

**The Impact of Prescribed Burning, Cutting and Salting
on Shrubs in *Iva frutescens* Dominated Wetlands
on Cape Hatteras National Seashore, NC**

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Abstract

Experimental prescribed burning of marsh elder, *Iva frutescens*, dominated wetlands had little impact on shrub cover or species diversity. Scorched shrubs resprouted almost immediately after a March, 1987, burn. Cutting was more effective for shrub suppression than burning, and cut plots had not regained full shrub cover by the fifth year after treatment. Grasses increased in cover in cut plots, and probably slowed shrub recovery. Salting of otherwise undisturbed plots had little effect, but salting probably slowed shrub recovery after cutting. Species not previously present were most likely to invade plots that had been cut. The vulnerability of cut, and to a lesser extent burned, plots to invasion suggests that care must be taken, when planning prescribed burns, not to spread *Phragmites communis* in these wetlands. Fire lines constructed in this plant community may be exceptionally vulnerable to invasion by "weedy" plant species.

Introduction

Changes in drainage and the construction of an artificial dune line on Cape Hatteras National Seashore, NC, have changed vegetation patterns in the inner-dune areas and in brackish wetlands. In many places, shrubs have invaded what were once open grasslands, displacing other species (Dolan et al. 1973; Godfrey and Godfrey 1973; Schroeder et al. 1976; Bratton and Davison 1987). Park management concerns include unnatural change in native plant communities, loss of vistas across the islands, potential loss of waterfowl nesting and foraging areas, and increased fire hazard near roads and structures.

The purpose of this project was to investigate the potential impact of prescribed burning on wetlands dominated by blackneedle rush, *Juncus roemerianus*, salt marsh cordgrass, *Spartina patens*, and marsh elder, *Iva frutescens*. Construction of a ditch or canal system for mosquito control has changed the watertable in these tidal wetlands on Bodie Island and has encouraged invasion by shrubs. Marsh elder and woody species such as sea ox-eye, *Borrchia frutescens*, and groundsel, *Baccharis halimifolia*, occupy the lower sites between the canals, while bayberry, *Myrica* spp. usually invade the higher mounds of spoil along the artificial channels. These communities are naturally low in vascular plant species diversity, although shrub invasion may have reduced the frequency of some native marsh species, particularly forbs. This project evaluated the degree of shrub suppression provide by burning and by cutting and salting, and provides information on potential positive and negative impacts of prescribed fire in the Bodie Island marshes.

Methods

In summer 1986 a series of vegetation sample plots were established in shrub communities on Bodie Island. Preliminary attempts at burning the plots failed because the prescriptions were too conservative and underestimated the moisture of the marsh vegetation. From Nov. 20, 1986 to Jan. 15, 1987, a series of sixteen new 10 x 20 m plots were established in two areas of wetland, near the first automobile turnout south of Whalebone Junction on Highway 12. In each plot, ten 1 x 1 m quadrats were sampled based on a randomly chosen alternating pattern along the center line. Investigators measured maximum vegetation height in cm, and the cover of each plant species present. Covers were based on the total area of leaf and stem coverage and therefore could exceed 100%.

On March 24, 1987, a National Park Service fire crew attempted to burn eight of the plots. The marsh was too wet, so a second fire was ignited on March 25, 1987. This fire spread unevenly, removing more vegetation at the south end of the study area, and burning more intensely where there was a greater volume of dry marsh cordgrass, *Spartina patens*. The burned and unburned plots were resampled between June 18 and 29, 1987. Work crews then cut four of the burned and four of the unburned plots with weed cutters, between July 17 and July 31, 1987. On Aug. 6 and 7, salt was spread on two unburned, uncut plots, two unburned and cut plots, two burned, uncut plots, and two burned and cut plots. Salt application was approximately 1.33 kg/m². On Aug. 10, 1987, an exceptionally high tide removed much of the salt. On Aug. 15, 1987, the plots were flooded again due to heavy rain. No further treatments were applied. The plots were resampled: from Aug. 21

to 26, 1987, from Aug. 15 to 18, 1988, from Aug. 20 to 22, 1989 and from July 7 to 10, 1991.

Statistical analysis in this paper utilizes the Statistical Analysis System (SAS 1985), including procedures MEANS, NPAR1WAY, and GLM. All botanical nomenclature follows Radford et al (1968).

