FACTORS AFFECTING THE GROWTH AND SURVIVAL OF NATURAL AND PLANTED STANDS OF *SCIRPUS OLNEYI*

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ABSTRACT

Various factors were tested to determine their effects on natural and planted stands of *S. olneyi* in coastal marshes of Louisiana. Factors tested were soil type, water level and salinity, site preparation, planting date, vegetative type, and effects of animal feeding.

Burning, tilling, and a combination of burning and tilling were tested as means of site preparation. Tilling alone was the best method tested and burning alone the poorest method; nevertheless, survival in the burned area was almost twice that in the area with no site preparation.

Plantings in the fresh, intermediate, brackish and salt marsh showed that a combination of best growth and survival occurred in the intermediate marsh. Growth was equal in 4 soil types tested.

Water level was a primary factor affecting growth and survival of stands. Overall growth and survival was best at 2 and 4 inches above the soil surface. Best water salinities for growth were 10 and 5 ppt, but effects of higher water salinities were reduced at deeper water levels.

Best monthly survival occurred in December and January plantings each having a survival of 100 percent. July was the poorest month with only 47.50 percent of the plants surviving.

INTRODUCTION

During the mid 1940's the harvest of muskrat *(Ondatra zibethicus)* along the Louisiana coast ranged upward to 8 million animals (O'Neil, 1949). Highest muskrat concentrations were associated with marshes dominated by the sedge, Olney bulrush *(Scirpus olneyi).* The value of *S. olneyi* to muskrat has been reported by various writers (Authur, 1931; O'Neil, 1949), and brackish marshes have been described as the vegetative type in Louisiana supporting highest muskrat populations (Palmisano, 1972).

The plant is used as food by Nutria *(Myocaster coypus)* (Harris and Webert, 1962), and nutria from a marsh with an abundance of *S. olneyi* usually have high quality pelts. The plant is also a choice food of blue and snow geese *(Chen caerulescens)* and the birds will often remain in a burned *S. olneyi* marsh feeding on the roots and rhizomes of this plant until an "eat out" is formed (McIlhenny, 1932; Lynch et al., 1947).

The distribution of *S. olneyi* has been greatly reduced in Louisiana since the 1940's and a survey in 1968 revealed that the species made up only 2.2 percent of the plant growth in the Louisiana Coastal Marsh (Chabreck, 1970). Principle factors associated with the decline are increased water level fluctuation and salt

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water intrusion associated with canals dredged for navigation, pipelines, and drainage.

Many landowners along the Louisiana coast manage marshes for the fur production and are interested in methods of establishing stands of *S. olneyi.* Almost 2 million acres of marshland lie within the intermediate and brackish vegetative types and could be potential sites for establishment of the plant. Palmisano (1967) tested seeds and rhizome nodes in experimental plantings and recommended the use of nodes because of low seed viability. Consequently, this study was set up to determine the growth requirements of the species and to evaluate the factor affecting the establishment of stands of the plant.

STUDY AREAS

Field studies were conducted on the Rockefeller Wildlife Refuge and adjacent marshes in southwestern Louisiana and tank studies on the Ben Hur Experiment Station in Baton Rouge. Rockefeller Wildlife Refuge is owned by the Louisiana Wild Life and Fisheries Commission and borders the Gulf of Mexico. Experimental planting of *S. olneyi* were made in saline, brackish, intermediate and fresh vegetative types on and adjacent to the refuge. Characteristics of each vegetative type were described by Palmisano and Chabreck (1972) and Chabreck (1972).

The Ben Hur Experiment Station is a part of the Agricultural Experiment Station at Louisiana State University. Tanks used for the study were set up under greenhouse conditions.

METHODS AND MATERIALS

Studies were established to test factors affecting the survival and growth of *S. olneyi* when planted to establish artificial stands. Factors tested during field studies were site preparation, vegetative type, and nutria predation. Tank studies were designed to test soil type, water levels and water salinities, and month of planting.

In order to assess the effects of marsh management practices on establishment and growth of *S. olneyi,* planted stock was exposed to various treatments: burning, tilling and a combination of burning and tilling. An undisturbed area served as the control.

Tilling was accomplished with a rotary tiller mounted on the rear of a marsh buggy which cut to an average depth of 6 to 8 inches. Areas were first treated and then sample plots were randomly located on these treated areas.

