

EVOLUTION OF A BURNING PROGRAM ON CAROLINA SANDHILLS NATIONAL WILDLIFE REFUGE

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ABSTRACT

Carolina Sandhills National Wildlife Refuge was purchased in 1939 and encompasses roughly 45,000 acres (18,219 hectares). The dominant habitat type is longleaf pine which covers about 32,000 acres (12,955 hectares). The early history of the refuge contained significant wildfires. From 1940 through 1959, about 500 wildfires burned over 30,000 acres (12,146 hectares) on the refuge. During this 20-year period, only 3,071 acres (1,243 hectares) were burned by prescription. Prescribed burning increased from 1960 through 1969 to 12,968 acres (5,250 hectares) and wildfire occurrence dropped to about 100 fires burning over 8,000 acres (3,239 hectares). The prescribed fire program expanded significantly during the decade of the 1980's, with acres treated more than doubling the previous decade. This trend has continued into the 1990's and is directly related to the initiation of aerial ignition in 1982. Both wildfire frequency and total acres affected by wildfire have remained at relatively low levels since 1970.

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INTRODUCTION

Carolina Sandhills National Wildlife Refuge is located in north central South Carolina. The refuge overlies a portion of the Fall Line which forms the transition zone between the Atlantic Coastal Plain and the Piedmont Plateau. The sandy soils in this region naturally support longleaf pine (*Pinus palustris*)-wiregrass (*Aristida stricta*) communities similar to those present in other xeric to subxeric regions of the coastal plain. Approximately 14,000 acres (5,668 hectares) of xeric longleaf pine (40–90 year age-class) habitat and 12,000 acres (4,858 hectares) of longleaf pine plantations (11–40 year age-class) are present on the 45,000 acre (18,219 hectare) refuge. Other major habitat types include 6,000 acres (2,429 hectares) of longleaf pine-scrub oak (*Quercus* spp.), 5,000 acres (2,024 hectares) of pocosin, and 2,000 acres (810 hectares) of fields and openings. During prehistoric times, the coastal plain was covered by an ancient ocean into which rivers drained, depositing sand and silt. These deposits built up into sand dunes and over time became vegetated. The refuge includes over 32,000 acres (12,955 hectares) of mostly longleaf pine-wiregrass habitat interspersed with scrub oak.

FIRE IN THE ORIGINAL FOREST

The natural fire regime for longleaf pine ecosystems is not known. However, plant life histories and patterns of fuel accumulation suggest that light- to moderate-intensity surface fires every 2 to 8 years were typical of pristine landscapes (Wells 1942, Garren 1943, Wahlenberg 1946, Parrott 1967, Christensen 1981). Indians frequently used fire to improve game

habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, enhance conditions for berries, and drive game.

Accounts from the Colonial Period describing Indian burning practices (Smith 1624, Lawson 1709, Byrd 1728, Martin 1973, Robbins and Myers 1992) indicate burning by Indians was largely limited to fall and winter. Lightning fires would have been frequent during the growing season from April through August. Komarek (1964, 1965, 1968, 1974) suggested that lightning alone was adequate to account for the fire-tolerant vegetation. Early colonial settlers also used fire to improve range conditions for livestock.

As time passed and Indians were removed from the Southeast, settlers stopped burning for grazing, the landscape was filled with more man-made firebreaks from land clearing, and the incidence of frequent large, naturally occurring fires decreased. Heyward (1939) and Veno (1976) report that several fire-free decades may be sufficient for less flammable species of trees to invade and suppress fire-dependent flora, as well as small longleaf pines and oaks.

THE INITIAL REFUGE

The United States government established Carolina Sandhills National Wildlife Refuge in 1939. Much of the longleaf forest had been cut, leaving understocked pine stands with a heavy scrub oak understorey. Most of the longleaf pine was naturally regenerated second growth. Many of the older trees were scattered turpentine trees that were left from the original forests. A high percentage of the refuge was abandoned, heavily eroded cropped farmland.

