PRESCRIBED BURNING: OBSERVATIONS ON THE INTERACTION OF WILDLIFE AND FIRE IN STATE PARKS OF SOUTHWESTERN FLORIDA

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ABSTRACT

Many state parks in Florida are fragments of a once extensive landscape across which fires burned frequently. Prescribed fire has replaced more random, natural fires. In order to acquire more information about how firing techniques and the frequency and seasonality of prescribed burning affect natural communities, descriptive, opportunistic wildlife observations were solicited from park personnel tending prescribed burns in state parks of southwestern Florida beginning in March 1977. Five hundred forty-two observations were collected from 14 parks, providing anecdotal information on fire-associated activities of 7 species of amphibians, 28 species of reptiles, 67 species of birds, and 24 species of mammals. Summarization of these records included discussion of notable observations, recognition of general patterns for vertebrate classes, and detection of a significant effect of burn season and size on categorized wildlife responses to fire. A shortcoming of the data was that most wildlife observations failed to describe contemporaneous fire characteristics that could be used to investigate statistical correlations. New data collection methods are suggested.

keywords: fire, Florida, monitoring, prescribed burning, state parks, wildlife.

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INTRODUCTION

Several comprehensive publications review much of the information available on wildlife interactions with fire (Kozlowski and Ahlgren 1974, Kirby et al. 1988, Robbins and Myers 1992, Whelan 1995). A common conclusion about fire and its effects on animals is that "surprisingly little animal mortality [occurs] during the passage of a fire, especially for vertebrates" (Whelan 1995). This statement tends to be based on studies of mammals. Nonetheless, Main (1981) reported that frogs and small reptiles in burrows and crevices survived the passage of a fire, and other authors have also documented amphibians and reptiles taking shelter to survive fire (Kahn 1960, Komarek 1969). Means and Campbell (1981) indicated that direct fire effects on amphibians and reptiles are probably of minimal importance relative to indirect effects.

Contrary to reports of low animal mortality due to fire, Aldo Leopold considered wildfire to be extremely destructive of wildlife (Bendell 1974). Reports of fire-related animal mortality can be found in many of the same publications that report survival, and in some that do not (Chew et al. 1959, Ahlgren and Ahlgren 1960, Bendell 1974, Newsome et al. 1975).

These conflicting reports, along with documentation of other types of interactions of wildlife with fire, have begun to suggest the complexity involved. The importance of some microhabitat features such as burrow ventilation has been recognized (Lawrence 1966). The relative importance of these features is in turn affected by fire characteristics, such as the residence time of the flaming front over a burrow opening (Whelan 1995). Fires offer some animals foraging opportunities, and make others vulnerable to predation. Parasite loads may be reduced for vertebrates on burned areas (Bendell 1974).

Use of prescribed burning in today's fragmented native preserves could be more effective with information about how firing techniques and the frequency and seasonality of prescribed burning affect wildlife. Whelan (1995:307) emphasizes the need "to include experimental work and monitoring as an integral part of management" by admonishing that with our present state of knowledge "imposing the same, regular fire regime across a landscape, will be an unwise strategy" (Whelan 1995:303).

Land managers in the Florida Park Service are in a position to contribute monitoring data on wildlife interactions with fire. Numerous prescribed burns are conducted in state parks each year. Fires are tended by park personnel exhibiting a range of basic wildlife observation skills.

The first records of fire-related wildlife observations in parks of southwestern Florida date from the 1970's, when prescribed burning was initiated. Systematic collection of observations began in the late 1980's at Myakka River State Park, and was adopted in state parks district-wide in southwestern Florida in 1993. This report will summarize the fire-related wildlife observations that have been collected, and report on patterns of response to fire.

METHODS

Fire-related wildlife observations were solicited from park staff in District 4, Florida Park Service,

Table 1. Southwestern Florida State Parks that contributed fire-related wildlife observations to this report from 1977–1996.

State Park	County
Caladesi Island State Park	Pinellas
Cayo Costa State Park	Lee
Collier-Seminole State Park	Collier
Dade Battlefield State Historic Site	Sumter
Fakahatchee Strand State Preserve	Collier
Fort Cooper State Park	Citrus
Highlands Hammock State Park	Highlands
Hillsborough River State Park	Hillsborough
Honeymoon Island State Recreation Area	Pinellas
Koreshan State Historic Site	Lee
Lake Manatee State Recreation Area	Manatee
Little Manatee River State Recreation Area	Hillsborough
Myakka River State Park	Sarasota
Oscar Scherer State Park	Sarasota

tending prescribed burns between 1 March 1977 and 23 August 1996. Consequently, the data consisted of anecdotal, opportunistic observations collected in 14 state parks in southwestern Florida (Table 1). Besides a list of species and descriptions of their behavior, data included location, date, time, weather, and observer. Vertebrates were emphasized.

