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THE ESTABLISHMENT OF *SCIRPUS OLNEYI* UNDER CONTROLLED WATER LEVELS AND SALINITIES

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ABSTRACT

From January 1973 to September 1974, a study was conducted at Rockefeller Refuge, Grand Chenier, Louisiana to determine the effects of irrigating *Scirpus olneyi* with various concentrations of salt water during drought periods. *Scirpus olneyi* was established in 12 one-tenth-acre impoundments and subjected to 6 water level and salinity treatments. Drying ponds for 1 and 3 months before the treatments were initiated had no measurable effects on culm density. The 20 ppt salinity treatments reduced culm density, but the 10 ppt salinity treatments and wet and dry controls had little or no effect on plant growth. The 6 experimental treatments had no effect on rhizome growth. Rhizome volume increased throughout the study.

INTRODUCTION

One of the most productive ecosystems in nature is the brackish marsh which totals 1,186,000 acres in Louisiana (St. Amant 1959; Chabreck 1972). The brackish marsh is an area where nutrients from saline water intergrade with fresh water to produce favorable conditions for plant growth. One of the major plant species in this marsh type is Olney bulrush (*Scirpus olneyi*)[a], a preferred food of muskrats (*Ondatra zibethicus*)[b] and snow geese (*Chen caerulescens*). O'Neil (1949) stated that *S. olneyi* made up 80 percent of the muskrat's diet in brackish marsh in Louisiana during the time of his study. Harris and Webert (1962) found that the large culms and rhizomes of *S. olneyi* were utilized by nutria (*Myocastor coypus*) as food. Ross (1972) also concluded that *S. olneyi* was a preferred food of nutria.

Brackish marshes support a greater muskrat population than other marsh types, and O'Neil (1949) reported that 80 percent of the muskrats trapped in the coastal zone during the 1940's were harvested from brackish marsh areas. The 1945-46 trapping season produced 8,337,411 muskrats, while the 1973-1974 trapping season produced only 286,087 muskrats (Linscombe personal communication, Fur Division, Louisiana Wild Life and Fisheries Commission, Baton Rouge, Louisiana, 1975). The decline in the muskrat catch parallels the deterioration of the brackish marsh areas. Areas once dominated by Olney bulrush and leafy three-square (*Scirpus robustus*) are now dominated by closed stands of two climax species, marshhay cordgrass (*Spartina patens*) and saltmarsh grass (*Distichlis spicata*). The later species are considered less valuable wildlife foods (St. Amant 1959).

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[a] Scientific nomenclature for plants follows Radford *et al.* (1968).
[b] Scientific nomenclature for animals follows Blair *et al.* (1968).

Because of the value of *S. olneyi* as a food for muskrat and snow geese, the present study was initiated to evaluate methods for managing established stands of *S. olneyi*. The objective of the study was to determine the growth response of *S. olneyi* subjected to summer drought and exposed to various water salinity treatments.

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MATERIALS AND METHODS

Twelve one-tenth acre impoundments, located 1 mile east of Rockefeller Refuge Headquarters, Grand Chenier, Louisiana, were used to conduct field studies during this project. *Scirpus olneyi* plants used during the study were collected in the vicinity of the refuge.

The impoundments used during the study were constructed by placing a levee system around a portion of marsh. The area was fenced to exclude nutria, muskrat, and swamp rabbits *(Sylvilagus aquaticus)* from the study area.

S. olneyi was planted in the impoundments after fence construction was completed. Planting dates were March 13, May 22 and July 22, 1973. Plant node spacings were 5 × 5 feet. Approximately 120 plant nodes were planted per pond.

Pumps were used to maintain water levels in the impoundments during the study. Water levels were kept slightly above the soil surface until the *S. olneyi* plants became established. Water levels were then increased to a range of 2 to 4 inches above the soil surface until the experimental treatments began on April 17, 1974.

The experimental treatments were set up to evaluate the effects of a summer drought and the reflooding of this drought area with various concentrations of salt water. The drying schedule, flooding schedule, and salinity concentrations for each impoundment are presented in Table 1.

Rock salt (NaCl), about 1cm in diameter, was used to attain the proper salinity concentrations in the ponds. The salt was dissolved in a 120-gallon water trough by circulating the water and salt in the trough with a centrifugal pump. The salt solution was then pumped into the ponds until the proper salinity concentration was reached (Table 1). Water salinities were monitored with a conductivity bridge.

