A STAND-REPLACEMENT PRESCRIBED BURN IN SAND PINE SCRUB

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ABSTRACT

This paper describes fire characteristics and the immediate effects of a prescribed, high-intensity burn on a 12.2 hectare portion of a stand of Ocala sand pine scrub. The fire team on the Seminole District, Ocala National Forest used the BEHAVE fire model to predict the conditions needed to accomplish a stand-replacement burn. Suitable conditions arose on May 11, 1993 with temperature 26° Celsius, relative humidity 50%, wind 3 kilometers per hour, and fuel moisture (1-hour fuel) 7%. The area was burned by establishing a 40 meter blackline with backfires and then setting a headfire. The prolific smoke produced was not a problem due to selection of proper atmospheric conditions. Fire intensity was variable and affected by position and fuel loading, but on average was twice as high in the interior compared to the edge. The crowns of nearly all sand pine were severely scorched, and all trees subsequently died. Twenty-seven percent of the preburn snags were felled by the fire. Fire eliminated the shrub layer and reduced the litter layer thickness by 50%. The amount of bare ground was 0.1% in control plots and 17% in the burned area. Following the burn, light increased from 6 to 17% at ground level but only from 16 to 22% at breast height, because most needles remained on the overstory sand pine.

Citation: Outcalt, Kenneth W., and Cathryn H. Greenberg. 1998. A stand-replacement prescribed burn in sand pine scrub. Pages 141–145 *in* Teresa L. Pruden and Leonard A. Brennan (eds.). Fire in ecosystem management: shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, FL.

INTRODUCTION

The sand pine scrub community is a unique habitat with a suite of species that occur in no other community (Christman and Judd 1990). Mature scrub has an overstory of even-aged sand pine (*Pinus clausa* [Chapm. ex Engelm.] Vassey ex Sarg.) and a variably thick understory of sclerophyllous evergreen shrubs (Myers 1990). Typical understory species include myrtle oak (*Quercus myrtifolia*), sand live oak (*Q. geminata*), Chapman's oak (*Q. chapmanii*), turkey oak (*Q. laevis*), rusty lyonia (*Lyonia ferruginea*), rosemary (*Ceratiola ericoides*), scrub palmetto (*Sabal etonia*), and saw palmetto (*Serenoa repens*). Species richness and diversity of herbaceous plants are significantly less in mature stands compared to recently disturbed areas (Greenberg et al. 1995b). The sparse cover of herbs and grasses that do occur in mature scrub habitats typically include beak rush (*Rhynchospora megalocarpa*), milk peas (*Galactia* spp.), and broomsedge (*Andropogon* spp.). Lichens (*Cladonia* spp.) form extensive patches on the forest floor (Greenberg et al. 1995b).

Scrub dominated by the Ocala variety of sand pine (*Pinus clausa* var. *clausa* D.B. Ward) is native to the central ridge of Florida (Figure 1). It is also found on a strip of old dunes stretching from St. John's County south to the northern portion of Dade County on the east coast and from near Cedar Key south to Naples on the west coast (Small 1921, Harper 1927, Myers 1990). The largest concentration is the interior scrub, which occupies about 101,215 hectares on the Ocala National Forest (Brendemuehl 1990).

Sand pine scrub grows on deep droughty infertile sands of marine and aeolian origin. Water and wind formed these features as sea levels fluctuated during past glacial and interglacial periods (Kurz 1942, Laessle 1958, Brooks 1972). Because of washing and sorting during transport and deposition, soil parent material was nearly pure quartz sand (Laessle 1958). These processes produced soils that are almost exclusively Entisols and mostly Quartzipsamments (Myers 1990) typified by the Astatula, Lakeland, Paola, and St. Lucie soil series.

Because ground cover is sparse, Ocala sand pine scrub will not burn most of the time. Periodically, every 10 to 100 years, usually during a spring drought, high wind and temperature results in a catastrophic fire. Such fires kill the sand pine overstory and burn off the understory (Myers 1990). Heat from intense fire also opens many serotinous cones in crowns of sand pine, which releases seed for establishment of the next stand. Herbaceous species, including many endemics, also respond rapidly to the disturbance by invading, resprouting, or germinating from the soil seed bank (Johnson 1982, Hartnett and Richardson 1989).

