EFFECT OF BURN DATE ON REGROWTH RATE OF *SCIRPUS OLNEYI* AND *SPARTINA PATENS*

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Abstract: Scirpus olneyi and *Spartina patens* were grown in mixed stands in containers (surface area: 900 cm^2) and burned during the fall and winter on 6 dates (Burn 1, 8 October; Burn 2, 23 October; Burn 3, 8 December; Burn 4, 20 December; Burn 5, 6 February; and Burn 6, 20 February). Plants in 18 separate containers were burned on each date and 18 containers were left unburned as a control. Biweekly counts were made of the number of culms of each species per container from 5 October to 18 April. A positive linear relationship ($P < 0.05$) was noted between culm production of both species and minimum temperature following burns. However, the regrowth of *S. olneyi* increased at a greater rate with increasing temperature than *S. patens*. The data indicated that photoperiod (decreasing day length) reduced the regrowth rate of *S. patens*. The mean density of *S. olneyi* approached or equaled pre-burn densities by the 4th week following burns, but *S. patens* did not approach the pre-burn density until the 8th week. The mean density of *S. olneyi* per container was greatest throughout the study period in the Burn 1 group ($\bar{X} = 52.8$) and declined gradaully to Burn 6 ($\bar{X} = 21.8$). However, the mean density of *S. patens* increased 49.4% from the 1st 3 burn dates (Burns 1, 2, and 3) ($\bar{X} = 21.8$) to the last dates Burns 4, 5, and 6, ($\bar{X} = 47.5$).

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Marsh burning was reported as a common practice in the Louisiana coastal marshes as far back as recorded history can be traced. Le Page du Pratz (1758) visited the region in September 1719 and noted that vast areas were being burned to remove dense grass cover and facilitate travel. Authur (1931) reported that 90% of the marsh burning in Louisiana during the early 20th century was done by trappers and alligator (*Alligator mississippiensis*) hunters. Trappers burned mainly to expose the trails used by muskrats (*Ondatra zibethicus*), although some trappers felt that burning improved food conditions for muskrats. Arthur (1931) believed that fire was generally harmful to muskrats but admitted that a carefully planned burn when the marsh was wet would be better than risking a lightning fire during a summer dry spell. He also noted that marsh fired when the ground was wet soon produced renewed growth of muskrat food plants, particularly in brackish marsh; three-corned grass (*S. olneyi*), an important muskrat food plant, appeared to send up stalks with renewed vigor following burns.

S. olneyi is an important food of snow geese (*Chen caerulescens*) as well as muskrats, and Lynch (1941) reported that growth of the plant was accelerated by removal of dense wire grass (*S. patens*) with fire. Other writers also found that *S. olneyi*, a sub-climax plant, produced rapid growth soon after burning and noted that burning gave the species an advantage over slower growing competitors, mainly *S. patens* (O'Neil 1949, Hoffpauer 1967, Hess 1975).

Most writers noted that burning during late spring and summer should be avoided because of possible destruction of nests and young of various wildlife species. O'Neil (1949) reported that marsh containing *S. olneyi* should be burned between 10 October and 1 January to maintain constant annual growth of the species. He also observed that fall burning favored *Scirpus robustus,* another valuable muskrat food plant. For best results in managing *S. olneyi,* he recommended making partial or spotty burns, beginning in mid-November and continuing until Mid-February. However, he did not indicate the response of *S. olneyi* to late winter or early spring burns.

Lynch (1941) felt that marsh vegetation could be damaged if burning was done without adequate moisture to protect root systems and recommended that cover burns be made when there was from 7 to 12 cm of standing water present. However, O'Neil (1949) found that for best results *S. olneyi* marsh should be burned with water levels 0 to 5 cm above the marsh surface. Hess (1975) evaluated the effects of water depth on growth of *S. olneyi* and *S. patens* and found little difference when burning was done with water levels ranging from 5 cm below to 5 cm above the marsh surface.

Marsh burning is still a common practice in the Louisiana coastal marshes, and Hoffpauer (1967) estimated that between 300,000 and 400,000 ha are burned annually. Much of this burning is done for the purpose of maintaining stands of *S. olneyi;* however, little information is available on methods for maximizing the effects of burning. The purpose of this study was to determine growth rates of *S. olneyi* and *S. patens* following burns at different times during the fall and winter.