Four plots were established on each of the treatment areas enclosed with weldwire. Planting stock was dug from a natural marsh and rhizome nodes with culms attached were used for planting. Four nodes were planted in each plot to a depth of 4 inches and 3 feet apart. Similar plots were established to evaluate planting in 4 vegetative types: saline, brackish, intermediate and fresh.

Nutria predation was evaluated by placing nutria in 0.1 acre pens planted with *S. olneyi* at 3-foot s)acing. A nutria was placed in Pond I 3 weeks after planting and another in Pond II 13 weeks after planting. Exclosures were used in the pens to establish controls.

S. olneyi growth response was tested on 4 soil types including the Lake Pontchartrain marsh soil from which planting stock was obtained, Rockefeller Refuge brackish soil where field plantings were made, Ben Hur loam which was used for tank studies, and coarse sand. Plastic pots were filled with each soil and 4 nodes planted in each. The pots were placed in metal tanks and submerged in freshwater to the level of the soil surface. The test had 2 replications and 1 repeat observation.

The survival and growth of *S. olneyi* at various water salinities and water levels was tested with planting in plastic pots placed in metal tanks. Five salinity levels of 0, 5, 10, 15 and 20 parts per thousand were chosen and were randomly assigned to 20 tanks, four tanks per salinity level. Five water levels for each tank were also selected: +4, +2, 0, -2, and -4 inches about the soil surface. In order to establish five water levels in each tank, platforms were constructed to hold the planting containers at the various heights.

For this test, 500 pots were used and 1 node was planted in each. The pots were then placed in pools with freshwater at the soil surface until the plants became well established. They were then placed in the tanks and subjected to the various water levels and salinities with 5 replications per treatment.

The planting date was tested for 11 months by collecting 40 nodes each month and planting them at rates of 2 nodes per pot in each of 20 pots. The pots were placed in one tank and the survival rate ascertained after one month. The data from all tests were submitted to analysis of variance (Snedecor, 1950).

RESULTS AND DISCUSSION

Site Preparation for Planting

S. olneyi plantings were made in brackish marsh treated to remove competition from other species by burning, tilling and a combination of burning and tilling. The first planting was made on May 1, 1971 and the second on May 15, 1971. During this time, the marsh was extremely dry and both plantings were complete failures. Water levels ranged from four to eight inches below the soil surface. Salinities ranged from 16 ppt at the time of the first to 17 ppt during the second planting.

The third planting was made on March 21, 1972. Water level at this time was four to six inches above the soil surface and water salinity was 8 ppt. The results of this planting are shown in Table 1 and the values presented are the means of the nested plots within each treatment. The differences between treatments was highly significant ($P < 0.01$) for the three variables measured.

Orthogonal comparisons were made among treatments to determine where the significance lay. Growth and survival in the till-only area was found to be significantly superior ($P < 0.01$) when compared to all other treatments. Burning combined with tilling ranked as second best treatment, and burning alone had the lowest survival of the treatments tested, but still showed a survival three times greater than areas with no site preparation.

Survival in Different Vegetative Types

No plants survived the first planting in the four vegetative types during June 1971, because of drought conditions following planting. A second planting was made March 21, 1972, and the mean values within each vegetative type are given in Table 2. The vegetative types are mostly a product of salinity (Chabreck, 1970), and the salinity values for the planting sites are shown in Table 3.

Plants in the fresh type produced the highest average number of stems, 18.62; however, plants in the intermediate type exhibited the best survival and height, 100 percent and 39.08 inches respectively. No plants survived in the salt marsh, thus no stem or height figures were available for these plants. Differences between vegetative types were highly significant ($P < 0.05$) for the three variables tested.

Table 1. Mean growth and survival of *Scirpus olneyi* on plots exposed to four site preparation treatments at Price Lake, Rockefeller Refuge, Grand Chenier, Louisiana, March 1971.

Treatment	Number of stems	Percent survival	Height (in.)
Control	0.50	25.00	22.75
Burn	1.06	62.50	17.56
Till	4.88	100.00	16.11
Burn & Till	3.31	81.25	16.06

Table 2. Mean growth and survival of *Scirpus olneyi* plantings in different vegetative types at Rockefeller Refuge, Grand Chenier, Louisiana.

Vegetative type	Number of stems	Percent survival	Height (in.)
Fresh marsh	18.62	93.75	34.93
Intermediate marsh	8.50	100.00	39.08
Brackish marsh	1.06	62.50	17.56
Salt marsh	0.00	00.00	00.00

Table 3. Water salinity during the first planting (May 1971), the second planting (March 1972), and the final measurement (April 1972) in the four vegetative types on Rockefeller Refuge, Grand Chenier, Louisiana.