Without high-intensity disturbance, the sand pine scrub would succeed to xeric oak hammock (Laessle 1958, Veno 1976) and lose many plant and animal species requiring young, open scrub sites (Greenberg et al. 1994, 1995a, 1995b). Most of the sand pine scrub on the Ocala National Forest is managed for pulpwood production by clear-cutting, followed by site preparation and direct seeding of sand pine. Recent research indicates only minor differences in vegetation recov-

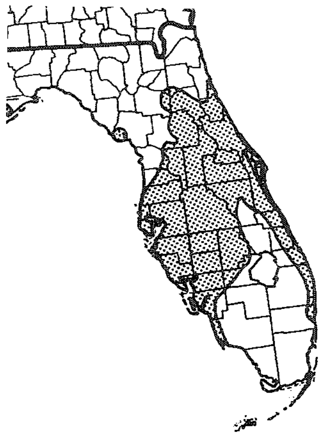

Figure 1. Range of Ocala sand pine scrub.

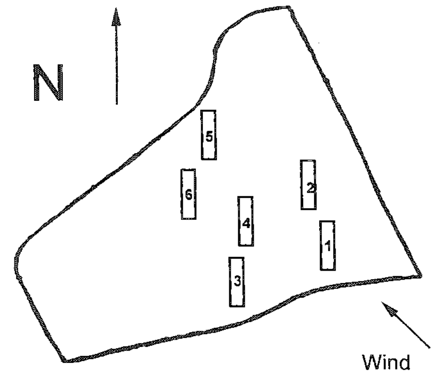

Figure 2. Location of sample plots within the prescribed burn area and prevailing wind during burn.

ery among stands disturbed by clear-cutting and site preparation versus wildfire and salvage logging (Greenberg et al. 1995b). However, the importance of standing snags and fallen trunks that are removed by salvage logging is not known, with respect to their role in forest community composition and structure. Stand-replacement prescribed burns may be important for ecosystem management of sand pine scrub when compatible with timber objectives and in wilderness areas.

Because the Ocala National Forest is in a heavily urbanized section of Florida with numerous property inholdings, prescribed burning is quite risky. Fires can produce excessive smoke or escape and damage private property. Previous work (Doren et al. 1987) demonstrated that coastal sand pine scrub can be successfully and safely burned under selected conditions with careful planning and execution. The objectives of this project were: 1) to determine if the interior sand pine scrub of the Ocala National Forest could be safely and effectively prescribed burned; 2) to provide a demonstration to reassure the public; 3) to serve as a learning tool for land managers; and 4) to provide a scientific study of fire characteristics and postfire recovery processes. This paper reports fire characteristics and immediate effects of the burn on the scrub community.

METHODS

The fire team on the Seminole District of the Ocala National Forest used the BEHAVE fire model to predict the conditions needed to produce a safe stand replacement burn. Custer and Thorsen (1996) give a complete discussion of these burn parameters. The day of the prescribed burn, May 11, 1993, the temperature was 26° Celsius; the relative humidity was 50%; and the wind was from the southeast at 3 kilometers per hour. The Keetch-Byram (1968) drought index was at 450 indicating moderate drought conditions that could result in intense fires if coupled with strong winds and high temperatures. The 12.2 hectare portion of a mature sand pine stand was burned by first establishing a 40 meter blackline with backfires along the north and west perimeters. At about noon a headfire was ignited beginning at the southeast corner of the stand. Within 10 minutes the headfire had burned the remaining 8 hectares of the area. The average flame length was 3 to 5 meters and the mean rate of spread was 12 meters per minute (Carrington 1996).

Before burning, six randomly located 10 by 50 meter plots were established in the mature sand pine scrub (Figure 2). Within these plots all sand pine, except seedlings, and all other trees and standing snags 6 centimeters or larger in diameter at breast height (dbh) were mapped and numbered. Numbered aluminum tags were attached to live trees and snags with aluminum nails 2 meters above the ground facing west. Diameter was recorded for all numbered stems, and height was measured on every tenth stem. Shrub cover, fine woody debris cover ($\leq$ 10 centimeters diameter), and coarse ($>$ 10 centimeters) woody debris cover were measured along 50 meter centerline transects within each plot before and after burning. Percent light was measured at ground level and at breast height (1.37 meter) using a spherical densiometer at 0, 25 and 50 meter intervals along each line transect. Because of time constraints it was not possible to get some measurements before the burn was conducted. Therefore, six control plots also 10 by 50 meters were installed after the burn in an adjacent unburned portion of the stand. Shrub height, which included all woody stems less than 6 centimeters diameter breast height (dbh), and litter layer thickness were taken at 0, 25, and 50 meter intervals along the centerline of control plots. Exposed mineral soil was recorded over the entire centerline of the transect.

