PRESCRIBED FIRE IN THE INTERFACE: SEPARATING THE PEOPLE FROM THE TREES

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Abstract—Land managers in Florida rely on prescribed fire to prepare sites for regeneration, improve wildlife habitats, reduce vegetative competition, facilitate timber management activities, and mitigate wildfire risk. More than one million acres of land is scheduled for prescribed fire each year in Florida, nearly five times more than the area burned by wildfires. However, little has been done to understand the characteristics of communities affected by fire: who live in these communities and where are they located, where could additional prescribed burning and other wildfire risk mitigation activities be targeted, and how might continued population growth affect future tolerance for these practices? To shed light on these questions we use GIS overlay and correlation techniques to characterize and compare fire-affected zones in Florida. Characteristics studied include: population demographics, road density, neighborhood forest stand attributes, amount of forest fragmentation, and sources and frequency of wildfire ignition. We find that prescribed burning occurs in places where, on average, people are younger, earn lower incomes, have less formal education, are more frequently Caucasian, and live in more rural areas than people living in places without any prescribed fire or wildfire. High rates of prescribed burning occur in areas with less fragmented forests, more government management, and greater dominance by pine (Pinus spp.) forest types. Wildfires, on the other hand, occur most often in areas where forests are fragmented, ecologically more diverse, and privately owned.

INTRODUCTION

Prescribed fire is used extensively in Florida. Silvicultural burn permits were issued for roughly 500,000 acres a year from 1993 to 1999. Since 1981 wildfires on average have accounted for an additional 200,000 burned acres each year, as severe or catastrophic years (those totaling in excess of 400,000 acres) occur every four or five years. Since prescribed burning and wildfire are not uniformly distributed across the state (figures 1 and 2), residents' experiences with fire are likely to vary depending on where they live. Florida, with almost 16 million people in 2000, is the fourth most populous state in the U.S., and its population grew nearly 24 percent during the 1990's. Much of this population growth is due to a large influx of retirees, immigrants, and other northern migrants. Coupled with the state's large seasonal population, many Floridians may be quite new to wildfires, not to mention its large prescribed burning program. Such unfamiliarity, combined with high populations in certain locations, may result in new and greater constraints on wildfire risk reduction strategies, thereby resulting in greater risks of wildfire.

The purpose of this paper is to examine the people of Florida's wildland-urban interface, areas with a mix of people, development, and wildlands, and the fire-prone landscape in which they reside. We characterize where wildfires and prescribed fires occur and the relationships between where fires are found and whom they affect. The state of Florida provides an excellent study area with its diverse and growing population scattered among landscapes that frequently burn.

DATA

Our analysis combines six datasets: two from the Florida Division of Forestry (FDF), and the others from publicly available Census, USDA Forest Service, and remote sensing products.

Wildfires

The first FDF dataset provides information on all wildfire incidents reported to the State including the date of incident, number of acres burned, the ignition source, and the township, range, and cadastral section in which it occurred. Ignition sources include lightning, arson, and several other human-caused ignitions, which we grouped as accidents. These data span the calendar years 1981 to 1999 and do not include fires on federal lands.

Prescribed burning

In order to start a prescribed fire in Florida, a permit must be obtained from the State less than one day in advance. Records for each fire permit include the date of issuance, number of acres to be treated, location of at least one section of the prescribed burn, and the reason for the burn. Reasons include hazard reduction, disease control, site preparation for seeding or planting, wildlife habitat enhancement, and others. We group the reasons into two different types: seed and site prep (prior to seed and site prep) and traditional (everything else). The data span calendar years 1989 to 1999, although full statewide coverage did not begin until 1993.

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Demographics

The US Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) 1995 data from the Environmental System Research Institute (ESRI), describe population, race, age, education, income, and home value by Census block-group for the 1990 Census. We also obtained from ESRI the TIGER/ line road coverage.

Fragmentation

A 30-meter resolution forest fragmentation grid coverage, derived from the Multi-Resolution Land Characteristics (MRLC) Consortium's land cover map, was obtained from the USDA Forest Service (see Riitters and others 1997). These data are used to classify Florida into 6 fragmentation classes based on percent forest cover and percent of forest connectivity: interior forest, edge forest, perforated forest, transitional forest, patch forest, and no forest (figure 3).