Vegetative type	1st Planting	2nd Planting	Final Measurement
	salinity (ppt)		
Fresh Marsh	0	0	0
Intermediate Marsh	3	0	5
Brackish Marsh	16	8	9
Salt Marsh	18	23	16

Nutria Predation

Results of the nutria feeding study are graphically shown in Figure 1. The data are based on periodic stem counts over a period of approximately 26 weeks. Three exclosures within Pond 2 served as a control in this study. Continuous growth of the control plants throughout most of the study period indicates that reduction in green stems resulted primarily from nutria damage.

Damage inflicted by the nutria to plantings of *S. olneyi* was a result of actual feeding on the plants, trampling and breaking of the stems. Many of the plants in Pond 1, which had a nutria placed in it shortly after planting, were uprooted because the root systems were not well developed. Very few of the plants in Pond 2 were pulled from the soil because the root systems were well developed by the time a nutria was placed in the pond.

All parts of the plants, with the exception of the fibrous roots, were utilized. The primary parts utilized were the more succulent green stems and shoots, the soft basal portion of the stem, and the softer rhizomes. A plant was severely damaged during feeding whenever the nutria broke the green stems. Once a stem was broken, it soon turned brown and died above the break. Whenever water levels rose above these broken stems, photosynthetic activity was reduced to the detriment of the plants. Plants located on higher elevations along the edges of the ponds suffered little or no damage.

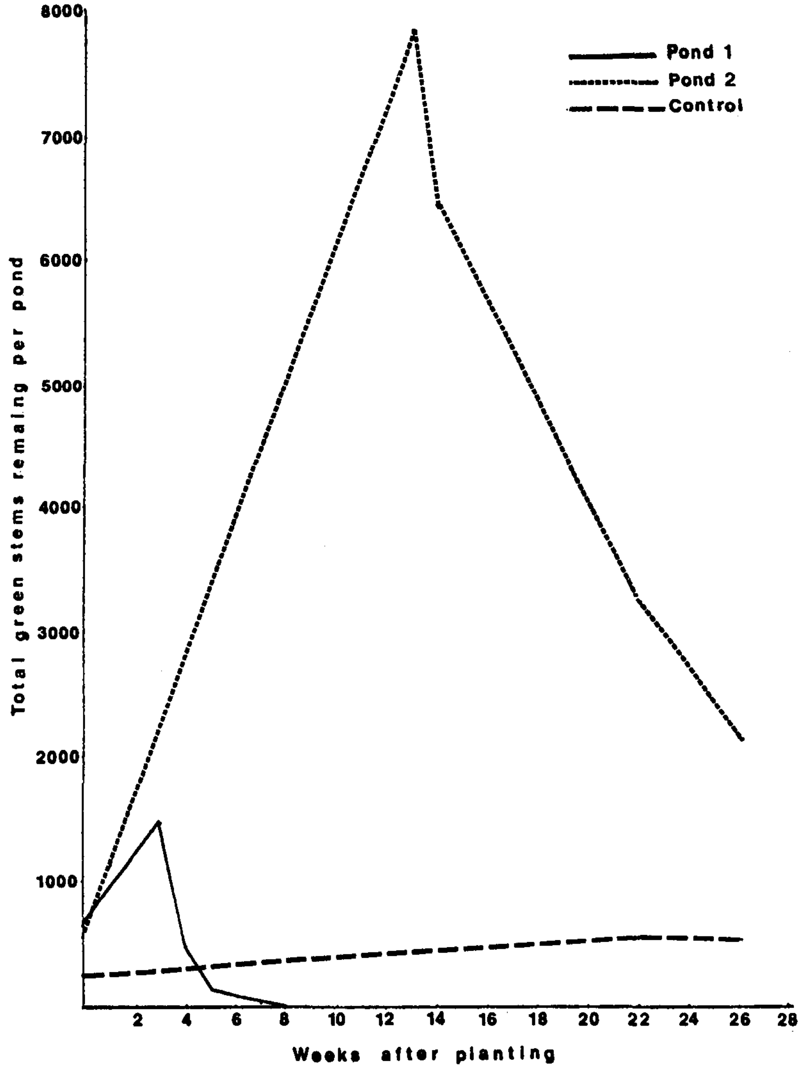

Figure 1: Extent of nutria damage expressed as total number of green stems per pond.

