ECOLOGICAL FACTORS AFFECTING OCCURRENCE OF *SCIRPUS OLNEYI* AND *SCIRPUS ROBUSTUS* IN THE LOUISIANA COASTAL MARSHES*

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INTRODUCTION

Technological advances in recent years have resulted in greater leisure time for the average American citizen. Participation in outdoor recreation such as hunting, fishing and camping has increased proportionately, resulting in more and more demand for areas offering facilities for these activities. Unfortunately the quality and quantity of such areas have been greatly reduced due primarily to exploitation by man. This same technology must now be used to improve and perpetuate the remaining areas so that optimum recreational benefits may be derived from them.

Louisiana contains an estimated 4,000,000 acres of coastal marsh which provides a livelihood and recreation for thousands of people through fishing, hunting and trapping. This vast area serves as the wintering ground for over 6,000,000 ducks, geese and coots, nearly one-fourth of the total United States' waterfowl population (Hansen and Hudgins, 1966). These marshes are also the leading fur-producing habitat in the nation. Over $4,000,000 worth of furs were taken in Louisiana during the 1964-1965 trapping season (O'Neil, 1966). This figure, however, is less than half of the value of muskrats (*Ondatra zibethicus*) alone in the 1946-1947 trapping season, when over 8,000,000 muskrat skins worth $8,029,746 were trapped (O'Neil, 1949). This decline in muskrat production closely parallels the reduction and deterioration of prime marshlands once dominated by two sedges, three-cornered sedge (*Scirpus olneyi*) and leafy three-cornered sedge (*Scirpus robustus*), long recognized as choice foods for muskrats and blue geese (*Chen caerulescens*) in Louisiana's coastal marshes.

In the brackish marshes of the state, these important plants are now excluded from vast areas by more competitive species such as couch grass (*Spartina patens*), saltmarsh grass (*Distichlis spicata*) and in some instances big cordgrass (*Spartina cynosuroides*), all of which tend to form closed stands. The reason or reasons for the inability of the choice sedges to successfully compete with these grasses are not clear. Therefore, this study was undertaken to investigate the basic ecological factors influencing establishment and growth of *Scirpus olneyi* and *Scirpus robustus* communities.

DESCRIPTION OF AREA

The study was conducted in the coastal marshes of southwest and southcentral Louisiana. Three study areas were located in Cameron Parish, and one was located at Cypremort Point in St. Mary Parish. Rockefeller Wildlife Refuge was the center of operation for the field studies.

* A contribution of the Louisiana Cooperative Wildlife Research Unit, Louisiana State University, Louisiana Wild Life and Fisheries Commission, Wildlife Management Institute and the U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, cooperating.

The coastal marshes are of Recent geologic age and rest on the oxidized and deeply dissected surface of the Prairie formation of late Pleistocene age (Russell, 1940; Byrne, 1959). The average depth of these Recent deposits is about 10 feet, gradually increasing to 25 feet near the Gulf of Mexico (Gould and McFarlan, 1959).

The marsh soils were derived from alluvial deposits of the Mississippi, Red and Atchafalaya rivers and are classified as organic soils containing from 50 to 80 percent organic matter. They are high in sulfides and chlorides and become strongly acid when drained and oxidized (Lytle, 1959; Chamberlain, 1957).

The vegetation of the marshes can be conveniently separated into three community types based primarily on the salinity tolerance of the plant species of which they are composed. The saline marsh forms a narrow band of approximately 0.5 mile in width adjacent to the beach rim. Vegetation is dwarfed and composed of only a few salt tolerant species. *Distichlis spicata, Spartina patens, Spartina alterniflora,* and *Juncus roemerainus* are the dominant species present in this marsh type. The saline marsh merges imperceptibly with the broad band of brackish marsh which is further removed from the sea rim and comprises the major marsh type in Louisiana. The brackish marshes can be considered an ecotone between saline and fresh marshes in which halophytic species decrease in frequency and abundance as salinity decreases and fresh marsh species increase. The most prevalent plant species, in order of decreasing abundance, in the brackish marshes are *Spartina patens, Distichlis spicata, Spartina alterniflora, Spartina cynosuroides, Scirpus robustus* and *Scirpus olneyi.* The fresh marsh type lies between the brackish marshes to the south and the rice growing prairie to the north. Water levels are generally deeper and plant species more diverse than in either of the other marsh types mentioned. Major plant species present are giant bullwhip (*Scirpus validus*), roseau cane (*Phragmites communis*), bulltongue (*Sagittaria* sp.), alligator weed (*Alternanthera philoxeroides*), cattail (*Typha* sp.), cutgrass (*Zizaniopsis miliacea*), water-hyacinth (*Eichhornia crassipes*), millets (*Echinochloa* sp.), and *Spartina patens.*

STUDY PROCEDURE

Transect Studies

Line transects were run through stands of *S. robustus* and *S. olneyi* and into the adjacent communities. Soil, water and vegetation composition samples were collected along the transect lines. The composition of the plant species was determined by clipping five randomly selected 1 square foot (6 by 24 inches) quadrats at each sampling point. Percent vegetative composition was calculated on the basis of oven dry weights of the individual species comprising each sample.