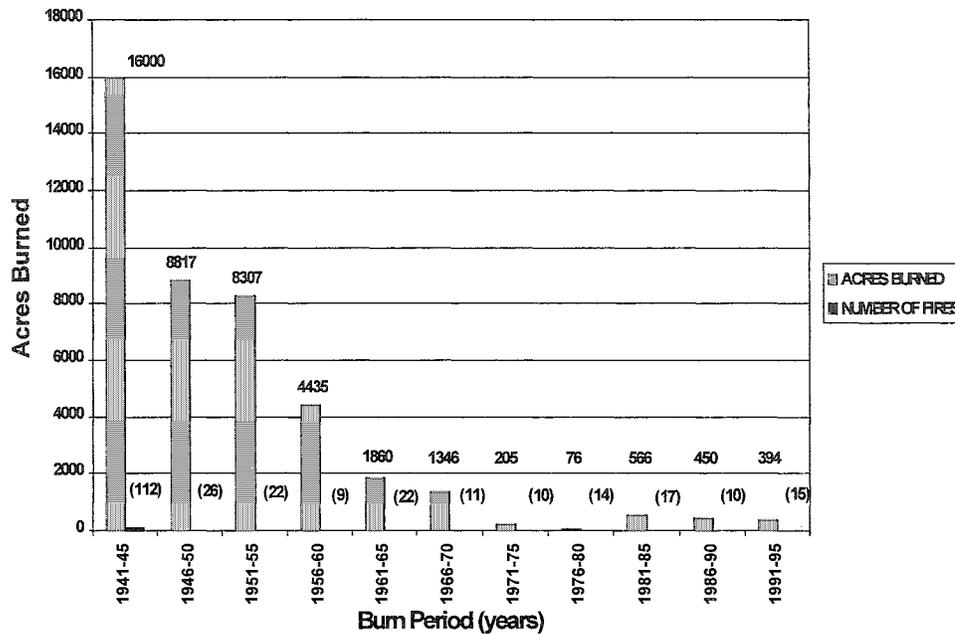


Fig. 1. Summary of acres burned by wildfires during 5-year cycles on Carolina Sandhills National Wildlife Refuge. Number of fires is shown in ().

WILDFIRE HISTORY

When the refuge was established, unchecked wildfires were a common occurrence. Figure 1 shows a summary of the wildfire history in 5-year increments starting from 1941. From 1941 to 1945 there were 112 wildfires recorded on the refuge that burned over 16,000 acres (6,478 hectares). During the early years of the refuge, wildfire control was a high priority. A system of dirt roads and firebreaks were constructed to give protection from large wildfires and provide access for firefighters. From 1942–1945, the Department of Army established and used a bombing range and a gunnery range on the refuge to train for World War II. Military exercises started many fires. These fires often covered large areas because once a training exercise started, no control personnel were allowed in the area until the mission ended. In 1942 alone, 14 fires burned over 10,000 acres (4,049 hectares). This was the largest acreage ever burned in one year by wildfire on the refuge.

During the period from 1946 to 1950, a total of 26 wildfires burned 8,817 acres (3,570 hectares) and from 1951 to 1955 a total of 22 wildfires burned 8,307 acres (3,363 hectares). The acreage burned in these two cycles was about half that burned from 1941 to 1945. The decrease resulted from establishing roads and firebreaks and initiation of county-wide fire protection in 1947. Two rangers and a warden were stationed at a fire tower on the refuge. This made early fire detection and quick initial attack possible. Another important factor was the county ranger's prosecution of all violations involving state fire laws. Prior to this time, farmers burned their fields any time and allowed their fires to go unchecked. The rangers prosecuted when fires spread to other landowner's property. The 1953 Refuge Annual Narrative states that, "County

and State Fire Organizations were doing a good job of publicizing the bad effects of woods fires and penalizing those careless with fire." This document also mentions public awareness of the harm caused by wildfires.

Wildfire frequency continued to drop from 1956 to 1960 with only 9 fires burning 4,435 acres (1,796 hectares). One fire started by a farmer resulted in more than 4,000 acres (1,619 hectares) of the above total. The number of wildfires increased from 1961 to 1965 to 22, but the total acreage burned declined to 1,860 acres (753 hectares).

Eleven wildfires burned 1,346 acres (545 hectares) between 1966–70. The last large wildfire on the refuge was 1,273 acres (515 hectares) in 1966. That fire occurred during extreme conditions in which 1,700 wildfires burned 76,000 acres (30,769 hectares) in South Carolina in a 2-week period. During March and April 1967 the state was averaging 75–100 wildfires a day; during February 1968 a record 2,271 wildfires burned 34,000 acres (13,765 hectares). The refuge had only one small wildfire during these extreme times. The small number of wildfires was attributed to prescribed burning, patrols, and luck.