The present study supports the contention that *S. olneyi* is readily taken as food by nutria and gives some indication of the amount of damage possible, especially if consideration is being given to the idea of establishing new or artificially planted stands of *S. olneyi.* Palmisano (1967) reported heavy muskrat and nutria utilization of planted *S. olneyi* and felt that feeding on freshly planted root stock might be the cause of limited success in attempts to establish artificial stands.

Comparison of Soil Types

The effects of different soils on the growth and survival of *S. olneyi* are shown in Table 4. A significant difference ($P < 0.05$) among the four soils was noted for number of stems, while height resulted in a highly significant difference ($P < 0.05$).

An orthogonal comparison was made to determine if a significant difference in growth capabilities existed between the soil from Rockefeller Refuge and soil from Ben Hur Experiment Station. No significant difference was found in either number of stems or height, although a significant difference was found in survival.

The number of stems produced by plants in the soil from Lake Pontchartrain was significantly less than the number produced by either the soil from Rockefeller or that from Ben Hur, although height of the plants were approximately equal.

Percent survival of plants in the soil from Lake Pontchartrain and Ben Hur were equal, both being 81.25%. Rockefeller soil had the lowest survival, 62.5%, while pure sand had the highest survival with 100% of the plants surviving.

Table 4. Average growth of *Scirpus olneyi* in four soils.

Soil[a]	Number of stems	Height (in.)
1	3.25	24.67
2	5.69	35.45
3	8.25	34.87
4	9.31	35.30

[a]Soil 1 — pure sand
Soil 2 — muck soil from Lake Pontchartrain Marsh
Soil 3 — clay soil from Rockefeller Refuge
Soil 4 — clay soil from Ben Hur Farm

Table 5. Mean height of *Scirpus olneyi* by water salinity, water level, and date.

Water salinity	Date	Water level about the soil surface (in.) -4	-2	0	+2	+4	Mean
		Height in Inches					
0	1	47.80	51.05	52.86	55.04	56.83	52.72
	2	26.91	26.47	32.87	34.78	39.25	32.04
5	1	40.53	39.86	41.09	44.64	45.69	42.36
	2	13.90	17.28	17.59	25.62	31.81	21.24
10	1	36.21	35.65	35.61	41.81	40.24	37.91
	2	11.41	13.66	18.34	28.97	31.19	20.71
15	1	28.79	29.64	27.41	32.23	33.32	30.27
	2	9.35	10.76	16.83	21.14	27.78	18.66
20	1	25.98	26.32	21.88	26.11	26.21	25.28
	2	14.00	11.00	10.83	19.51	24.26	19.30
Mean	1	35.86	36.63	35.77	39.97	40.46	37.74
	2	15.87	17.82	20.44	26.01	31.03	22.93

Water Salinity and Water Level Effect

Salinity and water level significantly effected the three variables measured ($P < 0.01$). Two measurements were made on the plants, the first was made in August 1971, at the peak of growth and the second in March 1972, after die-back had occurred and new growth was beginning. Dates were found to have a highly significant effect as well as salinity by date and water level by date ($P < 0.01$).

Palmisano (1970) found that as salinity increased from 0 ppt culm growth of *S. olneyi* decreased until the upper limit of growth was reached at 21 ppt. Similar results were obtained in this study for salinity values at Date 1 and at the average of both dates (Figure 2). However, data for Date 2 showed that an increase in salinity from 0 ppt to 10 ppt had no effect on number of stems present. This was the result of a greater ratio of stem die-back at 0 and 5 ppt than at the 10 ppt salinity.

Water level had a similar effect on number of stems. At the first measurement (Date 1), water level effects were barely noticeable; however, the second measurement (Date 2) and the average of the dates indicated that water level caused a significant increase at the +2 and +4 water levels (Figure 2).

Overall the data obtained indicate that a salinity of 10 ppt is the upper salinity limit for best growth of *S. olneyi.* At the time of the first measurement, it appeared that best growth occurred at 0 ppt followed by 5 ppt and 10 ppt, but by the second measurement, differences between 0, 5, and 10 ppt were less evident. A tremendous amount of stem die-back occurred at the 0 and 5 ppt salinities causing stem numbers and overall height to equal those of 10 ppt salinity (Table 5).

Effects of water level became evident at Date 2. The data indicate that 2 and 4 inches of water above the soil surface resulted in significant increases in growth for all salinities with the possible exception of 0 ppt. At 5 and 10 ppt, 2 and 4 inches of water tremendously increased stem numbers over any other water level, with 4 inches providing the highest number of stems.