Three weeks after the fire, burned plots were resurveyed noting the condition and position (standing or fallen) of all tagged stems. A qualitative measure of fire intensity was collected based on the condition of the tree tags using the following scale: 0 = no damage, 1 = tag tarnished, 2 = lower end of tag slightly melted, 3 = lower half of tag melted, 4 = 75% of the tag melted, 5 = tag completely melted, 6 = tag melted and nail melted, 7 = tag and nail burned completely off. Fine and coarse woody debris, light levels, shrub height, exposed mineral soil, and litter layer data were collected on burned plots using the same sampling scheme used for preburn measurements.

Table 1. Preburn shrub cover and fire intensity for prescribed burn of mature Ocala sand pine scrub.

Plot	Location	Shrub cover (%)	Mean intensity
1	Edge	79	1.7
2	Interior	74	4.3
3	Edge	92	1.3
4	Interior	60	1.5
5	Edge	82	1.3
6	Interior	80	3.9

RESULTS AND DISCUSSION

The burn was a successful operation. Although it produced a smoke column visible up to 25 kilometers away, the smoke rose quickly and dispersed rapidly creating no management problems (Custer and Thorsen 1996). Some minor spotting occurred during the backfire stage, but the spots were easily controlled. This study shows that high-intensity prescribed burns can be successfully implemented in the interior sand pine scrub of central Florida with careful planning.

Fire intensity varied with location and fuel loading within the burned area (Table 1). Intensity was lower in plots 1 and 3 near the edge and increased toward the northwest as the fire gained strength (Figure 3). Most of plot 5 (Figure 4) was burned with a low-intensity backfire. Greatest fire intensities were in the interior of the burned area as shown by data from plots 2 and 6 (Figure 5). Plot 4 was also in the interior, but did not burn as intensely as expected (Figure 4). Most of plot 4 was on the middle portion of a slope where conditions were drier and the sparse woody understory covered only 60% of the plot (Table 1). This lower fuel loading resulted in the lower observed intensity. Carrington (1996) also reported high variability of fire temperature at the soil surface during the burn.

Before prescribed burning the stand had 670 ± 54 Ocala sand pines/hectare, 77 ± 16 oaks/hectare and 137 ± 30 standing snags/hectare in the overstory. Sand pine diameter ranged from 6 to 30 centimeters with an average of 17.5 ± 0.3 centimeters and a mean height of 16.8 ± 0.4 meters. The oaks had an average diameter of 6.4 ± 0.6 centimeters and a mean height of 4.2 ± 0.3 meters. The fire felled 27% of the preexisting snags and 4% of the living oaks greater than 6

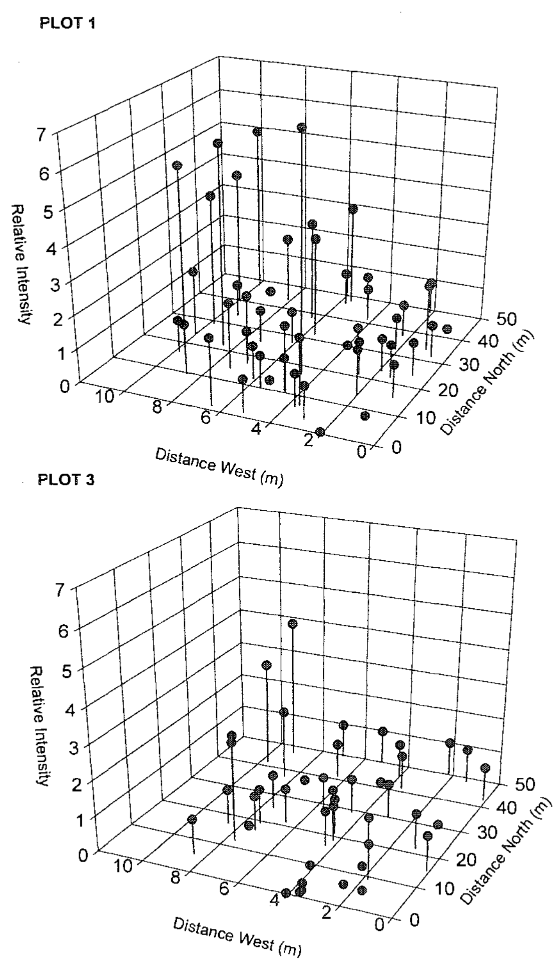

Figure 3. Relative intensity of fire across plots 1 and 3 (0 = no damage, 1 = tag tarnished, 2 = lower end of tag slightly melted, 3 = lower half of tag melted, 4 = 75% of the tag melted, 5 = tag completely melted, 6 = tag and nail melted, 7 = tag and nail burned completely off).