METHODS

S. olneyi and *S. patens* were collected from natural stands along the north shore of Lake Pontchartrain in Louisiana and planted in 126 metal containers. The containers were 20 cm deep, with a surface area of 900 cm^2. All containers were coated with epoxy paint to prevent metal contact with the soil. Two sprigs of each species were planted in each container and allowed to grow until the containers were completely vegetaged, which required approximately 6 months. The growth substrate consisted of soil collected from the coastal marsh in areas supporting natural stands of both species. During the 6-month establishment period, water levels in all containers were held at the soil surface. On the day prior to a burn, all free water was removed from the containers to be burned. After the burns, water levels were maintained within 5 cm of the soil surface.

Six burning dates were tested during the fall and winter of 1974 - 75 (Burn 1, 8 October; Burn 2, 23 October; Burn 3, 8 December; Burn 4, 20 December; Burn 5, 6 February; and Burn 6, 20 February). On each burn date, all vegetation in 18 containers was burned using a weed burner, and all plant material was burned down to the soil surface. Culm density was used as an indication of growth, and the number of culms of both species was 1st counted on 5 October and subsequent counts were made at biweekly intervals in all containers until 18 April.

To determine the relationship between temperature and growth of *S. olneyi* and *S. patens,* the number of culms produced at each biweekly interval following burns was tabulated along with minimum temperature during the interval. Only growth prior to 6 weeks was included in the analysis. The data were tested by regression analysis using the General Linear Model procedure of the Statistical Analysis System (Barr et al. 1979). Other data were tested with an analysis of variance using a randomized block design (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Effect of Temperature Following Burns on Growth

O'Neil (1949) noted that *S. Olneyi* in unmanaged marshes was usually dominated by other plant species, but fall burning favored *S. olneyi* because it grew during the winter when most competing species were dormant. He did not report on winter growth of *S. patens;* however, Babcock (1967) observed that in a burned marsh new sprouts of *S. patens* continued to appear throughout the winter with the rate of sprouting increasing in the spring. However, neither author compared growth rates of the 2 species when they grew in mixed stands in a burned marsh.

During this study culm counts were made on both species at biweekly intervals following burns (Fig. 1). Also, daily minimum temperature readings were taken at a nearby weather station (Table 1) and provided information for determining the relationship between culm density growth and temperature. The number of culms produced at biweekly intervals for 6 weeks were used in the analysis. After 6 weeks, growth appeared to decline naturally with factors other than temperature having a strong effect on growth.

Table 1. Mean daily minimum temperature (C) during biweekly growth intervals, 1975 - 76.

Biweekly intervals	Dates inclusive	Mean minimum temperature
1	8 Oct - 21 Oct	9.2
2	22 Oct - 3 Oct	12.6
3	4 Nov - 18 Nov	6.7
4	19 Nov - 7 Dec	2.8
5	8 Dec - 23 Dec	2.6
6	24 Dec - 3 Jan	12.0
7	4 Jan - 18 Jan	3.4
8	19 Jan - 2 Feb	9.4
9	3 Feb - 15 Feb	4.7
10	16 Feb - 5 Mar	5.0
11	6 Mar - 15 Mar	7.9
12	16 Mar - 6 Apr	9.1
13	7 Apr - 18 Apr	11.3

The analysis disclosed that for both species a positive linear relationship ($P < 0.05$) existed between minimum temperature and the number of culms produced (Fig. 2). Thus, the density growth of both *S. olneyi* and *S. patens* following burns was curtailed by low temperature. Growth rates for both species were very low when minimum temperatures averaged less than 5 C; however, the number of culms of *S. olneyi* increased at a much greater rate as temperature increased above that point (Fig. 2).