Germination Experiments

Germination experiments were conducted in commercial seed germinators to determine optimum germination conditions for the sedges. Seeds were collected by hand, cleaned with an Erickson seed blower and stored dry in a refrigerator. A single petri dish containing 100 seeds evenly distributed over two layers of moistened filter paper represented a single replication in each experiment.

Five different environmental conditions were used to determine optimum conditions for germination.

1. Alternating condition, 20°C (62°F) for 10 hours in darkness and 14 hours of light at 35°C (95°F) per day.
2. Alternating condition, 20°C for 10 hours and 30°C (86°F) for 14 hours in constant darkness.
3. Constant condition, 20°C in total darkness.
4. Constant condition, 21°C (70°F) light 24 hours.
5. Constant 3°C in refrigerator.

The effects of various salinity levels on the germination of *S. olneyi* and *S. robustus* were tested using serial dilutions of strongly saline canal water (26,000 ppm) and a solution of 30,000 ppm of sodium chloride. Three replications were tested at each salinity level. The seeds were germinated under condition No. 1 and moistened with 5.0 ml of saline solution.

Chemical analyses of soil and water samples were conducted following the procedures given by Page (1965), Richards (1954), and Am. Pub. Health Assoc. (1955).

RESULTS AND DISCUSSION

Transect Studies

The Meaux Study Area consisted of a transect line through an unusually good stand of *S. olneyi*. Figure 1 shows a profile of the area. A summary of the factors correlated with plant distribution is illustrated by the graphs below. Correlation coefficients were calculated between the distribution of the vegetation and the environmental factors measured (Table 1).

TABLE 1 — CORRELATION COEFFICIENTS FOR FACTORS AT THE MEAUX STUDY AREA.

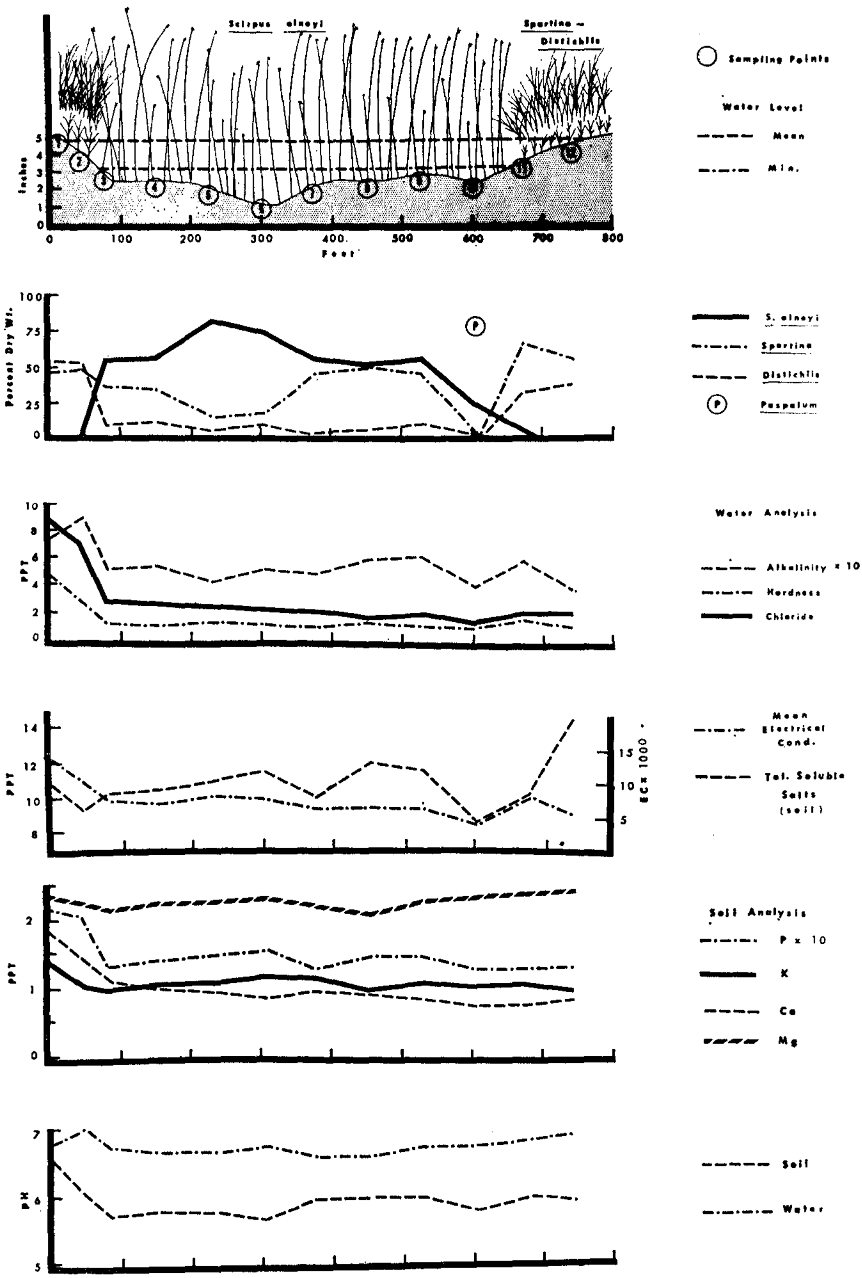
	Scirpus olneyi		*Spartina patens*		*Distichlis spicata*	
	Entire Transect	Less Sampling Stations 1 & 2	Entire Transect	Less Sampling Stations 1 & 2	Entire Transect	Less Sampling Stations 1 & 2
Water level	+.843**	+.905**	—.691*	—.686*	—.683*	—.890**
pH soil water	—.751**	—.651*	+.320	+.241	+.836**	+.790**
pH soil	—.601*	—.449	+.510	+.641*	+.661*	+.290
Chloride	—.478	+.373	+.221	+.085	+.763**	+.114
Hardness	—.467	+.234	+.248	+.305	+.733	+.116
Magnesium	—.402	—.475	+.006	+.002	+.382	+.616
Phosphorous	—.378	+.644	+.159	—.208	+.725*	—.258
Alkalinity	—.373	+.258	+.384	+.391	+.649*	—.127
Calcium	—.364	+.486	+.233	+.090	+.669*	—.283
Elec. Cond. soil water	—.360	+.346	+.339	+.343	+.725*	+.106
Tot. Salts soil	+.042	—.158	+.359	+.472	+.072	+.553
Potassium	—.040	+.506	—.051	—.281	+.358	—.170