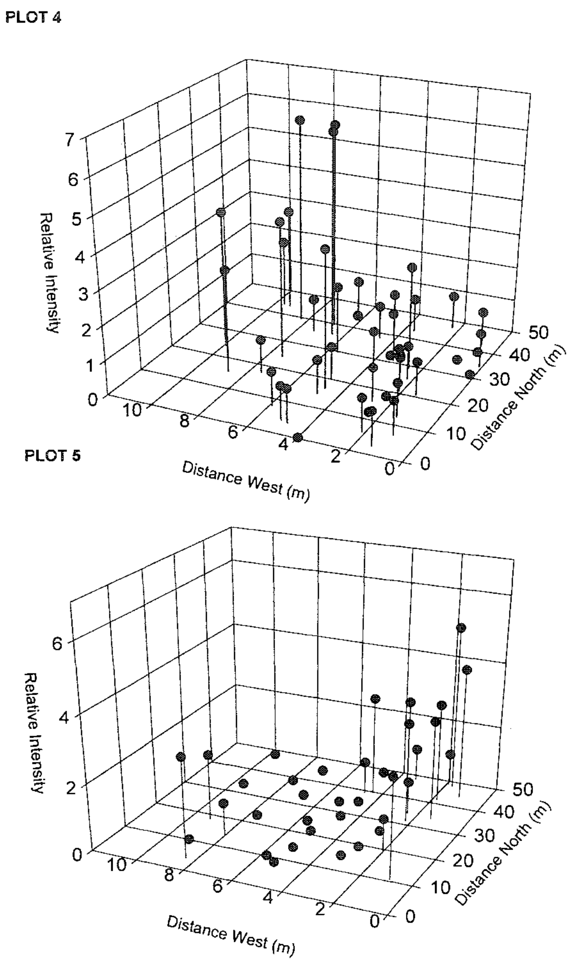

Figure 4. Relative intensity of fire across plots 4 and 5 (0 = no damage, 1 = tag tarnished, 2 = lower end of tag slightly melted, 3 = lower half of tag melted, 4 = 75% of the tag melted, 5 = tag completely melted, 6 = tag and nail melted, 7 = tag and nail burned completely off).

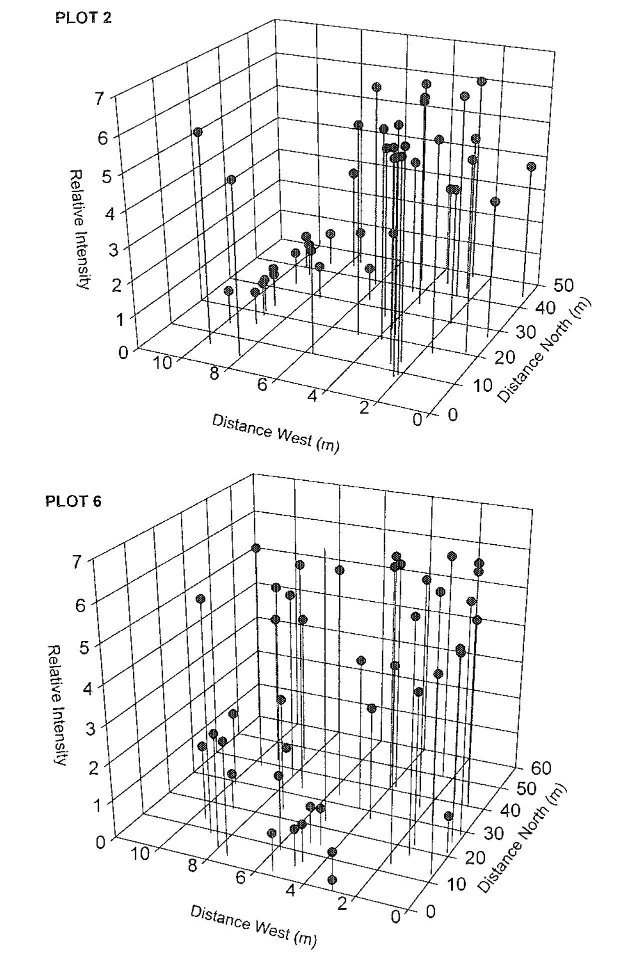

Figure 5. Relative intensity of fire across plot 2 and 6 (0 = no damage, 1 = tag tarnished, 2 = lower end of tag slightly melted, 3 = lower half of tag melted, 4 = 75% of the tag melted, 5 = tag completely melted, 6 = tag and nail melted, 7 = tag and nail burned completely off).