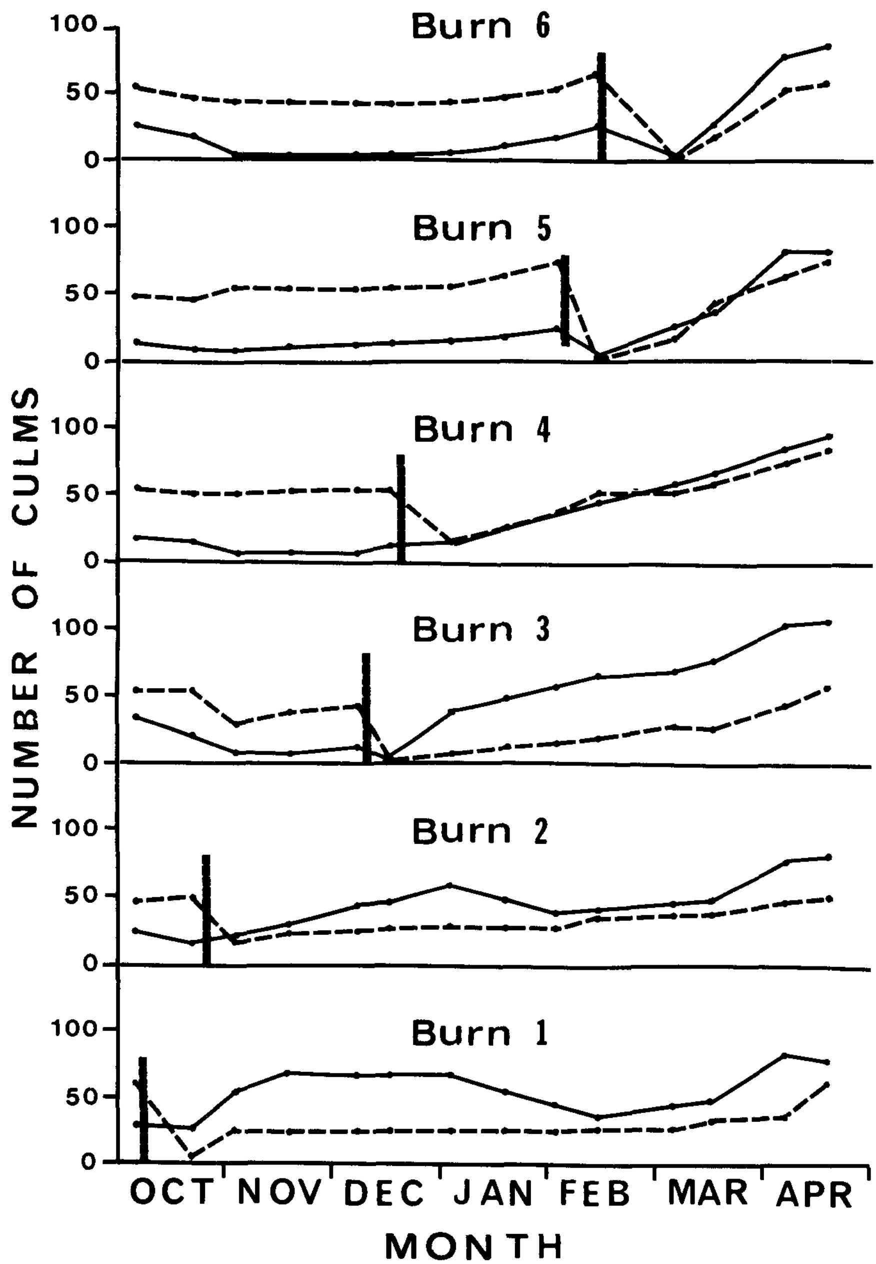

Fig. 1. Mean number of culms of *Scirpus olneyi* (solid line) and *Spartina patens* (dashed line) per container (n = 18) on each count date (solid circles) within different burn groups. The date of each burn is indicated by a vertical line.