Results

Prior to the burn, the plots were dominated by three species: blackneedle rush, marsh elder, and salt marsh cord grass. The second most common woody plant was sea ox-eye, but its cover rarely exceeded 10 to 15%. There were also scattered individuals of groundsel. The most frequent grass, other than saltmarsh cord grass, was salt grass, *Distichlis spicata*, but cover was generally less than 10%, with a few more dense patches. Broad-leaved herb cover was generally low, and the most common forb was salt marsh goldenrod, *Solidago sempervirens*. Other forbs recorded periodically through the study included native marsh species such as marsh mallow, *Kosteletzkya virginica*, and climbing hempweed, *Mikania scandens*. Prior to the preliminary sample a winter storm had caused some "salt burning" and top-kill of shrubs in the area. Shrub covers may, therefore, have been at a low (other than that caused by a hurricane or major northeaster), relative to grass and rush covers at the beginning of the study.

The prescribed spring fire did top kill shrubs and reduce their cover. Comparing burned to unburned (and uncut) plots in May of 1987, the unburned had total covers averaging 150.0%, and shrub covers averaging 49.3%, while the burned plots had total covers averaging 75.8% and shrub covers averaging 29.6%.

Total cover of grasses and rushes (hereafter termed grasses), was also lower (Table 1). The burned shrubs recovered quickly, however. Marsh elder resprouted from its stems (usually toward the bottom) and produce new foliage by early summer. In all but the most heavily scorched areas it had almost regained its full height by the August, 1987, sample. There was no significant difference between the shrub covers, grass covers, and total covers between the pre-burn sample and the first summer (Aug.) sample after the burn (Tables 1 and 2). The saltmarsh cord grass flowered profusely in the burned areas, and there was some flowering of blackneedle rush as well. By 1991, the shrub cover and total cover on the burned plots were significantly greater than in the pre-burn sample, perhaps due to lack of storm impacts in the year prior to the sampling.

Burning did not suppress species diversity significantly, and there was no evidence any specific type of species (grass, rush, forb, woody) was particularly sensitive to the fire. Burned plots (that were not cut) had 2.6 species per plot in the pre-burn sample, 2.5 species per plot, the August after the burn, and 3.1 species per plot in the final 1991 sample. The unburned plots were slightly more diverse to begin with, averaging 3.4 species per plot in 1987, and 4.1 in 1991. (Tables 1 and 2) Burning thus had no long term impact on species diversity, and species numbers per quadrat had stabilized by the first summer after the burn. Burned plots were generally not invaded by species that had not previously been present, but the very large species of cord grass, *Spartina cynosuroides*, did appear in new locations after the burn, as did some scattered clumps of forbs.

Cutting had a much more dramatic impact on shrub cover than did burning, and the woody species displayed almost no ability to resprout immediately from

stumps cut flush with the soil surface (Table 3). The cover of grasses increased in the cut plots, and this appeared to slow reinvasion by shrubs. Species not previously present, particularly *Spartina cynosuroides*, and swamp dock, *Rumex verticillatus*, spread in the cut plots. When the last sample was completed in Aug. 1991, the cut plots still had not completely recovered their shrub cover. (Tables 3 and 4). Note that the cut and burned plots appear to recover somewhat more slowly than those that were only cut.

Salting had little impact on plots that were otherwise undisturbed (Tables 5, 6 and 7). It may have inhibited shrub recovery slightly on cut plots. (Tables 5 and 8). The treatment with the greatest impact on the shrubs, however, was cutting. Combinations of treatments are very time consuming for the relative gain in shrub reduction.

Implications for management

The marsh elder dominated wetlands proved difficult to burn and their shrubs recovered quickly. Although repeated burning might increase the cover of grasses, particularly of *Spartina* spp., it is unlikely to eliminate the shrubs. There was no evidence that early spring burning damaged the marsh elder dominated wetlands or reduced their species diversity.

Cutting, however, encouraged dominance by grasses. The appearance of numerous clumps of invading species on the cut plots suggests that fire lines in marsh elder dominated wetlands may be prone to invasion by *Phragmites communis*. When controlling wildfires or developing prescriptions in this habitat type, it is better to utilize existing roads and canals as fire lines. Where *Phragmites*

is present, prescribed burning should be undertaken with great caution, as it may encourage spread of *Phragmites* into new locations. Use of heavy equipment carrying *Phragmites* seeds or clearing lines near *Phragmites* patches is more likely to modify the plant species composition of the wetlands than a wildfire is.