S. olneyi was sampled four times during the study, two times before the ponds were treated and two times after the ponds were treated. Sampling dates were: April 12, July 27, September 1, and September 28, 1974. Nine one-quarter milacre sampling stations were established in each pond, and wooden surveyor stakes were used to designate the boundaries of the plots. A one-quarter milacre sampling frame, similar in design to the quadrat used by Hoffpauir (1961) and McNease (1967), was used. The frame was divided into 4 subplots, and the number of stems and height of *S. olneyi* in each subplot was determined on each sampling date.

Table 1. The drying schedule, flooding schedule, and salinity concentrations assigned to the experimental impoundments located at Rockefeller Refuge, Grand Chenier, Louisiana.

Treatment	*Pond Number*	*Drying Schedule*	*Flooding Schedule*	*Salinity (ppt)*
1	1, 2	April 17, 1974[a]		5
2	3, 4	June 14, 1974	July 18, 1974	10
3	5, 6	April 17, 1974	July 18, 1974	10
4	7, 8	April 17, 1974	July 18, 1974	20
5	9, 10	June 14, 1974	July 18, 1974	20
6	11, 12		April 17, 1974[b]	5

[a] An attempt was made to keep treatment No. 1 dry from April 17, 1974 to September 28, 1974.

[b] From April 17, 1974 to September 28, 1974 treatment No. 6 was kept at a water depth of 2 to 4 inches above the soil surface and at a salinity concentration of less than 5 ppt.

Water depth readings were recorded before and after water levels were altered in the ponds. Water depth gauges were placed in each pond to facilitate water depth determinations.

Rhizome samples were collected twice during the study, once before the ponds were subjected to the salt water treatments and again after the salt water treatments were initiated. A 4-inch-diameter stainless steel tube with a sharpened edge was used to collect the rhizome samples. A wooden sleeve, which was bolted to the tube, regulated the length of the sample. Three samples, each 8 inches long, were collected from each pond at both sampling dates. The unbroken cores were removed from the tube and divided into four 2-inch sections with a sharp knife. The plant rhizomes and roots were separated from the soil sections, and the volumetric displacement and depth stratification were calculated for each sample.

RESULTS AND DISCUSSION

Stem Growth and Density

Differences Among Treatments

Treatments 4 and 5, which were dried for 1 and 3 months respectively and reflooded with a 20 ppt concentration of salt water, had the lowest number of stems of *S. olneyi* per treatment (Figure 1). These two treatments had the most detrimental effects on plant growth. Plants began to turn brown and die in the ponds 10 days after the treatments were initiated. Seventy to 80 percent of the plants subjected to treatments 4 and 5 were dead 28 days after the treatments began. However, these differences were not great enough to be statistically significant ($P > .05$).

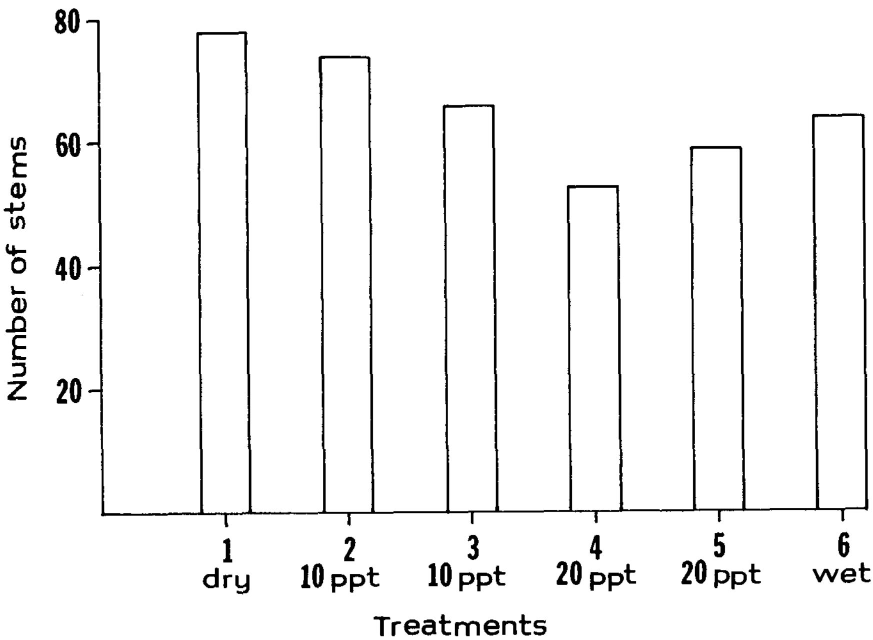

Figure 1. Average number of stems of *Scirpus olneyi* per experimental treatment with saline water.