Interior forests have 100 percent forest cover and forest connectivity. Perforated and edge forests have high levels of forest cover (greater than 60 percent), but differ in their levels of forest connectivity (ranging from 0 to 100 percent). For the same level of forest cover, the edge forest has a higher level of forest connectivity, whereas, for the same level of forest connectivity, the perforated forest has more forest cover.

Transitional and patch forests can both have any level of connectivity (ranging from 0 to 100 percent), but are differentiated by their levels of forest cover. Transitional forests have between 30 to 60 percent forest cover, whereas patch forest have between 0 to 30 percent forest cover.

Forest Ownership and Type

Stand level characteristics were obtained from the plot records of Florida's 1995 Multiple Resource (MR) database, maintained by the USDA Forest Service's Forest Inventory and Analysis (FIA) unit in Asheville, NC. We use the plot ownership and forest type variables.

METHODS

First, we relate the aggregated number of burn permits issued by cadastral section to the number of wildfire ignitions by source for the "fire years" 1993 to 1999. Since the fire year runs from October 1 to September 30, fire year 1993 encompasses October 1, 1992, to September 30, 1993.

Second, we create a cadastral section road density measure consisting of all State, Interstate, and US highways in the section, divided by the area (in acres) of the section. The road density measure, along with the section burn permit and wildfire records, is rasterized into a 30-meter cell grid, the same as the forest fragmentation index. The burn permit and wildfire records are then compared with road density and the forest fragmentation index.

Third, we examine the FIA 1995 plot survey data (point analysis) to relate the plot's forest ownership and forest type to the incidence of prescribed fire, wildfire, or no fire since the previous FIA survey (1987).

Fourth, we aggregate the Census TIGER block-group to the section level using a Geographic Information System (GIS), enabling us to observe the demographic attributes of those communities residing within a section (approximately a one square mile neighborhood) and observe how demographics vary with different levels of prescribed burning and wildfire.

RESULTS

The most intense areas of prescribed burning appear to be in the north central and panhandle regions of Florida (figure 1), while wildfire ignitions occur more evenly throughout Florida, most heavily in the southwestern region (figure 2). A negative relationship exists between the number of burn permits issued and the number of wildfire ignitions, regardless of the ignition source (table 1). Of the cadastral sections examined, only half (52 percent) of the Florida landscape escaped all fire (prescribed or wild) for the periods covered. However, this may be an overestimation since our data only specified one section for each burn permit and wildfire (the section it started in), and fires may span multiple sections. Approximately 75 percent of wildfire ignitions occur in sections without a record of any prescribed burning. Areas that average no more than one burn permit a year experience another 21 percent of the ignitions, with the remaining 4 percent occurring in areas with more than one permit a year.

Prescribed fire occurs more frequently on government owned (federal, state, and local) and managed forest, than on forests owned by industry or private landowner. Consistent with these statistics is that the most common forest type prescribed burned is slash pine (*Pinus elliottii*) (FIA analysis, table 2), a species widely planted and managed in the state.

Table 1—Number of prescribed burns and wildfires occurring in a township, range, section

PB Permits in a Section	Arson Ignitions	Accidents Ignititions	Lightning Ignitions	Number of Possible Sections
None	4,510	11,006	4,355	33,264
1 to 7	1,534	3,993	1,193	9,362
8 to14	171	538	100	1,067
15 to 21	52	177	31	321
>21	59	186	27	308
All (>0)	1,816	4,894	1,351	11,058

Table 2—Percent of fire disturbance type by Forest Inventory and Analysis (FIA) plot ownership and forest- type

Type of Fire Disturbance	Gov't	Forest Industry	Private	Predominant Forest Type (pct)
Prescribed Burned	59	14	23	Slash Pine (49)
Wildfire	19	8	49	Baldcypress-Water Tupelo (32)
No Fire Disturbance	29	26	52	Slash Pine (33)

Table 3—Percent of prescribed burning and wildfire found in each forest fragmentation type