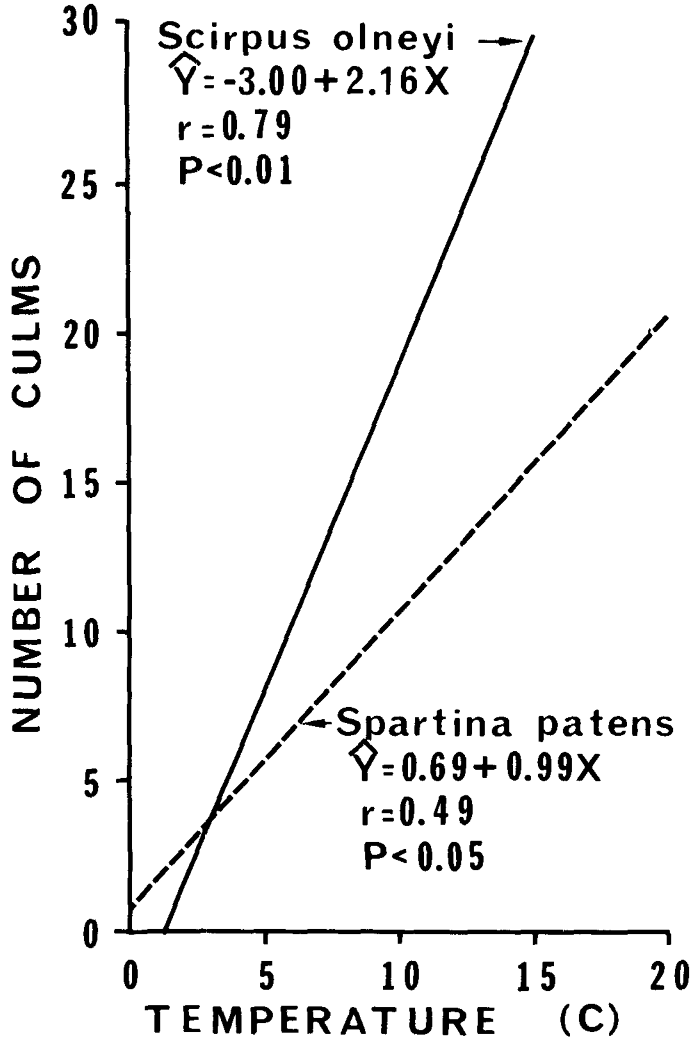

Fig. 2. The predicted number of culms of *Scirpus olneyi* and *Spartina patens* produced at biweekly intervals following burns in relation to minimum temperature.

When the mean minimum daily temperatures over a 2-week period was less than 5 C, *S. olneyi* averaged 4.4 culms per container and *S. patens* averaged 2.9 culms per container. The mean temperature throughout the study was 44.8 C and growth of *S. olneyi* averaged 12.3 culms and *S. patens* averaged 7.7 culms per 2-week interval.

The coefficient of determination (r^2) for *S. olneyi* indicated that 61% of the variation in culm density during the 2-week intervals following burns was accounted for by variation in daily minimum temperature. A similar computation for *S. patens* indicated that only 24% of the variation in culm density was accounted for by variation in minimum temperature.

Photoperiod was another factor possibly influencing the number of culms of *S. patens*. To evaluate the effects of photoperiod, the data were partitioned into 2 segments with segment 1 including growth intervals with decreasing day length and segment 2 including growth intervals with increasing day length. Mean minimum temperature was similar during both segments; segment 1 averaged 45.8 C and segment 2 averaged 43.8 C. The culm growth of *S. olneyi* followed a pattern similar to that of minimum temperature and during segment 1 the species produced an average of 13.6 culms per biweekly interval; during segment 2, it produced 11.1 culms. However, considerable difference was noted between segments in the number of culms of *S. patens*. During segment 1 the average growth was 5.1 culms, but during segment 2 the growth rate doubled and produced an average of 10.4 culms.

Short-Term Effects of Burning on Growth

The regrowth rates for *S. olneyi* and *S. patens* following burns were determined by culm counts at biweekly intervals for 8 weeks. Significant differences ($P < 0.01$) were noted among burn dates and intervals. Culm density after the burns varied considerably. Therefore, in order to evaluate the regrowth rate with time after each burn, the percentage of total growth taking place during the 1st and 2nd 4-week intervals was compared. This disclosed that the proportion of growth of both species during the 1st 4 weeks was greatest following Burn 1 (8 October) and Burn 2 (23 October), then declined progressively through Burn 6 (20 February) (Table 2). Thus, both species made greatest growth during the 1st 4-week interval following the October burns and greatest growth during the 2nd 4-week interval following the February burns. Growth rates following December burns were midway between October and February rates but slightly greater growth was noted during the 1st 4-week interval. The growth differences among burn dates were probably caused by differences in temperature.