Treatments 2 and 3, which consisted of drying the ponds for 1 and 3 months respectively, and reflooding with a 10 ppt concentration of salt water, had little or no effect on plant growth.

Little difference occurred between Treatments 1 and 6. Treatment 1 was kept dry, and Treatment 6 was kept at a water level of 2 to 4 inches above the soil surface at a salinity concentration of less than 5 ppt during the study. Treatment 1 was not kept totally dry during the entire study period because of excessive rains at that time.

Ross (1972) reported that salinities greater than 10 ppt were detrimental to the growth and survival of *S. olneyi*. Data collected during this study substantiate Ross's findings. Salinities at 20 ppt had a detrimental effect on the growth and survival of *S. olneyi*, while salinities at 10 ppt and wet and dry controls seemed to have little or no effect on plant survival and growth. The difference between treatments was probably not statistically significant because of the variation in elevation within each pond. The eastern side of each pond had a higher elevation than the western side. The difference in elevation caused poor water distribution when the ponds were treated with salt. Salinity concentrations were lower at higher elevations within the ponds. There would probably have been a greater difference among treatments if pond elevations had been equal.

Treatments 2 through 5 were subjected to simulated drought periods before the impoundments were subjected to the increased salinity concentrations. Ponds in Treatments 2 and 5 were dried for 1 month, and ponds in Treatments 3 and 4 were dried for 3 months. The results indicate that drying of the ponds 1 month and 3 months before reflooding with salt water had no effect on the growth and density of *S. olneyi* (Table 2). The average number of stems of *S. olneyi* for all ponds increased from the April sampling date to the July sampling date. The average number of stems would probably have remained the same or decreased from April through July if the drying periods had affected plant growth.

Differences Among Sampling Stations

The average number of stems of *S. olneyi* differed among sampling stations within ponds ($P < .01$). The greatest difference occurred within Treatments 4 and 5 which were subjected to salinities of 20 ppt. Sampling stations 7, 8, and 9 in Treatments 4 and 5 did not receive the full impact of the salinity treatments because of elevation differences and poor water distribution within the ponds.

Differences Among Sampling Dates

Vegetation was sampled four times during the study period (Table 2). The average number of stems of *S. olneyi* increased from Period 1 (April 12) to Period 2 (July 27). Experimental salinity treatments were initiated in July and the average number of stems of *S. olneyi* decreased significantly ($P < .01$) by Period 3 (September 1). A further decrease was noted by Period 4 (September 28).

The reduction in stems in Treatments 4 and 5 indicates that a 20 ppt salt concentration is detrimental to the growth of *S. olneyi*. The slight reduction in stem numbers in the remaining treatments was probably due to handling. Stem breakage caused the culm to turn brown and die above the break. Palmisano (1967) indicated that most culms of *S. olneyi* were dead by October. Some of the stems of *S. olneyi* could have died naturally during the later part of treatment period.

Table 2. Mean number of stems of *Scirpus olneyi* per plot[a] by experimental treatments and sampling dates.

	Experimental Treatments[b]						
Sampling Dates	*1*	2	3	4	5	6	*Mean*
April 12, 1975	79.63	57.75	54.53	63.43	62.07	54.72	62.02
July 27, 1975	117.53	88.93	74.43	88.36	85.74	87.96	90.49
September 1, 1975	74.42	78.92	63.26	34.72	43.78	63.00	59.68
September 28, 1975	42.76	68.53	71.82	27.50	42.50	49.36	50.41
Mean	78.59	73.53	66.00	53.50	58.52	63.76	

[a] Plots were ¼ milacre in size.

[b] Water salinities were as follows:
Treatments 1 and 6: 5 ppt
Treatments 2 and 3: 10 ppt
Treatments 4 and 5: 20 ppt

Rhizome Growth

Six soil cores were collected from each pond to determine the effect of salt concentrations on the growth and density of S. *olneyi* rhizomes. Collections were made on two dates: June 6 (6 weeks before salt application) and September 28 (10 weeks after salt application). The volume and depth were determined for the rhizomes in each sample. Eight sources of variation were evaluated to determine their effect on the growth and density of S. *olneyi* rhizomes.