Fragmentation	Prescribed Burned?		Burned by Wildfire?	
Type	Yes	No	Yes	No
Interior	18	12	11	17
Edge	15	9	17	15
Perforated	19	12	13	11
Transitional	19	22	10	8
Patch	21	27	33	28
No Forest	7	16	14	18
Total	99	98	98	97

Table 4—Demographic comparison between areas without fire and those with either prescribed burning or wildfire

Demographics	PB& No Fire	Wildfire& No PB	Any Fire& Burn	No Fire& Burn
Pop. Density	0.08	0.41	0.11	0.55
55&Over (pct)	23	26	24	25
Not Caucasian (pct)	19	17	15	21
No College (pct)	46	44	46	45
House Value ($)	8,202	12,220	8,702	10,532
Income ($)	9,431	10,595	9,613	10,102

House value and income given as per capita, in 1990 dollars. Population Density given as persons per acre.

Table 5—Demographic comparison between areas with any prescribed burning categories 'traditional' and 'seed & site prep' in the neighborhood

Demographics	Traditional Burn	Seed & Site Prep Burn
Pop. Density	0.10	0.06
55&Over (pct)	24	23
Not Caucasian (pct)	19	16
No College (pct)	45	47
House Value ($)	10,755	10,723
Income ($)	10,182	10,148

House value and income given as per capita, in 1990 dollars. Population given as persons per acre.

Table 6—Demographic comparison between areas with any wildfire ignition categories arson, accidental, and lightning in the neighborhood

Demographics	Arson Wildfire	Accidental Wildfire	Lightning Wildfire
Pop. Density	0.38	0.37	0.19
55&Over (pct)	26	25	27
Not Caucasian (pct)	15	17	14
No College (pct)	45	45	45
House Value ($)	11,003	10,417	13,713
Income ($)	10,200	10,143	10,874

House value and income given as per capita, in 1990 dollars. Population density given as persons per acre.

The landscape composition of wildfire-prone forests differs from those with prescribed burning. Almost half of the FIA plots reporting wildfire are privately owned. In contrast to the pine-dominated areas with prescribed burning, FIA plots with wildfire are dominated by the baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) forest type (32 percent, table 2). Furthermore, wildfires ignitions appear to occur most often in the patch fragmentation class, those forests with less cover and connectivity (table 3). Road density is also two times higher in these wildfire prone regions.

Demographic differences are correlated with the amount of wildfire or prescribed burning. Table 4 shows that population density is lower in areas with fire than without (0.11 persons/acre versus 0.55 persons/acre, respectively). Areas with prescribed burning or wildfires have populations that are, on average, slightly younger, more likely to be Caucasian, and wealthier than areas without any fire (prescribed fire or wildfire). However, neighborhood differences exist between areas with prescribed fire only and those with wildfire only. Areas with wildfire and no prescribed burning tend to be more densely populated, have a larger proportion of older Floridians, and have higher per capita income and home values.

Examining prescribed fire by management objective (traditional burns versus site prep/prior-to-seed burns), we do not observe any striking difference (table 5), but distinguishing areas by wildfire ignition source, regardless of whether prescribed burning exists in that area or not, reveals a couple of differences. Compared to areas without wildfires, lightning ignitions tend to occur in sparsely populated, predominantly Caucasian neighborhoods (table 6). Also, lightning ignition appears to happen in wealthier neighborhoods, whereas arson and accidental ignitions tend to occur in lower income, more populated neighborhoods.

CONCLUSION

Florida's fire-prone wildland-urban interface is quite different, both physically and socio-economically, from areas without fire (prescribed fire and wildfire). Areas with high rates of prescribed burning are more commonly slash pine forests under government ownership, and these areas have much lower rates of wildfire ignitions.

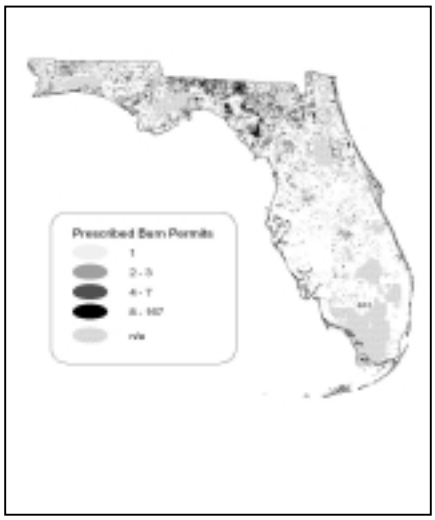

Figure 1—Number of prescribed burn permits issued from fire years (October-September) 1993-1999. Federal lands excluded.