S. olneyi produced a much faster growth response following burns than did *S. patens*. In all cases, the mean number of culms of *S. olneyi* 4 weeks after all burn dates approached or exceeded the mean number of culms present immediately before burning. However, the density of *S. patens* did not approach the density before burning until the 8th week, and then only for Burns 4, 5 and 6 was this noted. The differences within burn dates were probably an effect of photoperiod.

Long-Term Effects of Burning on Growth

On the 1st count date (5 October), before any burning was done, the mean number of culms of *S. olneyi* in the various burn groups (burn date) ranged from 13.1 to 32.6 and the number of culms of *S. patens* in the same groups ranged from 47.9 to 61.6. In practically all groups the density *S. patens* was more than twice the density of *S. olneyi* before burning (Table 3). The same condition was noted in the control group.

Table 2. Mean number of culms of *Scirpus olneyi* and *Spartina patens* in containers (n = 18) at biweekly intervals following burns.

Burn date	Before burn	Weeks after burn 2	4	6	8	Growth within 1st 4 weeks (%)
		Number of culms				
		Scirpus olneyi				
8 Oct	29.8	17.0	53.9	66.9	65.4	82.4
23 Oct	15.4	20.5	40.9	43.3	48.3	84.7
8 Dec	10.3	0.6	39.6	48.3	58.6	67.6
20 Dec	11.7	15.4	26.5	27.4	43.4	61.1
6 Feb	22.5	2.6	24.1	26.3	79.8	30.2
20 Feb	24.6	2.3	24.7	77.2	82.1	30.1
		Spartina patens				
8 Oct	61.6	6.4	24.6	26.9	27.5	89.5
23 Oct	49.5	9.9	21.3	21.9	28.7	74.2
8 Dec	43.0	0.1	7.5	11.6	14.9	50.3
20 Dec	52.3	15.6	27.0	37.3	50.5	53.5
6 Feb	72.1	0.0	16.2	44.4	61.9	26.2
20 Feb	64.7	0.9	14.5	52.0	57.2	25.3

Table 3. Relationship of the mean number of culms of *Scirpus olneyi* and *Spartina patens* on the 1st (5 October) and last (18 April) count date to the time of burn (n = 18).

		Scirpus olneyi			*Spartina patens*		
Burn number	Burn date	5 Oct	18 Apr	Change (%)	5 Oct	18 Apr	Change (%)
1	8 Oct	29.8	60.9	104.4	61.6	60.7	1.5
2	23 Oct	23.7	81.7	244.7	47.9	49.6	3.5
3	8 Dec	32.6	106.4	137.6	52.8	56.8	7.6
4	20 Dec	18.7	92.7	395.7	52.9	83.7	58.5
5	6 Feb	13.1	80.9	517.6	48.7	71.8	47.4
6	20 Feb	26.2	82.3	214.1	53.6	57.2	6.7
	Control	22.7	45.8	101.8	52.0	125.0	140.4

On the last count date (18 April), which followed the burn dates for time periods ranging from 57 days (Burn 6) to 192 days (Burn 1), the number of culms of *S. olneyi* equaled or exceeded the number of culms of *S. patens*. However, in the control (unburned) group, the density of *S. patens* remained more than twice that of *S. olneyi*.

From the 1st count date (5 October) to the last count date (18 April), the density of *S. olneyi* increased ($\bar{X}$ = 269.0%) in all 6 burn groups, and the density in the control group increased 101.8%. However, the density of *S. patens* during the same period remained essentially unchanged in 4 burn groups and increased

58.5% and 47.4% in the 21 December (Burn 4) and 6 February (Burn 5) burn groups, respectively. In the control group, the density of *S. patens* increased 140.4% over the same period.

The effects of burn date on the abundance of *S. olneyi* and *S. patens* throughout the study period extending from 5 October to 18 April were determined by comparing the mean density of plants by burn date (Table 4). Burns were made on 6 dates and the mean density of *S. olneyi* throughout the entire study period was greatest ($\bar{X} = 52.8$) in containers burned on 8 October (Burn 1). The overall mean density of *S. olneyi* gradually declined with each subsequent burn date and the lowest mean density ($\bar{X} = 21.8$) resulted from the burn on 20 February (Burn 6).

The mean density of *S. olneyi* was considerably greater after each burn than before (Fig. 1). The mean density after burns varied only a small amount among burn dates (Table 4). Consequently, the earlier then burn, the longer was the after-burn growth period, hence, the greater mean density with Burn 1.