**—Highly significant at .01 level.
*—Significant at .05 level.

Water level was the most important factor influencing the distribution of plant species in the study area. A highly significant positive correlation was found between water level and the distribution of *S. olneyi*. The boundary of this community closely coincided with minimum water level recorded during the study. The marsh floor, at this time, was covered by 0.5 to 2.0 inches of water in the *S. olneyi* community. Minimum water levels in the adjacent *Spartina-Distichlis* community ranged between —0.5 and —4.5 inches. A significant negative correlation was found between these two species and water level. During periods of highest recorded water level in late August, the entire marsh was covered by 4 to 8 inches of water. Minimum water level was more important than either mean or maximum water level in affecting the distribution of plant species in this study area.

Chemical analyses of water and soil samples showed that only pH was correlated with the distribution of *S. olneyi*. A highly significant negative relationship was found between pH and this species. Bolen (1965), reported *S. olneyi* in Utah growing at a pH of 8.0 but found that an optimum range was between 6.0 and 7.0. The pH values at the Meaux Study Area ranged between 5.7 and 7.0 in the *S. olneyi* community and between 5.9 and 6.4 in the *Spartina-Distichlis* community. Water level and pH were found to be closely correlated and a controlled experiment would be necessary to determine if pH limited the growth of *S. olneyi*.

Figure 1. Meaux Study Area



Salinity, measured as electrical conductance or as total soluble salts in the soil, was not found to be related to the distribution of *S. olneyi* in this study area. Soil salinity ranged between 10,100 and 12,000 ppm in the *S. olneyi* stand and from 9,200 to 14,200 ppm in the *Spartina-Distichlis* community.

Chlorides and pH of the soil water were found to have a highly significant relationship to the distribution of *Distichlis spicata*. This species also correlates significantly with increasing concentrations of all ions except potassium and magnesium. These data indicate that this species is associated with high salinities and low water levels. *Spartina patens* showed no correlation with salinity but was associated with lower water levels.

The Little Constance Study Area, Figure 2, was located on either side of a recently constructed canal (1961) on Rockefeller Wildlife Refuge. Both sides of the canal supported unusually dense stands of *S. robustus*. This species invaded the disturbed area along the canal subjected to slight tidal fluctuation. The *S. robustus* community south of the canal was growing on the berm of the spoil levee in a zone of moderately high soil salinity (12,000 to 18,000 ppm) and deeper water levels (—6.0 to +5.0 inches). Significant correlation coefficients were found with increasing salinity and decreasing soil pH and magnesium concentrations. The community to the north of the canal was located on the slightly elevated natural levee where water levels ranged from —3.5 to +4.0 inches and soil salinity ranged between 14,100 and 21,000 ppm. The salinity was less than that of the adjacent *Distichlis* community which ranged between 20,700 and 26,300 ppm.

The Cypremort Point Study Area was selected because the *S. olneyi* community there represented one of the most stable and productive stands in the state. Significant positive correlations were found between magnesium, potassium and total soluble salts and the distribution of *S. olneyi*. Total soil salts ranged between 13,000 and 16,000 ppm in the *S. olneyi* community and between 2,300 and 9,400 ppm in the adjacent

TABLE 2 — CORRELATION COEFFICIENTS OF FACTORS AT THE LITTLE CONSTANCE STUDY AREA.