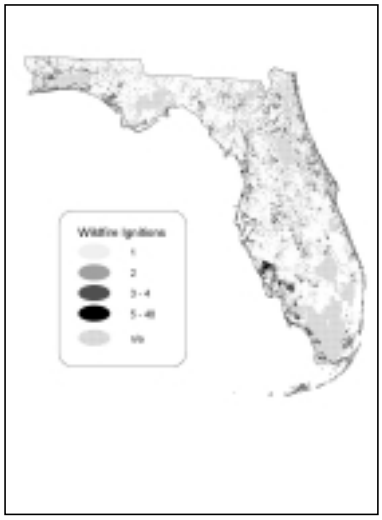

Figure 2—Number of wildfire ignitions from fire years (October-September) 1993-1999. Federal lands excluded.

Figure 3—Forest fragmentation index, 1992

Government land managers may use prescribed fire, more so than private land managers, for a numbers of reasons including that governments maintain large land holdings, have greater expertise with prescribed fire, and are more likely to operate under policies to maintain the health of fire adapted ecosystems. Liability concerns over possible prescribed fire escapes may deter private landowners from using it, perhaps inducing them to use other types of fuel reduction techniques. Forests frequented by wildfires, however, tend to be privately owned, dominated by baldcypress-water tupelo, and have relatively less forest cover and lower forest connectivity than their prescribed burning neighbors. Reducing wildfire risk in baldcypress-water tupelo stands may be difficult given their close association with open water. However, drought condition may be severe enough to dry out these areas, leaving the baldcypress stands susceptible to wildfire, as seen during the catastrophic fires of 1998 (Mercer and others 2000).

The residents of those parts of Florida where fire is more common are, on average, more likely to be Caucasian, older, less educated, and earning lower incomes than those living in less risky areas. However, there is a marked difference between those living in places that experience prescribed burning and no wildfire, and those living in areas with wildfires and no prescribed burning. Those living in wildfire areas tend to be older, more often Caucasian, and wealthier than those with only prescribed fires, and this is particularly true for wildfires started by lightning. These differences may highlight the reasons people choose to live within the wildland-urban interface in the first place. Many people choose the interface for its amenities, while others, especially the retired and the poor, base their decision on economic criteria (Davis 1990). Prescribed burning may serve as a proxy for intensively managed forestlands, which may offer fewer amenity benefits, creating lower land prices, and thereby attracting those with lower incomes. Wildfire-prone areas without prescribed burning, on the other hand, may provide greater amenity benefits over areas without fire, providing benefits such as greater forest access than prescribed burned areas, providing benefits such as less smoke and a feeling of a more 'natural', undisturbed forest (less active management). Differences may also be related to differences in forest types. Many of these unmanaged wildfire-prone forests may be baldcypress-tupelo forests, located on more valuable properties near water. This would help account for the income and housing value differences between prescribed burned and wildfire only areas.

With Florida's continuing population growth, more and more people are moving into the wildland-urban interface and creating greater challenges for policymakers and land managers to reduce wildfire risk. Since catastrophic fires can produce large economic effects (Mercer and others 2000, Butry and others 2001), successful risk reduction programs can reap great dividends. However, populations either unaccustomed to prescribed fire or those with compromised respiratory health may be opposed to the use of fire and the resulting smoke. These attitude can be changed however, as Cortner and others (1990) found attitudes towards fire management have been changing over the last few decades. Indeed, demographic analyses such as these may help land managers and educators better target prescribed fire and wildfire education programs, potentially easing some concerns of residents. Alternatively, identification of such populations could facilitate the development and targeted application of wildfire risk reduction strategies that do not involve prescribed fire or that encourage such burning in times of the year when residents are least affected.

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