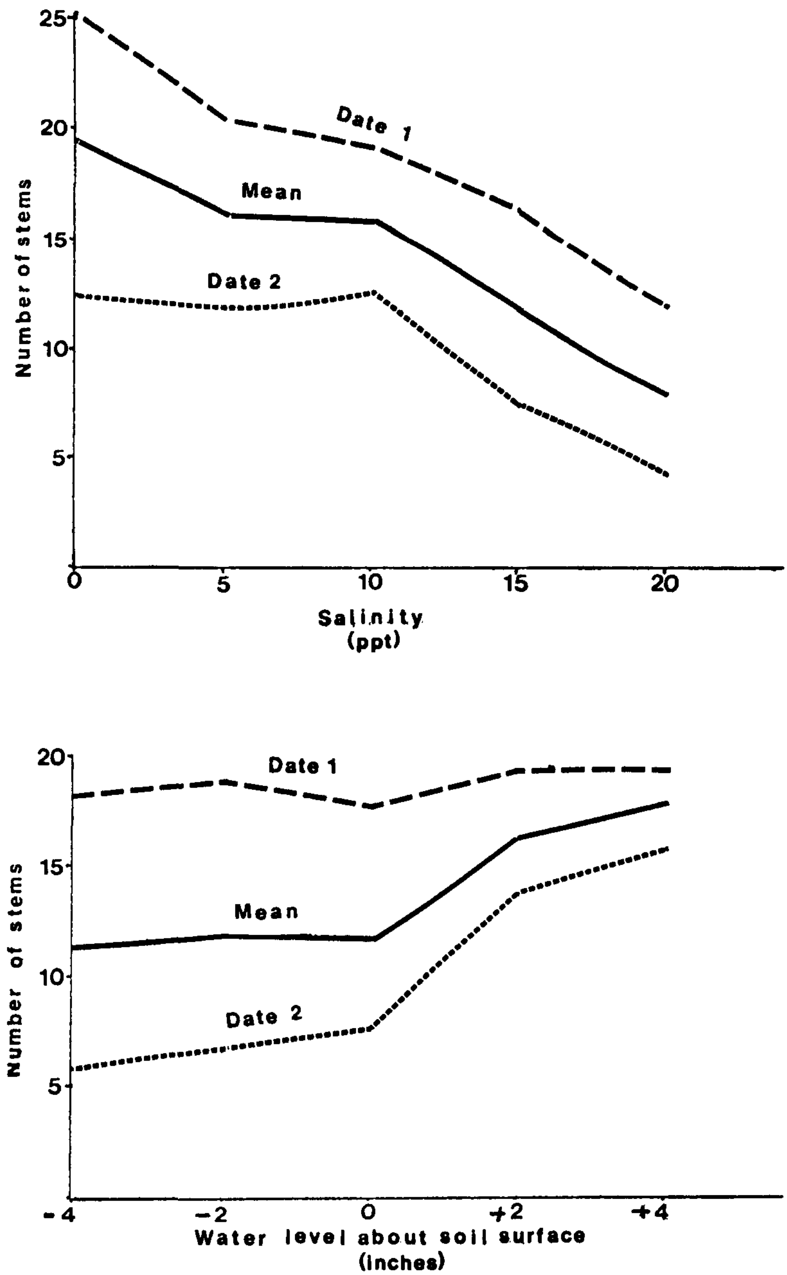

Figure 2: Average number of stems per plant by salinity and water level for third planting in tanks at Ben Hur

When the study was begun, percent survival was considered an adequate variable for showing differences between all water levels and salinities. However, by the end of the study, percent survival appeared to serve as a significant variable only at the higher salinities of 15 and 20 ppt. Survival of plants at 0, 5, and 10 ppt was essentially 100 percent for all water levels.

The data show that at high salinities water depth played an important part in the number of plants surviving. Water depth of 2 and 4 inches increased survival of plants at 15 ppt to 100 percent, while at 20 ppt, 2 inches increased survival to 100 percent, but fell to 87.50 percent at 4 inches.

Monthly Survival

The data indicate that the best time for transplanting *S. olneyi* is in December and January. Percent survival during each of these months was 100 percent. The month with the lowest percent survival was July with 47.50 percent.

Months of fast active growth appeared to have the lowest survival. Exact reasons for this are not known: however, since food reserves are low in the plant at this time, plant roots cannot develop adequately to provide the necessary water and nutrient up-take. Other causes of reduced survival during these months may be due to excessive drying from evaporation, transpiration rate, or high water temperatures.