In 1969, a devastating ice storm occurred in the Sandhills belt of South Carolina. The storm damage reduced total commercial timber volume on the refuge by 33%. A tremendous fuel accumulation occurred from broken tops and limbs and debris from salvage logging operations. Surprisingly, only 10 wildfires burning 205 acres (83 hectares) occurred from 1971 to 1975. Very active patrols, wet weather, and the increase in prescribed burning during the previous 7 years kept fire occurrence low.

Acreage burned by wildfire was at an all-time low from 1976 to 1980 with 14 fires burning only 76 acres

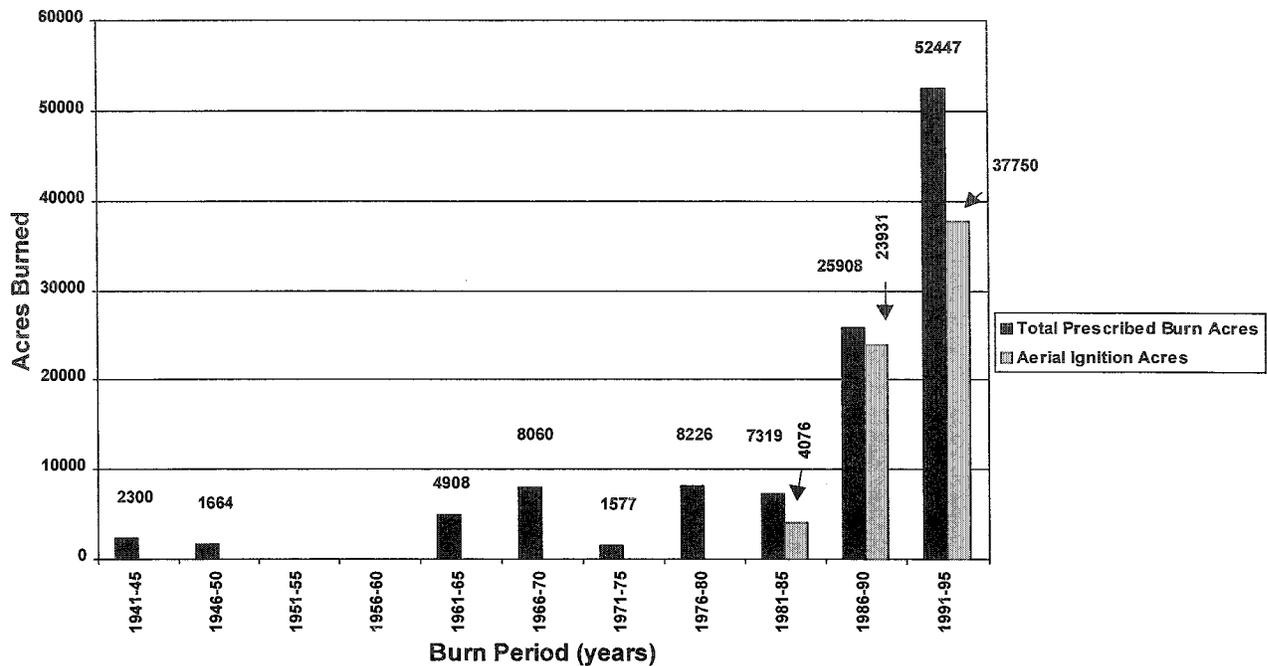


Fig. 2. Summary of acres prescribed burned during 5-year cycles on Carolina Sandhills National Wildlife Refuge.

(31 hectares). Wildfires have remained fairly constant with 17 fires from 1981 to 1985, 10 fires from 1986 to 1990, and 15 fires from 1990 to 1995. Total area burned for each 5-year period was never more than 600 acres (243 hectares). Many of these fires were caused by lightning strikes and a few were caused by arsonists. No single wildfire burned more than 250 acres (101 hectares) since 1967.

PRESCRIBED FIRE HISTORY

The first prescribed burning on the refuge was recorded from 1941 to 1945 when approximately 2,300 acres (931 hectares) of grass firebreaks, fields, and woods were burned (Figure 2). Less than 500 acres (202 hectares) per year were burned during this time. Prescribed fire was used minimally with 1,664 acres (674 hectares) burned during 1946–50 and no documented acreage burned during 1951–60.

Prescribed fire became a management tool again during 1962 when 195 acres (79 acres) were burned. This acreage increased over the next 3 years to a total of 4,908 acres (1,987 hectares). The 1962 Refuge Annual Narrative stated, "Annual control burns on the refuge will contribute toward habitat improvement." The 1964 Annual Narrative stated that, "Control burning has a vital role in the management program and improves habitat for deer, turkey, and other species while greatly reducing wildfires." The thinking that "all fire is bad" was reversed during this time. Managers realized that prescribed burning decreases the wildfire threat while enhancing wildlife habitat.