	Scirpus robustus		*Spartina patens*		*Distichlis spicata*	
	South Study Area	North Study Area	South Study Area	North Study Area	South Study Area	North Study Area
Tot. salts soil	+.997**	—.822	—.761	—.176	—.249	+.352
Alkalinity	+.846	—.807	—.679	—.624	—.166	+.740
Water level	+.763	—.363	—.869	—.769	+.203	+.809
Magnesium	+.759	—.321	—.998**	+.461	+.386	—.293
Chloride	+.651	—.796	—.656	—.644	+.055	+.739
pH soil	+.602	+.123	—.983**	+.265	+.570	+.249
Potassium	+.578	—.099	—.813	+.420	+.367	—.394
Phosphorous	+.501	+.569	—.407	—.012	—.091	—.014
Calcium	—.399	+.428	—.055	+.467	+.594	—.495
Hardness	—.337	—.789	+.252	—.595	+.092	+.703
Elec. Cond. soil water	—.130	—.812	+.251	—.630	—.176	+.738
pH soil water	—.059	—.857	+.629	—.316	—.778	+.483

**—Highly Significant at the .01 level.

Spartina-Distichlis community. The distribution of *S. olneyi* was again associated with deeper water levels which ranged from —3.0 to +5.0 inches in this community. In the *Spartina-Distichlis* community, water levels ranged from —1 to —8 inches. *Spartina patens* reached is greatest abundance where salinity and water levels were lowest. *Distichlis spicata* dominated areas of moderate salinity and low water levels (Figure 3 and Table 3.)

Figure 2. Little Constance Study Area.