Table 4. Mean number of culms of *Scirpus olneyi* and *Spartina patens* per biweekly interval during the period between 5 October and 18 April in relation to burn date.

Burn	Burn	Before burn		After burn		Entire period	
number	date	*S. olneyi*	*S. patens*	*S. olneyi*	*S. patens*	*S. olneyi*	*S. patens*
1	8 Oct	29.8	61.6	55.5	29.1	53.6	31.5
2	23 Oct	19.6	48.7	47.3	31.4	43.3	33.9
3	8 Dec	15.0	42.6	63.4	23.1	46.1	30.1
4	20 Dec	10.5	51.7	53.1	49.8	34.8	50.6
5	6 Feb	13.2	55.3	45.5	38.9	24.7	49.5
6	20 Feb	11.9	47.2	46.6	31.2	21.8	42.6

The mean number of culms of *S. patens* present throughout the entire period from 5 October to 18 April was greater in containers burned on the 3 later dates (Burns 4, 5 and 6) (Table 4). In all burn groups the mean density of *S. patens* was greater before the burn date than after the burn date. However, no trend was noted among burn dates in mean densities either before or after burning. Since the mean density was greater before burns than after burns, the lower overall densities noted during the earlier burn dates occurred because burns contained more days under post-burn conditions.

SUMMARY AND CONCLUSIONS

S. olneyi grows within a specific range of water level and salinity conditions (Palmisano 1967, Ross 1972, Hess 1975). However, the species was described as a subclimax plant by O'Neil (1949); and even in marsh with proper soil and water conditions, *S. olneyi* often is eliminated by more dominant plants. *S. patens* is the species most commonly found in mixed stands with *S. olneyi* in Louisiana.

The application of management procedures that "set back" plant succession are usually necessary to sustain annual stands of *S. olneyi* (O'Neil 1949). Marsh burning is the procedure most commonly used and should be done at a time and under conditions that produce the species in greatest abundance and reduce stands of competing species. Burning is usually restricted to the fall and winter seasons in order to minimize losses of nests and young of various wildlife species.

The present study was conducted to determine and compare the regrowth rate of *S. olneyi* and *S. patens* when grown in mixed stands and burned at different dates during the fall and winter.

Air temperature below 5 C greatly reduced culm production of both *S. olneyi* and *S. potens* following burns. A positive linear relationship was noted between culm production and minimum temperature of both species. However, the density increase with a unit increase in minimum temperature was more than twice as great in *S. olneyi* than in *S. patens.* Variations in minimum temperature between October and April accounted for 62% of the variation in culm production of *S. olneyi* following burns but only 24% of the variation in *S. patens.* Photoperiod apparently affected culm development of *S. patens*, and the regrowth rate with increasing day length (after 21 Dec.) was more than twice the rate with decreasing day length (prior to 21 Dec.).

S. olneyi grew at a much greater rate following burns than did *S. patens.* The density of *S. olneyi* 4 weeks after all burn dates approached or exceeded the density immediately prior to the burn. However, the density of *S. patens* after the burns did not approach the density before burning until the 8th week.

O'Neil (1949) reported that marshes managed to produce *S. olneyi* should be burned annually between 10 October and 1 January. He observed that burning during this period favored the growth of *S. olneyi* over other species. The results of my study were mostly in agreement with O'Neil's (1949) observations. However, my data indicate that for maximum production of *S. olneyi,* marshes should be burned as early in the fall as possible. The mean density of *S. olneyi* throughout the study period (5 Oct. to 18 Apr.) was greatest in the Burn 1 group and gradually declined through Burn 6. In the 1st 3 burn groups (Burns 1, 2, and 3), the overall density of *S. olneyi* averaged 47.7 culms, and in the last 3 burn groups (Burns 4, 5, and 6), the density of *S. olneyi* averaged 27.1 culms, a difference of 43.2%. However, the mean density of *S. patens* in the 1st 3 burn groups was 31.8 culms and in the last 3 burn groups was 47.5, a difference of 49.4%. Consequently, the earlier burns produced stands during the fall and winter dominated by *S. olneyi* and later burns produced stands dominated by *S. patens.*

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