After reviewing all of the descriptive accounts of animal behavior, 9 categories of response to fire were recognized: (1) escaped from the burn zone, (2) granivory after a fire, (3) herbivory on regrowth after a fire, (4) predatory activity, (5) scavenging, (6) succumbed, (7) survived passage of the flaming front within the burn zone, (8) other, and (9) unknown. Each observation was assigned to 1 category, and nonparametric data analyses were conducted using chi-square tests. Four attributes of prescribed burns were analyzed for effects on wildlife behavior: (1) seasonality, (2) size of the burn, (3) frequency of burns (number of burns in a zone since March 1977), and (4) firing technique. The "scavenging" response category was combined with "predatory activity" because of the few species in the former category, and because of the difficulty of determining whether prey was scavenged or captured alive.

Information about acreage burned, firing technique, and season of burn was gleaned from "Burn Procedures Form—Day of Burn" reports required for each prescribed burn. If burns had any head fire component, they were classified as head fires. If they had a flanking component but no head fire, they were classified as flank fires. Otherwise, they were classified as backing fires. Prescribed burns were started as early as 0900 hours, with 72% started by 1100 and completed by 1700 hours. Burns were arbitrarily categorized by size: <40 hectares, 40–400 hectares, and >400 hectares. The average size burn was 139 hectares (SE = 25 hectares).

Season of burn was defined as either spring (Mar–May), summer (Jun–Aug), fall (Sep–Nov), or winter (Dec–Feb). Where fire had been excluded for long periods, fall or winter burns were often conducted initially in order to reduce fuel loads. Thereafter, spring and summer burns were usually preferred. State parks divided their fire-dependent community types into burn zones. Size of a zone usually did not exceed the number of hectares that could be burned in 1 day, and was often smaller because of natural fire barriers. Burn plans were drafted annually for each park.

RESULTS

Summary of Anecdotal Observations

Fire-associated activities of 7 species of amphibians, 28 species of reptiles, 67 species of birds, and 24 species of mammals were documented in 542 observations from state parks. Observations came from 192 of 373 different burns: 64 of 139 spring burns, 41 of 111 summer burns, 18 of 18 fall burns, and 64 of 105 winter burns (5 were of unknown season). The preponderance of observations came from Myakka River State Park (44%), Oscar Scherer State Park (18%), and Hillsborough River State Park (11%), and from the decade of the 1990's (93%). More observations were reported from spring and summer burns (59%) than from fall and winter burns.

Most amphibians observed during prescribed burns were fleeing the fire, often jumping ahead of the flames, or concentrating in large numbers in wetlands and puddles in the burn zone. None were observed consumed by flames, nor were any carcasses observed. Some apparently survived the passage of the flaming front and emerged onto the blackened ground afterwards (e.g., green treefrogs [*Hyla cinerea*]). One treefrog (*Hyla* sp.) survived in a depression, but a dusky pigmy rattlesnake (*Sistrurus miliarius*) found on top of it was killed by the fire. Several instances of predation on amphibians were observed during and immediately after burns.

Among reptiles, several species seemed to suffer inordinately high mortality from fire, or their carcasses were simply more likely to be noticed. Many observations noted fire-killed box turtles (*Terrapene carolina*) (70% of box turtle observations, n = 10). Glass lizards (*Ophisaurus* spp.) were also frequently reported killed (50% of glass lizard observations, n = 8). Snakes were most often reported fleeing fires, sometimes in large numbers. Other observations suggested that some snakes may have been hunting prey flushed by fires. An eastern garter snake (*Thamnophis sirtalis*) captured and consumed a southern toad (*Bufo terrestris*) within minutes after a burn, and a southern black racer (*Coluber constrictor*) did the same with a green treefrog. Observations of eastern diamondback rattlesnakes (*Crotalus adamanteus*), dusky pigmy rattlesnakes, and corn snakes (*Elaphe guttata*) moving rather slowly near the flaming front of fires suggested these predators may have been seeking dislodged prey. Reptiles were also able to survive the passage of a flaming front, as evidenced by several observations.

The largest category of fire-related wildlife observations involved birds (40%). Although a few were flushed by fires, most took advantage of the foraging opportunities offered. Cattle egrets (*Bubulcus ibis*) stationed themselves along firelines as a fire approached and passed, apparently catching insects. Wild turkeys

Table 2. Numbers of fire-related wildlife observations from southwestern Florida State Parks, 1977–1996, by season for 4 response categories. Expected values were calculated under the assumption of equal proportions across seasons for response categories, resulting in $\chi^2 = 29.62$, df = 9, $P < 0.001$.