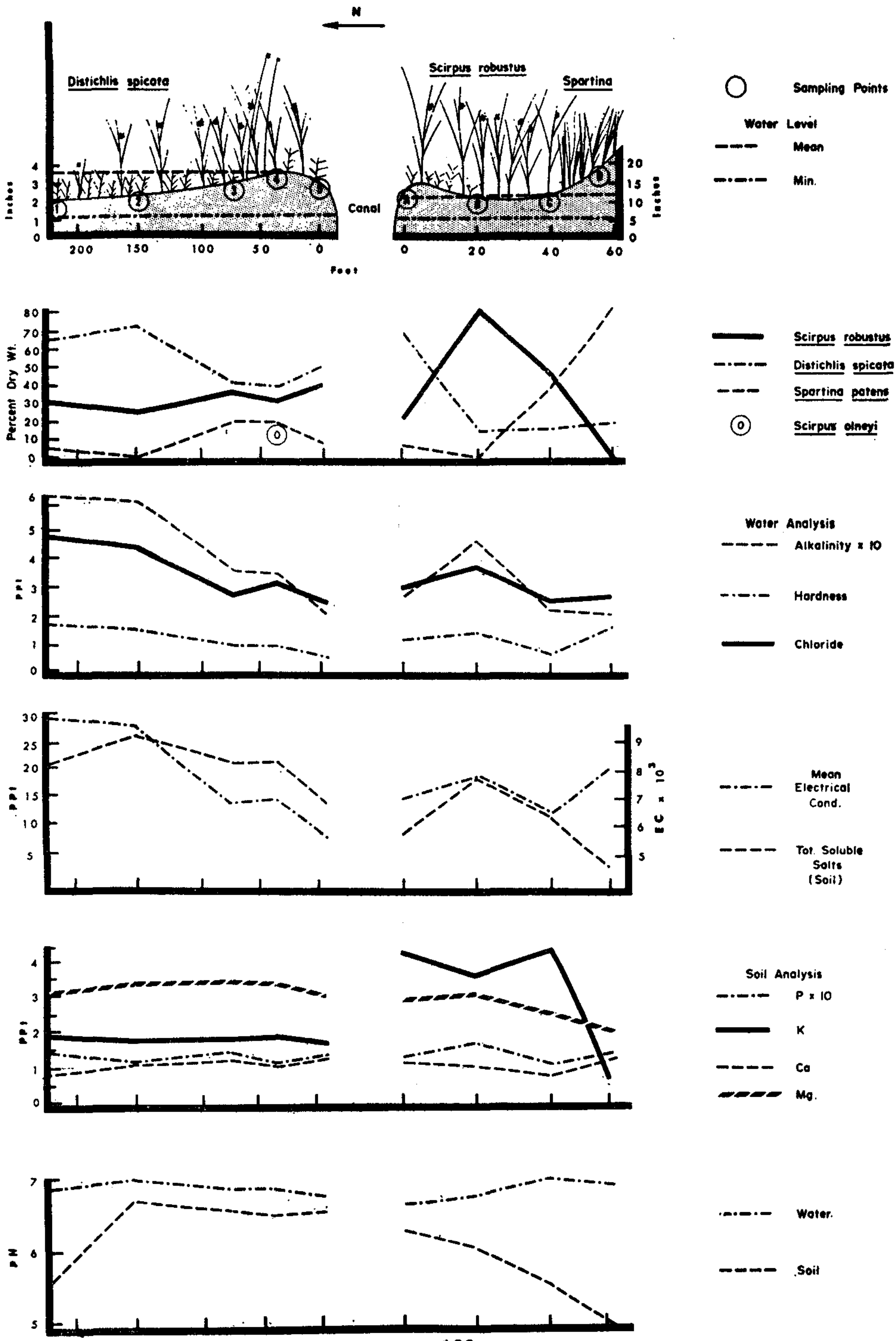


Figure 3. Cypremort Point Study Area

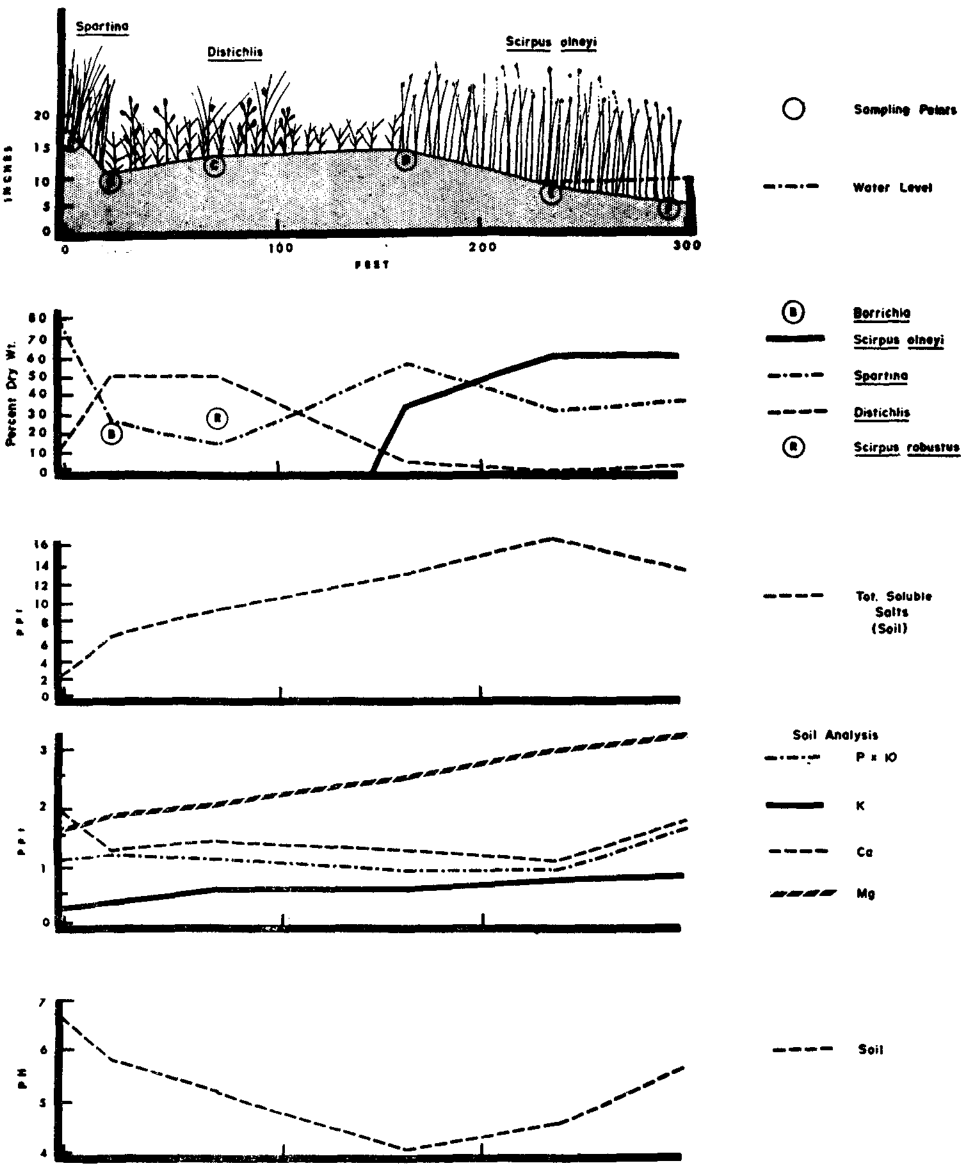


TABLE 3 — CORRELATION COEFFICIENTS OF FACTORS AT THE CYPREMORT POINT STUDY AREA.

	Scirpus olneyi	*Spartina patens*	*Distichlis spicata*
Magnesium	+.956**	—.301	—.646
Potassium	+.875*	—.457	—.490
Tot. salts soil	+.865*	—.428	—.523
Water level	+.618	—.736	—.049
pH soil	—.532	+.300	+.339
Calcium	—.336	+.656	—.097
Phosphorous	+.098	—.206	+.126

**—Highly significant at the .01 level
*—Significant at the .05 level

A summary of the environmental factors recorded for the various study areas is presented in Table 4.