In summary, burning is unlikely to control or eliminate shrubs in marsh elder dominated communities. On the other hand, fire causes little change in species composition on these sites. There is little to be gained by burning this vegetation type, but patches of this community may be included in prescriptions without major concerns for vegetation damage. Cutting could be used to reduce shrubs in local areas in marsh elder, but is very labor intensive. Cutting would need to be repeated every three to four years for shrub control. The best long term strategy for returning these wetlands to their pre-park species composition is reversing hydrologic changes initiated by the drainage canals.

References

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Table 1: Average heights, covers, and number of species per quadrat for burned versus unburned plots (neither cut but including salted) for a selection of dates.

<i>Date</i>	<i>Height cm</i>	<i>Total species</i>	<i>Total cover</i>	<i>Shrub cover</i>	<i>Grass cover</i>
BURNED					
Preburn 11-86	139	2.6	114.8	49.1	65.8
6-87 (burned)	83	3.1	75.8	29.6	46.2
8-87	107	2.5	111.5	54.4	57.1
8-91	134	3.1	141.5	67.2	74.2
UNBURNED					
Preburn 11-86	133	3.4	134.1	47.5	86.9
6-87	128	4.0	150.0	49.3	99.3
8-87	123	3.3	138.4	62.8	75.5
8-91	138	4.2	158.2	72.3	82.5

Table 2: Results of analysis of variance testing for significant impacts of burning, cutting and salting

One way nonparametric ANOVA, significant results at $p > .05$ marked with an *

1986 versus summer 1987, burned only (not cut, including salted)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
Total cover	.31	.5793
Total shrub cover	.33	.5662
Total grass cover	1.78	.1858
Total species	1.20	.2775
*Height	72.93	.0001

1986 versus summer 1991, burned only (not cut, including salted)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	22.14	.0001
*Total shrub cover	4.00	.0490
Total grass cover	1.85	.1782
*Total species	14.26	.0003
Height	2.85	.0954

Table 3: Differences between cut and burned and cut and unburned plots (both including salted plots) for height, species per quadrat and cover.

<i>Date</i>	<i>Height cm</i>	<i>Total species</i>	<i>Total cover</i>	<i>Shrub cover</i>	<i>Grass cover</i>
BURNED AND CUT					
Preburn 11-86	142	2.8	122.6	58.2	64.5
6-87 (uncut)	93	3.4	82.1	32.8	49.2
8-87 (cut)	42	1.5	22.2	0.0	22.1
8-91	114	3.0	162.0	16.7	145.2
UNBURNED AND CUT					
Preburn 11-86	137	3.1	143.5	59.3	84.2
6-87 (uncut)	132	3.8	154.0	63.2	90.4
8-87 (cut)	41	1.6	12.7	.6	12.1
8-91	123	4.0	164.9	46.6	116.9

Table 4: Analysis of variance of recovery after cutting for burned and unburned plots, all one way nonparametric ANOVA, significant results at $p > .05$ marked with an *

1986 versus 1991, burned and cut

<i>Variable</i>	<i>F</i>	<i>p > F</i>
*Total cover	47.21	.0001
*Total shrub cover	25.15	.0001
*Total grass cover	207.78	.0001
Total species	.74	.3939 (same number in 1991)
*Height	66.18	.0001

1986 versus 1991, unburned and cut

<i>Variable</i>	<i>F</i>	<i>p > F</i>
*Total cover	6.25	.0145
*Total shrub cover	1.53	.2204
*Total grass cover	20.61	.0001
* Total species	29.81	.0001 (more species in 1991)
*Height	13.56	.0004

Table 5: The relationship of salting to recovery after cutting (including burned plots), for average height, covers and number of species per quadrat.