Differences Among Treatments

The six experimental treatments had no significant effect ($P > .05$) on the growth of S. *olneyi* rhizomes in the one-tenth acre ponds (Figure 2). Mean volume of rhizomes for the various treatments ranged from 2.40 to 3.89 ml per treatment. Palmisano (1970) reported that the root/shoot ratio was reduced for S. *robustus* and S. *olneyi* with increasing salinity levels, and culm growth was more restricted than root growth. Treatments 3 and 4, which were subjected to 20 ppt salinities, had severely restricted culm growth while root growth increased. Although there was an apparent difference among treatments, the absence of a statistical difference probably resulted from variation in root growth due to variation in elevation within each pond. The variation in elevation caused variation in salinity concentrations within the treatments.

Differences Between Sampling Dates

The mean volume of rhizomes for all samples increased from 2.78 ml at Date 1 (June 6) to 3.70 ml at Date 2 (September 28). The apparent difference between Dates 1 and 2 was caused by the growth of S. *olneyi* rhizomes between sampling dates. Increased rhizome growth could have resulted from the salinity treatments or could have occurred naturally. However, the statistical analysis indicated that the differences between dates were not significant ($P > .05$).

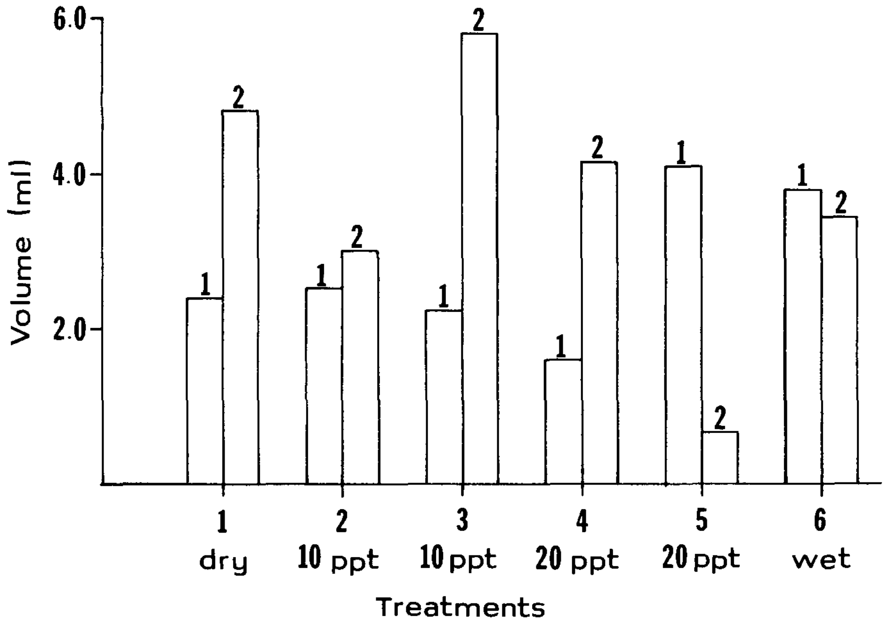

Figure 2. Average volume (ml) of *Scirpus olneyi* rhizomes for various treatments at two sampling dates (Date 1, June 6, 1974; Date 2, September 28, 1974).