	Response category			
	Escaped	Predatory activity	Succumbed	Survived
Spring				
Observed	89	29	11	17
Expected	86.1	31.7	17.8	10.4
Cell χ^2	0.10	0.23	2.60	4.19
Summer				
Observed	35	5	6	3
Expected	28.9	10.6	6.0	3.5
Cell χ^2	1.29	2.96	0.00	0.07
Fall				
Observed	4	6	1	0
Expected	6.5	2.4	1.3	0.8
Cell χ^2	0.96	5.40	0.07	0.80
Winter				
Observed	46	24	18	1
Expected	52.5	19.3	10.9	6.3
Cell χ^2	0.80	1.14	4.62	4.46

Table 3. Numbers of fire-related wildlife observations from southwestern Florida State Parks, 1977–1996, by size of burn for 4 response categories. Expected values were calculated under the assumption of equal proportions across burn sizes for response categories, resulting in $\chi^2 = 23.24$, df = 6, $P < 0.001$.

	Response category			
Burn size (hectares)	Escaped	Predatory activity	Succumbed	Survived
<40				
Observed	67	35	22	3
Expected	76.8	25.8	14.9	9.5
Cell χ^2	1.25	3.28	3.38	4.45
40–400				
Observed	86	19	9	16
Expected	78.6	26.4	15.3	9.7
Cell χ^2	0.70	2.07	2.59	4.09
>400				
Observed	17	3	2	2
Expected	14.5	4.9	2.8	1.8
Cell χ^2	0.43	0.74	0.23	0.02

(*Meleagris gallopavo*) appeared to be drawn to fires. American kestrels (*Falco sparverius*) preyed on katydids (*Orthoptera*) flushed by fires, and northern mockingbirds (*Mimus polyglottos*) caught fleeing grasshoppers. Both turkey vultures (*Cathartes aura*) and black vultures (*Coragyps atratus*) consistently circled over fires and associated blackened areas, alighting to forage on carcasses in the burned area within an hour after burns. Most often they fed on nine-banded armadillos (*Dasypus novemcinctus*), but also on snakes and Virginia opossums (*Didelphis virginiana*).

Other species of birds were observed hunting in conjunction with fires. Red-shouldered hawks (*Buteo lineatus*) preyed on marsh rabbits (*Sylvilagus palustris*) and peninsula ribbon snakes (*Thamnophis sauritus*). American crows (*Corvus brachyrhynchos*) were observed foraging over blackened ground. Red-tailed hawks (*Buteo jamaicensis*), bald eagles (*Haliaeetus leucocephalus*), and swallow-tailed kites (*Elanoides forficatus*) circled over fires and burned areas. They may have been hunting, taking advantage of thermals created by the fire, or both. Herons, ibises, and cranes were observed foraging in burned marshes within a short time after fires. Finally, several species of birds seemed to prefer habitat that had been recently burned, including mourning doves (*Zenaida macroura*), common ground-doves (*Columbina passerina*), common nighthawks (*Chordeiles minor*), and hairy woodpeckers (*Picoides villosus*).

One mammal seemed particularly ill-adapted to fire. The nine-banded armadillo was the mammal most often reported killed by fire (45% of armadillo observations, n = 11), but its remains are also highly visible. This animal's nest was also noted to be vulnerable to fire.

Most other mammals were observed fleeing from fires. Several were observed to survive passage of the flaming front, including an eastern cottontail (*Sylvilagus floridanus*), hispid cotton rat (*Sigmodon hispidus*), and wild pig (*Sus scrofa*). Others, including rabbits and mice, were captured by predators during or after burns. A trapping study at Myakka River State Park suggested that small mammals such as cotton mice (*Peromyscus gossypinus*) reach higher densities on burned areas within months after fire (J. Huffman, Myakka River State Park, unpublished data). White-tailed deer (*Odocoileus virginianus*) were the most frequently observed mammal (32% of mammal records), and often responded to fire without panic by simply moving into a marsh as fire burned all around, or stepping through a break in the flaming front to reach blackened ground.

Wildlife Response Relative to 4 Attributes of Prescribed Burns

The proportion of observations in each season was significantly different for the 4 categories of wildlife responses exhibited during or immediately following a fire (i.e., escaped, predatory activity [including scavenging], succumbed, and survived, excluding other and unknown) (Table 2). Taking shelter to survive passage of a flaming front was observed much more than expected during spring burns, and much less than expected during winter burns. Succumbing to fires was observed more than expected during winter burns and less than expected during spring burns. Similarly, predatory activity was observed more than expected during fall and winter burns, and less than expected during spring and summer burns. Proportions of animals observed escaping from fires were similar across seasons.