Prescribed burning increased to 8,060 acres (3,263 hectares) from 1966 to 1970. All of the prescribed burns utilized relatively cool backfires due to the heavy fuels present. The refuge prescribe burned a rec-

ord 3,715 acres (1,504 hectares) during 1968 and the burning program appeared to be accelerating. However, an ice storm during 1969 resulted in tremendous fuel loads which shut down prescribed burning on the refuge from 1969 to 1974 due to fire safety concerns. Also, management of the refuge at this time did not consider prescribed burning a top priority.

A new manager and forester arrived in 1974 and prescribed burning became a priority again with 1,577 acres (638 hectares) burned during 1975. Another key element that raised the priority of prescribed burning on the refuge was passage of the Endangered Species Act of 1975 which listed the red-cockaded woodpecker (*Picordes borealis*) as endangered. The refuge had over 100 clusters of red-cockaded woodpeckers during 1975 and both their cavity sites and foraging areas must be maintained by fire.

Prescribed burning during the periods 1976–80 and 1981–85 was about 8,000 acres (3,239 hectares) which was near the 1966–70 total (before the 1969 ice storm). Starting in 1975, the refuge planned to burn the uplands on a 5-year rotation with backing fires to reduce the heavy fuel buildups. By 1982, these heavy fuel accumulations were reduced enough to change to strip head fires and point source (spot) fires. The objectives of the prescribed burning program were: (1) wildlife habitat improvement, especially for open forest conditions favored by the red-cockaded woodpecker; (2) wildfire suppression; and (3) hardwood control.

A key event for the burning program occurred during 1982 when the refuge first used aerial ignition by helicopter. The first aerial ignition was performed using a cable-suspended helitorch with gelled gasoline. Acreage burned by aerial ignition was 744 acres (301 hectares) in 1982; 2,174 acres (880 hectares) in 1983; and 1,202 acres (487 hectares) in 1984. Almost 60%

of the acreage burned in 1981–85 was accomplished by aerial ignition.

Utilizing a helicopter allows much larger areas to be burned in a shorter time with fewer personnel than hand burning. Usually, weather on the refuge allows for less than 15 good burning days per year which limits the acreage that can be hand burned. The refuge burning crew usually consists of seven to nine people. An average day of hand burning utilizing this size crew with the refuge's fuel load is less than 500 acres (202 hectares). With a helicopter, the average increases to 1,500 acres (607 hectares) per day.

The development of aerial ignition burning allowed the refuge to use roads, permanent firebreaks, and natural barriers such as wet creek bottoms to contain fires instead of plowed firebreaks. Instead of plowing around most drains, fire was allowed to burn into them. Several fire-dependent endangered and rare plants are located in these ecotones between the uplands and wetlands. Another advantage to aerial ignition is that total cost per acre burned is less than hand burning. The reason for this is the reduction in personnel costs with aerial burning. Smoke management concerns favor aerial ignition, as the smoke is compressed and dissipated in a shorter length of time.

From 1986 to 1990 the refuge staff burned 25,908 acres (10,489 hectares), a 300% increase over any other 5-year period. The primary factor for this increase was the use of aerial ignition. Other factors that contributed to the increased amount of area burned were: 1) a greater national interest in the fire program which resulted in more training; 2) better equipment, and; 3) more experienced crews. Beginning in 1990, a mounted helitorch with gelled gasoline was used instead of the cable-mounted torch. This system is very similar in operation to utilizing an aerial ignition device system (ping pong ball machine). Much better control of the helicopter and fire ignition occurred with this change.

From 1991 to 1995 the refuge burned a record 52,447 acres (21,234 hectares). Around 1992, a change was made from a burn rotation of 5 years to 3 years. This change was made to prevent heavy fuel buildup and maintain better hardwood control. The rotation change resulted in an annual burning increase of around 5,000 acres (2,024 hectares).

GROWING SEASON BURNING

During 1992, the refuge started phasing in growing season burning. Previously, all burning was done in the winter because of more favorable winds, temperature, and humidity. Also, winter burns are much less expensive and risky to conduct. However, the historical natural fires appeared to be lightning-caused and occurred between April and August. Periodic growing season fires appear to be very important in maintaining several species within the ecosystem. The main reasons for introducing growing season fires were: 1) to more closely match the natural fire history of the property; 2) maintain hardwood control; 3) restore open structure to longleaf pine stands for red-

cockaded woodpecker habitat; 4) enhance rare plant species, and; 5) reduce hazardous fuels. Growing season burns appear to cause a shift to lighter fuels, which reduces wildfire danger and impacts.