Germination Experiments

Studies were conducted to determine the effects of temperature, light, salinity and water level on the germination of *S. olneyi* and *S. robustus* seeds. Optimum results were obtained in germinators set at 35°C with light for 14 hours and 20°C with darkness for 10 hours. No germination was recorded at the other conditions tested. Only 5 percent of 900 *S. robustus* seeds tested in total darkness germinated. Ninety percent of the seeds subjected to 14 hours of light per day germinated. Twenty-five percent of the *S. olneyi* seed tested germinated in light; none germinated in darkness. *S. robustus* began to germinate after 7 days in the germinator and continued to germinate for another 30 days. *S. olneyi* first germinated at 10 days and continued to germinate after 50 days.

Increased amounts of dissolved salts in a solution was found to significantly reduce the germination of *S. olneyi* and *S. robustus* seeds (Figures 4 and 5). Optimum germination occurred in distilled water. *S. robustus* germination was reduced 50 percent at a salinity level of 9,000 ppm. No *S. robustus* seed germinated above 21,000 ppm. Salinity level had a greater effect on *S. olneyi* seed germination which was reduced 50 percent at 4,000 ppm. No germination was recorded above 13,000 ppm.

Seeds of both species buried 1 inch and 2 inches below water level in pure quartz sand failed to germinate after 25 days in the germinator. When water level was reduced to a saturated condition, the seeds germinated normally. The seeds of both species were capable of sustained flotation (129+ days) and germination was recorded while floating.

TABLE 4 — RANGE OF ENVIRONMENTAL FACTORS RECORDED IN THE PLANT COMMUNITIES STUDIED.

	Scirpus olneyi		*Scirpus robustus*		*Spartina patens-Distichlis spicata*			
	Meaux Study Area	Cypremort Point Area	Little Constance North	South	Meaux Study Area	Cypremort Point Area	Little Constance North	South
Water level (inches)	+1.5a +8.0b	−3.0 +5.0	−3.5 +4.0	−6.0 +5.0	−3.0 +6.0	−8.0 −1.0	−2.0 +5.0	−22.0 +3.0
Tot. salts soil (ppt)	10.1 12.0	13.0 16.6	14.1 21.6	12.0 18.1	9.2 14.2	2.3 9.4	20.7 26.3	3.4 8.5
Magnesium (ppm)	2015 2292	2483 3300	3043 3327	2617 3060	2212 2424	1517 2070	3097 3284	2117 2950
Phosphorous (ppm)	129 154	96 151	123 135	126 161	130 211	114 122	123 139	140 142
Calcium (ppm)	860 997	1187 1523	1243 1343	917 1190	787 1760	1230 1913	787 1187	1287 1343
Potassium (ppm)	958 1158	537 783	1708 1875	3627 4373	983 1316	283 537	1708 1875	723 4320
Soil pH	5.7 6.0	4.1 5.5	6.5 6.6	5.6 6.1	5.9 6.4	5.2 6.6	5.6 6.7	4.8 6.3
Elec. Cond. (mmhos)	3.9 13.3		3.6 11.1	3.8 10.4	2.2 14.0		4.4 12.6	3.1 12.4
Soil water pH	5.8 7.9		6.4 7.2	6.4 7.5	6.0 8.4		6.2 7.8	6.2 7.8
Chloride (ppm)	1300 5950		1475 6400	2275 6250	1150 8600		2100 6800	1375 7000
Hardness (ppm)	500 2300		450 1650	550 2250	450 6000		600 1850	400 3100
Alkalinity (ppm)	175 630		140 490	195 890	210 1705		200 1640	170 365