<i>Date</i>	<i>Height cm</i>	<i>Total species</i>	<i>Total cover</i>	<i>Shrub cover</i>	<i>Grass cover</i>
NOT CUT, NOT SALTED					
Preburn 11-86	138	3.1	124.2	54.2	68.9
6-87	106	3.5	108.8	46.0	61.9
8-87	117	3.1	133.3	77.0	56.5
8-91	141	3.5	147.6	76.3	69.1
NOT CUT, SALTED					
Preburn 11-86	135	3.0	124.9	42.0	82.8
6-87	105	3.6	117.0	32.9	83.6
8-87 (salt)	112	2.7	116.6	40.2	76.4
8-91	131	3.7	151.7	63.1	87.4
CUT, NOT SALTED					
Preburn 11-86	138	2.9	131.1	54.4	76.7
6-87	118	3.7	125.0	44.6	79.9
8-87 (cut)	41	1.6	13.5	.6	12.9
8-91	120	3.8	166.4	38.8	126.2
CUT, SALTED					
Preburn 11-86	141	3.0	135.0	63.0	72.0
6-87	110	3.5	111.0	51.4	59.6
8-87 (cut,salt)	42	1.5	21.4	0.03	21.3
8-91	117	3.2	160.4	23.6	135.9

Table 6: One way nonparametric analysis of variance of plots that have been cut and/or salted for differences between pre-burn 1986 samples, and late summer post-treatment 1987 samples. Significance at the .05 level indicated by an *.

1986 to summer of 1987, not cut, salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
Total cover	2.06	.1557
Total shrub cover	.04	.8339
Total grass cover	.97	.3286
Total species	2.36	.1285
*Height	29.62	.0001 (probably due to recovery from storm damage)

1986 to summer of 1987, cut, not salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	587.42	.0001
*Total shrub cover	45.03	.0001
*Total grass cover	147.80	.0001
*Total species	55.21	.0001
*Height	672.10	.0001

1986 to summer of 1987, cut, salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	343.15	.0001
*Total shrub cover	50.08	.0001
*Total grass cover	91.09	.0001
* Total species	112.43	.0001
* Height	860.22	.0001

Table 7: One way nonparametric analysis of variance of plots that have been cut and/or salted for differences between pre-burn 1986 samples and final summer 1991 samples. Significance at the .05 level indicated by an *.

1986 to summer 1991, not cut and salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	11.90	.0009
Total shrub cover	3.78	.0556
Total grass cover	.39	.5365
Total species	1.73	.1924
*Height	42.38	.0001

1986 to summer 1991, cut and not salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	26.50	.0001
*Total shrub cover	2.76	.1010
*Total grass cover	61.42	.0001
*Total species	17.31	.0001
*Height	21.99	.0001

1986 to summer 1991, cut and salted (includes burned)

<i>Variable</i>	<i>F</i>	<i>p>F</i>
*Total cover	10.10	.0021
*Total shrub cover	14.34	.0003
*Total grass cover	71.51	.0001
*Total species	1.73	.1924
*Height	42.38	.0001

Table 8: Two way parametric ANOVA investigating the relationship between cutting and salting through time. Model: Variable = cut salt date, in SAS PROC GLM. All values are for Type I tests.

1986 to summer of 1987 (first season of recovery)

<i>Variable</i>	<i>CUT</i>		<i>SALT</i>		<i>DATE</i>	
	<i>F</i>	<i>p>F</i>	<i>F</i>	<i>p>F</i>	<i>F</i>	<i>p>F</i>
Total cover	119.7	.0001	.06	.8123	162.2	.0001
Total shrubs	24.2	.0001	4.5	.0344	24.5	.0001
Total grasses	61.9	.0001	8.0	.0049	106.8	.0001
Total species	64.4	.0001	1.1	.3042	68.9	.0001
Height	145.7	.0001	.04	.8478	428.2	.0001

1986 to summer of 1991 (final sample)

<i>Variable</i>	<i>CUT</i>		<i>SALT</i>		<i>DATE</i>	
	<i>F</i>	<i>p>F</i>	<i>F</i>	<i>p>F</i>	<i>F</i>	<i>p>F</i>
Total cover	9.5	.0023	.03	.8616	57.0	.0001
Total shrubs	7.1	.0080	2.4	.1252	.36	.5465
Total grasses	44.9	.0001	5.7	.0179	60.6	.0001
Total species	1.3	.2651	.93	.3351	28.6	.0001
Height	12.5	.0005	1.8	.1842	29.1	.0001