Growing season burns started with 133 acres (54 hectares) during 1992, 310 acres (126 hectares) during 1993, 1,044 acres (423 hectares) during 1994, and 3,164 acres (1,281 hectares) during 1995. Hand burning was utilized on all growing season burns until 1995 when one area of 932 acres (377 hectares) was ignited aurally. Excellent results have been achieved with our growing season burns. Observations on the refuge show much greater hardwood control with growing season burns. Also, these fires burn deeper into the pocosins and stream heads which reduces encroaching vegetation in the ecotones where rare plant species exist (i.e. white wicky, *Kalmia cuneata* and sweet pitcher plant, *Sarracenia rubra* ssp. *jonesii*). Wiregrass appears to produce more robust plants with greater seed production after growing season burns. More herbaceous and diverse understory plants also appear to occur after a growing season burn. While the refuge does not have firm data to document these differences, a 5-year study is underway to determine understory responses to different fire regimes. The tentative plan on the refuge is to incorporate a growing season burn into an area 2 years after a winter burn and then complete two winter burn cycles before repeating a growing season burn. Some growing season burn areas will be followed in 2 years with a second growing season burn if greater hardwood control is needed.

SUMMARY

Carolina Sandhills National Wildlife Refuge was established in 1939 and had an early history of frequent and large wildfires. Initially, the refuge established permanent firebreaks and roads for protection and to allow access for control. County-wide fire protection began during 1947 when prosecution of state fire law violations was implemented. Educational efforts regarding harm caused by wildfires were also effective during 1940–60. Relatively large wildfires occurred sporadically on the refuge until 1966. Since that time wildfire occurrence has averaged less than 3 fires per year burning an average of 26 acres (11 hectares) per fire. Figure 3 shows a comparison of the wildfire history versus the prescribed fire history for the refuge.

Prescribed burning was done on a very small scale on the refuge during its first 20 years. Table 1 shows how the burning program began to grow during the 1960's. The severe ice storm in 1969 resulted in no burning through 1974, which accounted for the drop in the annual acreage burned between 1970–79. The lack of fire had major negative effects on the longleaf pine ecosystem. Turkey oaks invaded the uplands and became the midstory under the longleaf pine overstory. Several red-cockaded woodpecker groups were lost as the midstory oaks reduced habitat quality. Very few longleaf pine were able to regenerate since fire is necessary to expose bare soil for longleaf seed and reduce

