study on wild turkey habitat use demonstrates that fire regimes developed to restore or sustain pine savanna habitats are within the suitable bounds for wild turkeys and the researchers argue that turkeys evolved with the pine savanna ecosystem, which likely burned every 1-3 years and turkeys are therefore suited to a management style designed to maintain pine savanna at the climax vegetation community.

The effect of fire season on small mammal populations remains poorly studied. The general thought is that historical fires in eastern forests may have been of sufficiently low intensity and patchy in nature that the general needs of small animal populations were met regardless of burn season.

There is limited direct information on the effects of fire on amphibians and reptiles. Burns conducted at any time of the year when moisture is high have a lower probability of consuming fuels in wetter areas. It is quite possible that amphibian and reptile species are indirectly influenced by burn season through the differential effects on vegetative (habitat) structure. Burns that reduce the height of understory vegetation and increase herbaceous groundcover are known to benefit gopher tortoises. Varying the burn season to include both dormant and growing season burns has been suggested as one method of reducing the potential negative impacts of fire.

BURN PRESCRIPTION PARAMETERS AND ECOLOGICAL EFFECTS

Application of Fire to Produce Specific Ecological Effects

Prior to applying fire land managers should have specific objectives and desired outcomes clearly defined. Once the objectives are set the burn can be planned, and what you now know about fire can be used to your advantage to produce the desired ecological effects. Understanding how each prescription parameter can affect the burn is important for understanding how to best prescribe conditions in which to conduct your burn to meet your objectives. Weather parameters before, during, and after the burn; timing of the burn; and ignition patterns will influence the ecological effects of your burn.

The following sections offer effective guidelines to Florida burn managers, but there are always exceptions. In many cases, some parameters can be used to offset other parameters. As a burner, it is up to you to determine what combination of factors works best. Take good notes of weather parameters the day of burn, along with the fire behavior and then revisit your burn units often to see the effects. This is a crucial step in understanding fire effects and choosing future burn parameters.

Weather Parameters

Precipitation (long and short-term rainfall) – the burner needs to consider both the amount of rain and then length of time it has rained (duration) and put that information into the longer term weather pattern. Four inches of rain after months of prolonged drought may put standing water in places, but that amount of rain will not remove the long-term stress and deep soil drying from months without rain. If there are concerns about duff consumption, conduct burns within three days of significant rainfall (1-2 inches); also consider ignition techniques. The Keetch-Byram Drought Index is a rough guide that does a good job of predicting the possible consumption of ground organics for the Florida natural communities with organic soils – baygall, flatwoods, swamps, domes, etc.

If there has been an extended dry period, large fuels including snags regain their internal moisture levels very slowly over repeated rainfalls. If the desire is to maintain these dead standing snags for wildlife management objectives, their moisture levels must increase to minimize their consumption.

Because of the vagaries of rainfall over extremely short distances in Florida, a critical part of making the final decision to burn or not burn to produce certain ecological effects related to moisture levels is to actually walk into the wetland or shaded upland areas of a burn unit and to judge current on-site conditions by first-hand evaluation. This allows the burn boss to examine the amount of moisture present in the organic (or duff) layer. Keep in mind that the time of year can also affect absorption/drying rates of organic soil.

The length of time of drying after rainfall can impact the amount of fuel consumption, smoke production, control abilities, and the ecological outcomes. Light fuels (grasses, pine needles) dry out much quicker than heavier fuels (palmetto, gallberry). In a good condition/frequently burned unit with lower fuel loading (maintenance burning), there is a much longer window in which to apply fire than in a unit where fuel loads are higher (restoration burning).

Rainfall amounts and time of drying also have an effect on the live fuel moisture content of the fuels on-site, which in turn can affect your ecological goals. Since the live fuel moisture levels largely dictate the available fuel on any given burn day, even short-term dry spells (2-3 weeks) can lower the live fuel moisture content in shrubs and hardwoods, therefore increasing the amount of top-kill on those plants. For managers looking for hardwood reduction guidelines, the live fuel moisture content is a key component.

Relative Humidity – relative humidity demands much attention from the fire control perspective as fuels burn more readily as humidity drops lower, but it also directly impacts ecological effects

by the amount of fuel consumption. Higher relative humidity means higher fuel moisture which affects the intensity and effectiveness of the fire. Growing season daily humidity is usually higher, and the burner may need to balance humidity against the desired amount of consumption. In order to balance high relative humidity levels, the burn boss may plan for a fire after many days without rain.