Proportions of observations for the 4 wildlife response categories were also significantly different for each burn size category (<40 hectares, 40–400 hectares, and >400 hectares) (Table 3). For the intermediate-size fire category, there was less predatory activity, fewer animals succumbed, and more animals survived passage of the flaming front than expected. The opposite was found for the small-size fire category. Proportion of animals observed escaping fires was similar for all sizes. Effects of burn size are not independent of the effects of season of burn. Sixty percent of intermediate-size burns were conducted in the spring, and only 25% in the winter.

Considering firing technique, the proportion of wildlife observations in each of the 4 response categories was similar for backing, flanking, and head fires ($\chi^2 = 5.06$, df = 6, $P > 0.5$).

Finally, effect of frequency of burning was tested for the 4 categories of response. Eighty-seven percent of observations came from zones burned once. The remaining observations came from zones burned twice (8%) or from zones for which number of burns could not be determined (5%). There was no evidence in these data for any effects of burn frequency on wildlife response ($\chi^2 = 4.93$, df = 3, $P > 0.1$).

DISCUSSION

This study was not a controlled experiment. Many variables could have acted to influence the outcome, and any interpretation of the data must acknowledge the problem of confounded effects. Nevertheless, the data are useful for directing further inquiry into the complex interactions of wildlife and fire. These diverse interactions may span many cycles of a fire regime. Experimental investigation of the effects of different fire regimes on wildlife is needed. In the meantime, anecdotal descriptions like those summarized here are an important source of information.

The anecdotal observations collected in this study suggest some very general conclusions. Amphibians and mammals were most often seen escaping, and occasionally being preyed upon. There were no observations of amphibians directly killed by fire. Reptiles and birds were more often observed using the foraging opportunities presented by fires. Amphibians and reptiles were able to survive the passage of the flaming front of a fire. Several species of reptiles and mammals seemed particularly vulnerable to fire, but this conclusion may be an artifact of their observability. Detailed conclusions about species-specific behaviors associated with prescribed burning will have to await the accumulation of many more records.

The observations suggest that season and size of burns have more pronounced effects on wildlife, while firing technique and fire frequency, within the ranges observed, have less effect. Robbins and Myers (1992) suggested that season of burn could cause differences in wildlife population responses due to differences in patchiness of the burn, rate of regrowth, vegetation physiognomy, and production of fruits and seeds. Differences observed in survival of the flaming front of a fire may have been due to increased patchiness in growing-season burns. This variable could also account for reduced predatory activity in growing-season burns.

In general, response to an approaching fire has been related to the size and mobility of an animal, and to the size and intensity of the fire (Bendell 1974). The simple categorization of burns by size in this study suggested that intermediate-size burns had reduced predatory activity, fewer mortalities, and better survival during the passage of flaming fronts of fires. However, larger fires tended to be conducted in the spring, while smaller, fuel-reducing fires tended to be conducted in the winter. The seasonal effect of burning is confounded with the effect of burn size, and patchiness of burns may again have been important.

Although anecdotal observations are valuable, they unfortunately provide almost no information on some critical aspects of wildlife response to fires. The effects of fire on population birth, death, immigration, and emigration are practically unknown. Experimental studies are needed to resolve these types of effects of fire on wildlife, as well as to substantiate the effects suggested by anecdotal observations.

MANAGEMENT IMPLICATIONS

As much information as feasible should be collected about fire characteristics for each burn. Observations on wildlife responses to fire are much more insightful when correlated with observations on contemporaneous fire behavior. Modifications of our present system of gathering data are needed.

Most observations reviewed for this report did not describe the behavior or physical characteristics of the fire coinciding with the wildlife observation. A new data collection form might help remedy this oversight, if coupled with standardized measures of fire intensity, duration, rate of spread, and patchiness. A relatively small amount of specific information can be collected about the fire when wildlife is observed, including flame length, rate of spread, distance between gaps in the flaming front, and whether it is a head fire, flanking fire, or backing fire. In addition, a brief evaluation of the burn immediately after the fire would add considerably to the characterization of the burn. For example, several random locations could be evaluated for crown scorch height, height of bark charring, size of nearest unburned patch, distance to nearest unburned patch, and depth of litter remaining. Finally, wildlife responses may be categorized to guide the observer's focus on specific aspects of behavior. A descriptive narration of any wildlife behavior would still be very important.

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