a—Minimum
b—Maximum

Figure 4. Germination of Scirpus robustus

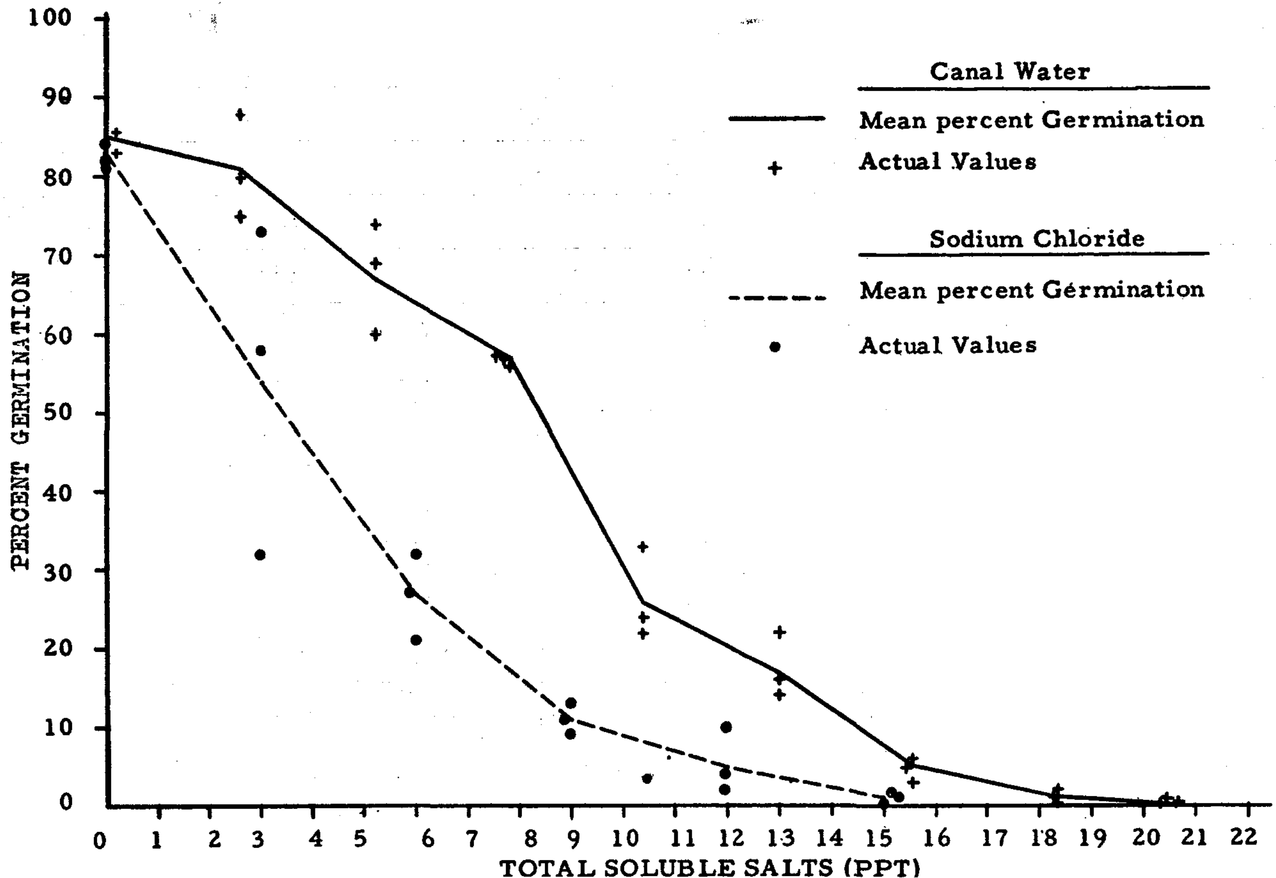
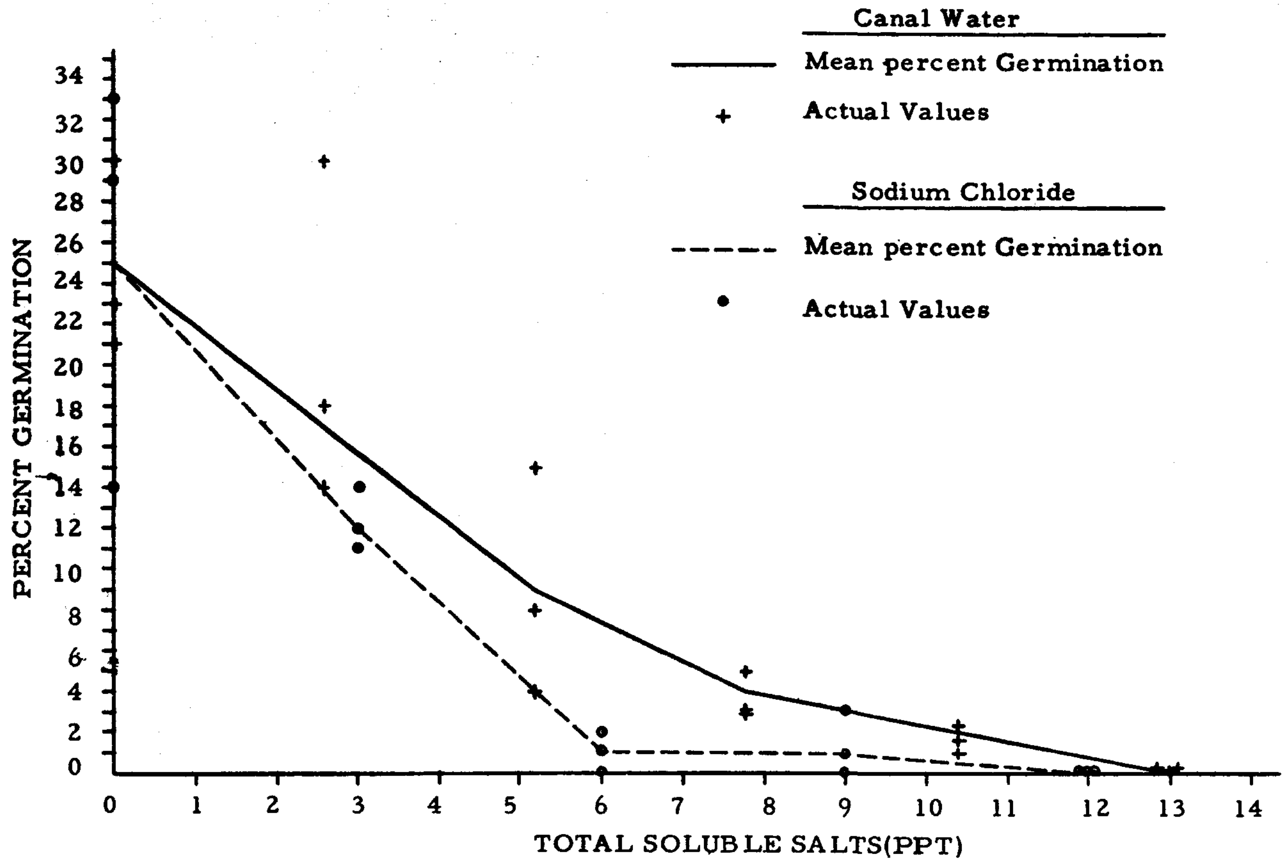