Sea breeze impacts are not only a concern related to wind direction, but sea breeze impacts the amount to humidity in the air thereby impacting ecological effects by changing the moisture levels of the fine dead fuels. Higher humidity translates into less fuel consumption and less fire intensity which will change the desired ecological outcomes.

In sites with poor quality fuels, such as disturbed or overgrown sandhills, low relative humidity and low fuel moisture levels are a powerful combination to produce significant impacts on invading hardwoods. There are many conditions under which these sites will burn but only a certain combination of parameters will actually produce a desired outcome versus simply putting fire on the ground.

Air Temperature – the air temperature interacts with a fire's radiant heat to impact the overstory canopy. Accordingly, a low intensity burn in the winter might produce no browning of the pine canopy while the identical burn applied in the summer growing season (higher air temperatures) may result in almost complete browning of the pine canopy due to the fire's radiant heat added to an air temperature in the 90's. This ecological effect is somewhat unavoidable during the summer, although a combination of higher wind speeds and backing, flanking and point source ignitions help reduce the amount of needle scorch, especially when applied to well-managed fuels.

The ecological outcome for the pines is often the same – browning of the canopy during the summer from a low intensity fire, while unsightly, rarely kills longleaf and South Florida slash pines. The pines relatively quickly drop their needles and put out a new set while they are actively growing. This is the time of the year when these communities historically frequently burned under low fuel conditions. This is in contrast to the winter months when pines are not putting out new needles for months, thus creating much more stress on the trees.

Wind – wind speed directly affects how quickly a fire moves (residence time and heat pulse) and how the generated radiant heat is dispersed. Lower wind speeds allows a fire to burn through an area slowly which may generate more impact in a smaller area (canopy scorch or increased soil heating, for example) due to the more concentrated amounts of radiant heat. Higher wind speeds may speed up the drying of available fuels and may also contribute to control problems due to a potential for rapidly changing fire behavior. Minimum wind speeds are important for sites with poor or patchy fuels. It is important to remember that wind may have a variety of effects on the fire's behavior throughout the day, often impacted by variable vegetation densities and topography, which might then alter the ecological outcome.

Timing/Season of Burn

Growing season versus dormant season burning produces very different ecological effects for most plants. A burn manager uses these outcomes to achieve their desired objectives. Hardwoods are impacted most severely by burns during the spring as they are concentrating their carbohydrate reserves in their leaves. By removing the existing leaves with fire, this forces the hardwood to replace those leaves before they were able to produce starches for the roots to store, and they will be effectively topkilled.

Grasses tend to respond very positively to growing season burns beginning in the spring-summer transitional time of year and continuing through the growing season. The best seeding response for wiregrass can result from burns conducted throughout the growing season, often varying within different latitudes. For example, burns conducted in May at the Apalachicola Bluffs & Ravines Preserve (close to Tallahassee) result in the maximal wiregrass viability (wiregrass seed viability since 2007 has been 70-80%).

Burning in the dormant season with lower air temperatures and a lower relative humidity does not produce the same intensity of fire and ecological impacts as a spring burn done at the same lower relative humidity, but in the interest of maintaining a good landscape mosaic, not all burns can occur in the growing season. Current research indicates a minimum of 1 out of every 3 burns that occur within a unit in maintenance stage condition needs to be a “good” growing season burn.

A burn in late summer to early fall and throughout the non-growing season will have a much slower vegetation re-growth response compared to a growing season burn because plants are simply not actively growing. This means that the ground will stay bare for longer and the visual impacts of the burn will last longer. The lack of re-growth will also be seen in the tree canopy if it is impacted by the burn.

Different fire-adapted plant species have very different responses to burns at different times of the year. The fire manager should look up the known fire effects on particular species of interest and use that information to develop their prescription parameters.

While not an ecological effect, time of year and humidity levels can also affect the chances of fog developing. Fog is often common and a normal event in the cooler times of the year, but fog problems can occur during high humidity, low wind and low atmospheric dispersion growing season events.