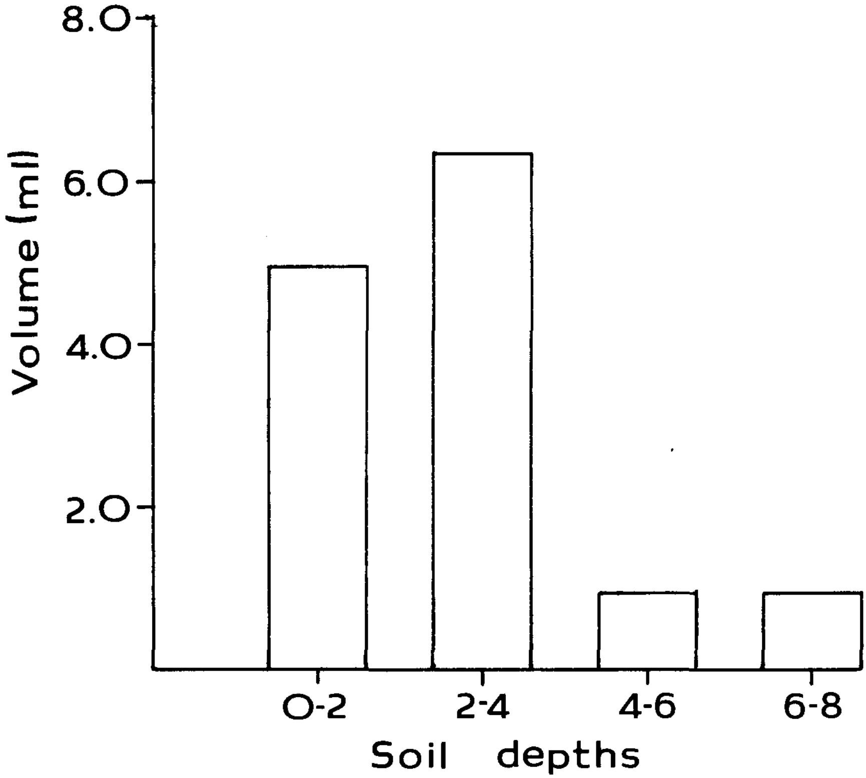

Figure 3. Average volume (ml) of *Scirpus olneyi* rhizomes at various soil depths.

Differences Among Soil Depths

There was a highly significant difference ($P < .01$) in the volume of rhizome production among core sections (Figure 3). Seventy-one percent of the rhizomes were within 4 inches of the soil surface. Palmisano (1967) reported that 97 percent of the *S. olneyi* rhizomes collected at the Meaux study area, which is similar to the Rockefeller study area, were within 4 inches of the soil surface. Variation among core sections was due to the shallow root system of *S. olneyi* and apparently was not affected by salinity.

SUMMARY AND CONCLUSIONS

S. olneyi was successfully established in 12 one-tenth acre impoundments by planting. Root stock was planted three times (March, May, and July 1974). A combination of high water levels and crawfish predation caused the first planting to fail. Methyl parathion was used to eliminate crawfish from the area. High water levels, which inundated the entire study area to a depth of 24 to 36 inches for 2 weeks, killed 80 to 90 percent of the *S. olneyi* after the second planting. The third planting was successful.

S. olneyi was planted at 5 × 5-foot spacings as recommended by Palmisano (1967). Plants were buried to a depth of 4 to 6 inches below the soil surface to insure adequate rooting and soil moisture levels during dry periods as recommended by Ross (1972).

Optimum growth was obtained when water levels were maintained slightly below the soil surface. Each time water levels were lowered, the growth of *S. olneyi* was stimulated by soil aeration. After the third planting, water levels were kept slightly below the soil surface for approximately 6 weeks until the plants became established. After the plants were established, the impoundments were flooded to a depth of 2 to 4 inches above the soil surface. Flooding reduced competition from other plants and curtailed swamp rabbit depredation.

Nutria and swamp rabbits caused depredation problems throughout the entire study in spite of attempts to exclude them by fencing. Palmisano (1967) and Ross (1972) reported depredation problems from nutria, muskrats, and geese on newly planted stands of *S. olneyi*. Evans (1970) found that carrots covered with zinc phosphate and placed on floating rafts was an effective method for poisoning nutria, but it was not used during this study. Instead, nutria and swamp rabbits were live-trapped and moved from the study area.

Ross and Chabreck (1972) conducted and concluded from tank studies that optimum growth of *S. olneyi* occurred at 5 to 10 ppt salinities. During the present study, a 10 ppt salt concentration was best for *S. olneyi* growth, while a 20 ppt salt concentration was detrimental to plant growth. Detrimental effects of the 20 ppt salt concentration were noticeable 10 days after the initial salt application. A total of 26,280 pounds of salt (NaCl) were applied for the 4 salinity treatments in order to maintain the desired water salinity concentrations. The combined acreage of the ponds treated with salt water was 0.8 acre.

Although the 20 ppt salinity concentration reduced culm density, it had no apparent effect on the growth of *S. olneyi* rhizomes. Rhizome growth increased throughout the study for all treatments. Palmisano (1970) concluded that rhizome growth influenced by salinity may be an important aspect of perennial grasses and sedges because rhizomes constitute a major portion of the diet of fur-bearing animals and waterfowl in the coastal marshes.

The present study indicated that *S. olneyi* could be established in small impoundments. Large impoundments, which are used for waterfowl management in the Chenier Plain marshes of southwestern Louisiana, could also be managed for *S. olneyi* production. Palmisano (1967) reported that the use of airboats may make marsh vegetation plantings practical on a large scale. Impoundments located in brackish areas, with salinities of 5 to 10 ppt and water depths from 0 to 4 inches, would probably be the best place to initiate *S. olneyi* plantings on a large scale.

The success of any *S. olneyi* management program would depend upon the maintenance of proper water levels and salinities and the control of animal depredation. Animal depredation could be a major limiting factor for the establishment of *S. olneyi* on a large-scale basis.

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