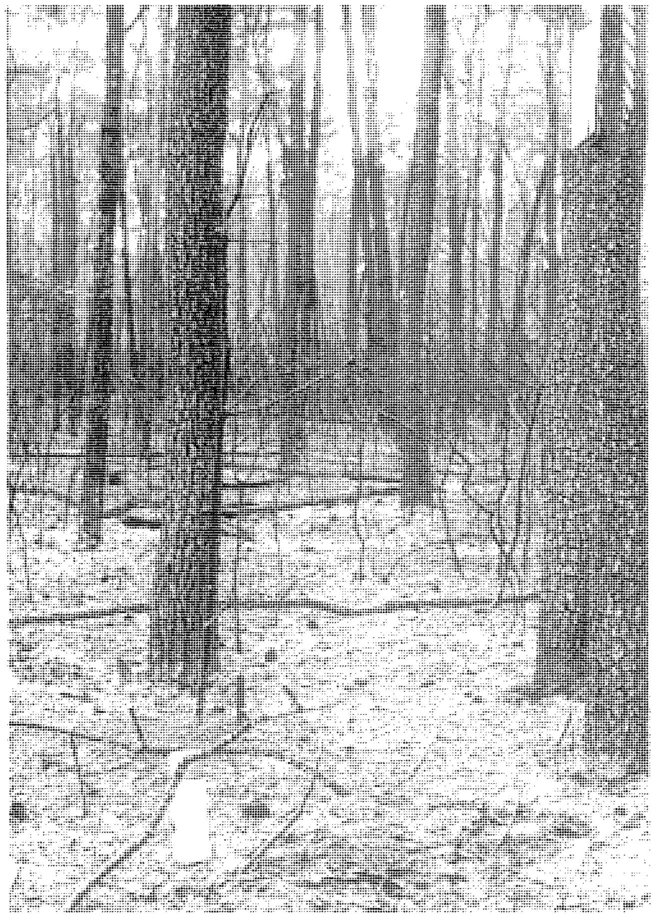

Figure 6. Interior of sand pine stand following stand-replacement prescribed burn showing near total consumption of understory layer.

centimeters dbh. No live sand pine trees were felled by the fire.

The fire consumed most of the understory reducing it from a preburn height of 1.18 ± 0.19 meters to 0 meter for living stems immediately after the burn. Litter layer thickness was 6 ± 1 centimeters on unburned control plots and 3 ± 1 centimeters on burned plots. The amount of exposed mineral soil was higher on the burned site at 17 ± 14% compared to only 0.1 ± 0.2% on the control area. Fine woody debris was reduced from 4.5 ± 3.7% to 2.7 ± 2.6% cover after the burn. Coarse woody debris covered 0.28 ± 0.29% of the area before and 0.36 ± 0.46% after the burn. This slight increase resulted from addition of large stems from the snags felled by the burn.

The amount of light reaching the forest floor increased from 5.6 ± 0.9% before the fire to 17 ± 1.4% postburn, because the understory was eliminated. Even though flames from the burning understory sometimes reached into the overstory canopy, most material consumed was from the litter layer (a 50% reduction) and the understory (a 98% reduction) (Figure 6). Although the fire severely scorched the crowns of the sand pine, it only consumed a small portion of them. Thus, the fire most closely fit the intense surface fire classification (Stocks 1989) developed for mature jack pine (*Pinus banksiana*) forest, a community with a structure similar to sand pine scrub. Because most of the needles remained on the trees immediately following the fire, changes in light at breast height (1.37 meter), above most of the understory, were initially small. Preburn light averaged 16.4 ± 3.2%, and post burn was only slightly higher at 21.5 ± 2.5%.

Fire intensity varied within the burn area. However the fire severely scorched the crowns of all overstory trees except for a small strip on the edge burned with the backfire. Although other southern pines can recover from severe crown scorch (Johansen and Wade 1987, Wade and Johansen 1987), these trees did not. All trees were dead by the end of the growing season, including the edge trees that had intact crowns following the burn. The high intensity of the fire and the thin bark of sand pine likely resulted in significant cambium damage as severe charring occurred on the boles to an average height of 3 meters. In addition, trees also likely suffered high root mortality resulting from consumption of the litter layer. A few days after the burn, wood borers were actively working in the boles of the sand pines.

Death of the overstory, creation of new snags, elimination of the understory, and reduction in the litter layer significantly changed the structure of this patch of scrub. The plant community has been successfully reset to the beginning point where early successional plant and animal species requiring open scrub habitat can again thrive.

ACKNOWLEDGMENTS

We thank the staff of the Seminole Ranger District, Ocala National Forest, U.S. Department of Agriculture, Forest Service, for conducting the prescribed burn. Dr. Tom Waldrop and Dr. Tom Lloyd provided valuable reviews for manuscript improvement. We are indebted to Patricia A. Outcalt and Liz O'Neill for help in study installation and data collection.

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