MANAGEMENT IMPLICATIONS

Management of the marshes for *S. olneyi* whether natural or artificially planted, appears to depend primarily on maintenance of water levels and secondarily on salinity levels.

The data from this study indicate that maximum survival and growth occur when water levels do not fall below a minimum yearly average of 2 inches to 4 inches above the soil surface. Conclusions drawn by Palmisano (1967 and 1970) tend to bear this out.

Water levels are particularly important for the artificial establishment of stands. Both tank and field plantings indicate that from the time of planting until the plants are established, water levels are of particular importance. Plantings during the dry period of 1971 had no survival, while the survival for those planted in 1972 ranged from 100 percent in an intermediate marsh to 62 percent in a brackish marsh. Water levels at this time ranged from 2 to 6 inches in all marsh types.

Maintaining a water level of 2 inches above soil surface may be an impossibility in a large portion of the brackish marsh. One solution for maintaining water levels is the use of weirs. Chabreck and Hoffpauir (1962) discussed the effects of weirs in coastal marsh management in Louisiana. They found that the greatest effect of weirs was the stabilization of water levels, but they concluded that salinities were not greatly affected or controlled by weirs. The installation of Wakefield-type weirs in drainage systems has been successful in stabilizing water levels, although initial cost is high (Joanen, 1964).

A second alternative to maintaining water levels may lie in the use of impoundments. Impoundments are used in waterfowl management in the prairie marshes of Louisiana (Chabreck, 1960). Further research, however, is needed in this area since no plantings were made in impoundments.

Salinity appears to be of secondary importance in management because of the seemingly moderating effects of higher water levels on salinity influences. Also, since there is no practical or economic means of regulating salinities over large areas, management of existing stands of *S. olneyi* must be aimed at water levels; therefore, the primary effect of salinity appears to be that of a limiting agent. Planting studies at Rockefeller Refuge indicate that best growth and survival was in the intermediate marsh with a salinity of approximately 5 ppt. Although this salinity may be somewhat low for continued growth and survival, a need may be indicated for exploring the possibilities of planting in a brackish area with average annual salinity maximums of 5 to 10 ppt. Tank studies also indicate this need, since best growth and survival occurred at 5 and 10 ppt.

Means of artificially establishing stands of *S. olneyi* were also explored in this study. Three methods of site preparation in a wiregrass stand were used. Till-only was found to be the best means of site preparation prior to planting. This method of preparation far outranked either of the other two methods of preparation. Burn-only ranked a poor third as a means of site preparation.

Tilling, however, may not be feasible for the average land owner to use. Chandler (1969) discussed the feasibility of using a tiller mounted on a marsh buggy for preparing large areas of the marsh. He felt that use of this system was not practical for the average land owner, since initial cost of the buggy and tiller exceeded $20,000 and maintenance cost was approximately $10.00 per mile.

Chemicals were not used as a means of site preparation in this study. However, McNease (1967) and Soileau (1968) indicate that various soil sterilants may be used with success in reducing and controlling wiregrass and saltmarsh grass. Soileau found that the soil sterilant Bromacil caused a significant reduction of competition from these two species and increased growth of *S. robustus.* A combination of chemical treatment and burning was better than either of the two treatments alone.

Therefore, from an economic viewpoint, a combination of burning and chemical application may be the only site preparation treatment available to the average landowner at present.

Best months for planting appear to be December and January. February should be the latest planting month for best survival. Since considerable time and money would be expanded on any planting project, planting should be kept within this time period to obtain best survival.

Planting density is probably not critical. A spacing of six by six feet should be enough for adequate closure. Palmisano (1967) suggested that a five by five foot spacing would be adequate. Planting depth should be approximately four to six inches below soil surface to insure adequate rooting and also better soil moisture levels during dry periods.

Planting from the back of the tiller was planned for this study but a lack of plants and a tiller breakdown forced abandonment of this project. If a tiller is used in any planting attempt, the tilling of small plots or strips throughout the marsh should be sufficient for establishment of stands.

As stated earlier, water levels are particularly important. The water level should be at least two to four inches above soil surface for three to four weeks after planting. After plants are established, water levels can fluctuate, but excessive drying for long periods should be avoided.

Any attempt at planting should include some method of nutria and muskrat control. Evans (1970) found that carrots covered with zinc phosphide and placed on floating rafts was the best procedure for poisoning nutria. Extensive trapping, poison baits, or some form of exclosure must be used. Even a few animals can severely reduce planted stock.

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