Figure 5. Germination of <u>Scirpus</u> <u>olneyi</u>



SUMMARY

Distribution of *S. olneyi* was associated with slight depressions in the interior of marshes where minimum water levels ranged from —3 to +2.0 inches. The maximum soil salinity recorded in these communities was 16,000 ppm and the minimum recorded was 10,100 ppm. The pH of the soil varied from 4.1 to 6.0. Soil water had higher maximum salinity and pH values than the soil.

S. robustus tolerated higher salinity and greater water level fluctuation than *S. olneyi*. In *S. robustus* communities soil salinities ranged from 12,000 and 22,000 ppm; water depths varied between —6.0 and +5.0 inches. Soil pH ranged from 5.6 to 6.4. Communities of *S. robustus* were often associated with disturbed sites, and this species is a primary invader on areas of exposed soil in brackish marshes subjected to slight water level fluctuation.

Optimum seed germination of both sedges was at temperatures which fluctuated on a daily cycle from 20°C to 35°C; light was a very important factor influencing germination. Submergence by only one inch of water inhibited germination. A sharp decline in the percent germination of *S. robustus* occurred between 8,000 and 10,500 ppm salinity. The germination of *S. olneyi* was reduced 50 percent at 4,000 ppm salinity.

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THE EFFECTS OF SOME ATMOSPHERIC VARIABLES ON ROADSIDE ACTIVITY IN THE COTTONTAIL RABBIT

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ABSTRACT

The widespread use of road counts in estimating population trends emphasizes the need for information on factors influencing animal behavior patterns. The present study, conducted on the Atomic Energy Commission Savannah River Plant in South Carolina, attempted to relate the atmospheric variables of Temperature, Relative Humidity, Vapor Pressure Deficit, and Barometric Pressure to numbers of rabbits (*Sylvilagus floridanus*) seen during morning and evening activity peaks along a specially selected 30-mile route. The route was driven twice in each 24-hour period from July 31 to September 4, 1964. Sling psychrometer readings were taken at five permanent points along the route each time it was counted and the averages converted to the appropriate variables by use of the U. S. Department of Commerce Psychrometric Table No. 235. Barometric pressure was obtained at the beginning of each peak activity period from the U. S. Department of Commerce Weather Bureau at Augusta, Georgia.

The limited number of observations available from this study suggest that although little if any correlation exists between rabbit activity and either temperature or vapor pressure deficit, a positive correlation does exist between activity patterns and both barometric pressure and relative humidity.

INTRODUCTION[1]

It has long been suspected that animal activity patterns are influenced by atmospheric variables. Despite the obvious impact which such factors could have on many wildlife census data, only limited work has been done in this area. Information on roadside activity of rabbits is contained in the reports by Alkon (1961) and Lord (1963) for New York and Illinois, respectively, but to our knowledge no such studies have been conducted in the southeast. This paper summarizes a preliminary investigation on the effects of temperature, relative humidity, vapor pressure deficit and barometric pressure on roadside activity of cottontail rabbits (*Sylvilagus floridanus*). The study was conducted in portions of Aiken and Barnwell Counties, South Carolina, on the Atomic Energy Commission Savannah River Plant (SRP) between July 26 and September 4, 1964. Despite the numerical limitations in our data we present them here as a possible stimulus to further investigation in this important area.

METHODS

An initial study route was selected for high rabbit concentration on July 25, 1964. This route traversed the SRP for 25.7 miles and covered portions of roads 2, F, E, B, and 9 (Figure 1). Permanent points for gathering psychrometric data were set up at five road junctions as follows:

Point No.	*Location*	*Dist. from start*	*Dist. from previous station*
1	Jct. 2&D	....	....
2	Jct. 2&F	4.2 mi.	4.2 mi.
3	Jct. F&E	10.7 mi.	6.5 mi.
4	Jct. F&B	17.5 mi.	6.8 mi.
5	Jct. 9&A	25.7 mi.	8.2 mi.

A speed of 35 m.p.h. was selected as the appropriate rate at which to

[1] Journal Series paper number 136 of the University of Georgia College of Agriculture Experiment Stations, College Station, Athens, Georgia.