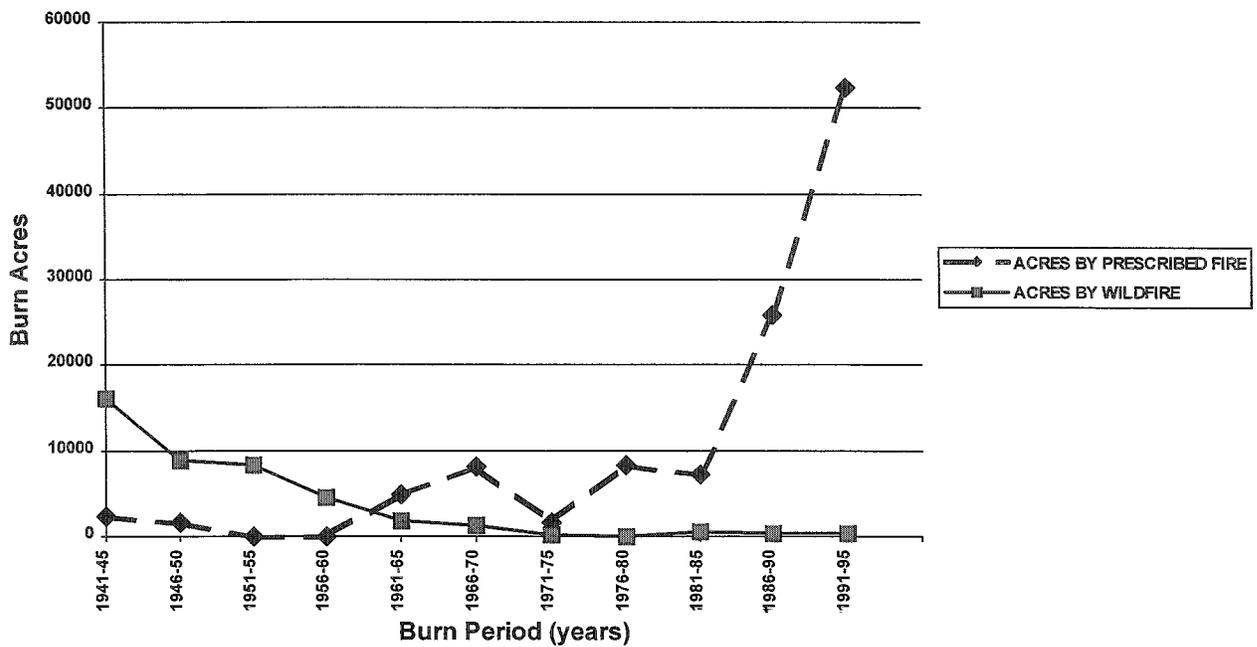


Fig. 3. Comparison of acres burned by wildfire versus prescribed fire on Carolina Sandhills National Wildlife Refuge from 1941 to 1995 by 5-year increments.

competition for seedlings. The diversity and health of plants in the understory was limited because the native species were fire-dependent.

During 1975, burning became a higher priority with passage of the Endangered Species Act and listing the red-cockaded woodpecker as endangered. Both woodpecker cavity sites and foraging areas must be maintained by fire. Burn rotations were on a 5-year cycle and most burns were backing fires to reduce the heavy fuel loads. Around 1982, fuels were reduced enough to use strip-head fires and point-source (spot) fires. Another key occurrence during 1982 was the first use of aerial ignition. The utilization of aerial ignition was the single most important factor in accomplishment of prescribed burning of large acreages during a given year. With limited personnel and suitable burning days available, aerial ignition allowed 1,000–1,500 more acres (405–607 hectares) burned per day than hand burning. Between 1990 and 1995, an average of almost 10,000 acres (4,049 hectares) were burned per year. Another major advantage of aerial burning is smoke management. The State of South Carolina has developed very strict smoke management guidelines. Under these guidelines, the amount of available fuels

(tonnage) to be consumed is doubled with the use of aerial ignition. Even with extra personnel, the refuge could not burn large acreage blocks by hand and meet the state's smoke management guidelines. Growing season burns were initiated slowly during 1992 and have increased to over 3,000 acres (1,215 hectares) burned in 1995. Better hardwood control, habitat improvements, and fuel reductions appear to occur with growing season burns. Wiregrass, a dominant understory component, provides fuel to carry fires and requires late winter or growing season fire to produce seed and remain vigorous.

CONCLUSIONS

Although the importance of fire in maintaining the sandhills ecosystem is accepted widely today, fire management on the refuge has spanned the gamut from primarily wildfire suppression to aggressive prescribed burning that is used to achieve a variety of management objectives. While an aggressive prescribed burning program will not prohibit wildfire occurrence, it certainly will result in smaller wildfires that are easier to contain. Prescribed burning on a 3-year cycle controls the fuel and provides a mosaic of habitats throughout the refuge. Therefore, continuous heavy fuels are not available. Based on our experience at Carolina Sandhills National Wildlife Refuge, we suggest the following factors are critical to building and maintaining a successful prescribed burning program: (1) have experienced and qualified fire personnel running the program; (2) educate management and the local community to the benefits of fire; (3) maintain a trained and experienced fire crew; (4) obtain adequate funding to support staff and equipment need; and (5) get started, the perfect day seldom comes.

Table 1. Prescribed burn acreage since refuge establishment at Carolina Sandhills National Wildlife Refuge.

Year	Total Acres (Hectares) Burned	Average Acres (Hectares) Burned per Year
1940-49	3,071 (1,243)	307 (124)
1950-59	0 (0)	0 (0)
1960-69	12,968 (5,250)	1,297 (525)
1970-79	8,043 (3,256)	804 (325)
1980-89	30,351 (12,288)	3,351 (1,357)
1990-95	56,952 (23,057)	9,492 (3,843)

Prescribed burning is an economical management tool to treat large areas. In fire-dependent systems, prescribed burning is essential to the health of the ecosystem. Both plant and animal diversity in these systems are dependent upon fire. Since an ignition source will eventually reach the fuels, a manager has two options: (1) start a prescribed fire under approved conditions; or 2) chase and attempt to suppress a wildfire under extreme conditions.

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