Firing Plans/Ignition Patterns

Slow moving fires of all types are hotter at the soil surface, and slower moving fires with longer residence times have more potential to heat and ignite ground (subsurface) fuels. Once ignited, the ground fuels can burn for extended periods and to deeper levels, producing undesired ecological effects to key plant species by damaging root systems without any above ground scorch or consumption of leaves/needles. Surface fire temperatures will have much more impact

on areas with more organic soils (ex. flatwoods) compared to areas with more sandy (ex. sandhills) soils.

The pattern of ignition (how the fire is applied, could be solid line, point source or a combination) will alter the intensity of the resultant fire. A tight firing pattern (strips) can be more intense than a more widely spaced pattern, and that intensity may then impact the eventual ecological effects. In sites with poor surface fuels, specific ignition patterns must be coupled with lower fuel moistures and lower Rh levels to produce the optimal conditions. Other factors, such as fuel loading and the horizontal distribution of flammable fuels have to be considered with ignition patterns. These can be tailored to have the desired ecological effect (hardwood top-kill, canopy reduction, etc.).

Application of Fire and Invasive Plants

The spread of many invasive plants before and after the application of fire can be a serious management issue, accordingly the proper identification of these plants is important. Many species require eradication before fire since some invasive plants can increase the intensity and spread of fire, negatively impacting the native vegetation. Other invasive plants can actually benefit from fire, outcompeting native vegetation. Adopting a good decontamination strategy for equipment and PPE post-fire is critical in order to prevent the spread of invasive plant seeds from site to site.

Application of Mechanical Treatments to Produce Specific Ecological Effects

For a variety of reasons (the challenges inherent in managing natural areas adjacent to densely populated areas, specific ecological restoration goals, etc.), there has been an increased interest in utilizing what is broadly described as “mechanical treatments” in addition to controlled burning within habitats. These treatments may include roller-chopping, deck mowing, chain-sawing, logging and the application of herbicides to rapidly achieve the goals of reducing the amount and/or height of natural fuels before the controlled burn is conducted. Mechanical treatments are also used to manipulate the species and height of vegetation not just to reduce fuel loads and enhance fire control.

While these techniques are useful for site-specific goals, it is important to remember that “mechanical treatments and herbicide often accelerated vegetation structure changes, but ecological benefits were generally greatest when they were combined with fire.” (Menges and Gordon 2010).

While there are clear benefits to utilizing these techniques which can result in a safer operational component to the fire, and which can help “re-set” the fire return interval clock quickly as fire is reintroduced to a system long excluded from fire, there are many problems with utilizing these techniques, such as:

1. Soil disturbance
2. Increase in weedy/invasive species
3. Rapid hardwood resprouting
4. Failure to follow-up the treatment with a fire

Research performed within the Osceola National Forest reinforced the concept that mechanical treatments applied to long-unburned sites prior to fire resulted in lower fire behavior and fire risk, but can potentially increase the cover of herbaceous and grassy species.

These treatments should be utilized primarily in the initial phase of habitat restoration, and the transition to “fire-only” management should be the ultimate goal. The benefits of mechanical treatments can be lost if they are not followed up with fire within a short period of time due to vigorous resprouting of some species. Caution is stressed when utilizing these techniques and additional long-term monitoring is needed.

SUMMARY

Most of Florida’s diverse flora and fauna have evolved within a fire environment and fire is still a vital element of good stewardship of these fire-dependent and fire-influenced natural communities. Today, ecological fires occur in a fragmented and dramatically altered Florida landscape. The current conditions of the natural communities we manage are greatly altered and may respond differently than they would have under historical conditions. We cannot go backwards in time to what a community once was but we can work towards a defined desired future goal for each natural community and burn unit. Today’s conditions are what the land manager has to work with so our management must be tailored to the conditions that exist today. Today’s ecological conditions and development pressures will force the land manager to compromise on what might be considered the ideal type of burn, the ideal time of year, the ideal wind direction, etc. Land managers must plan and execute prescribed burns that meet their specific goals but that also provide sustained floral and faunal values for the benefit of all Floridians. Despite all of the land management changes over time, fire is still a necessary and powerful ecological function, and the ecological process set forth by fire is still vital despite the compromised condition of Florida ecosystems.

ADDITIONAL READING

Information on the ecological effects of fire continues to become available as considerable research and consolidation of information is underway nationwide. This short list of suggestions provides a jump off point to find more information on fire effects in Florida ecosystems.

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