PLANT SUCCESSION AFTER SAW-GRASS MORTALITY IN SOUTHWESTERN LOUISIANA

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ABSTRACT

A mortality of saw-grass (Cladium jamaicense) *and other plants occurred between 1957 and 1961 in southwestern Louisiana involving 162,000 ha. of marsh. Flooding and high salinities associated with Hurricane Audrey (June 1957) and subsequent droughts are blamed. Plant succession in an area affected by the die-off was studied by line-intercept transects on the Lacassine National Wildlife Refuge from 1958 through 1974. In 1958, 86 percent of the area sampled by the transect lines was open water while only 2 percent was open water in 1974. In 1974, bulltongue* (Sagittaria lancifolia) *occupied 71 percent of the transects and white waterlily* (Nymphaea odorata) *12 percent. Alligatorweed* (Alternanthera philoxeroides), *spikerushes* (Eleocharis *spp.), floating heart* (Nymphoides aquatica), *buttonbush* (Cephalanthus occidentalis), *and willow* (Salix nigra) *were common associates ranked in order of abundance. During spring droughts (1960-1965) annual grasses and sedges were abundant. The die-off of sawgrass and the subsequent plant succession affected populations, distribution, and food habits of wintering waterfowl in southwestern Louisiana.*

Most documented marsh die-offs in the United States are minor when compared to immense vegetation changes that have occurred in coastal Louisiana. Thousands of acres of saw-grass burned during the 1924 drought, creating persistent openings and ponds (Lynch 1941). During the 1940 flood, fresh-water marshes in Cameron and Vermilion Parishes were inundated with several feet of rain water for two months, which destroyed many acres of marsh vegetation (O'Neil 1949).

Nichols (1959) ascribed a large saw-grass die-off (1947-1952) on Rockefeller Refuge, Cameron Parish, to salt-water floodings from a canal. Several thousand hectares of saw-grass and cattail (*Typha* sp.) died in 1952-1953 in Vermilion Parish (Glasgow and Ensminger 1957) from drought and salt-water flooding. Harris and Webert (1962) reported saw-grass and other plants dying in Cameron and Vermilion Parishes in 1954-1956. They concluded that nutria (*Myocaster coypus*) did not have a major effect on marsh vegetation, and added that a four year drought with increased salinities may have affected some plants adversely.

In 1957, the total area of saw-grass marsh in southwestern Louisiana was about 162,000 hectares (Fig. 1). Hurricane Audrey struck on 27 June 1957 forcing Gulf waters over Cameron Parish and most of Vermilion Parish. Coastal stations reported maximum tides ranging from 3.17 to 4.24 meters, while inland stages in the Mermentau Basin were over 2.44 meters (Morgan et al. 1958). Marsh elevations in these areas are about .3 to .6 meters above mean sea level. The effect of flood waters on saw-grass in the Mermentau Basin was immediate. Bourn and Perkins (refuge files) reported that saw-grass was dead on the Lake Misere marsh, Lacassine Refuge, on 5 August 1957.

Saw-grass in western Cameron Parish did not die as precipitously as that east of Calcasieu Lake. The flooding here was not as deep nor prolonged. Nearly all of the saw-grass marsh in western Cameron Parish died during 1958-1961. Mortalities of paper plant (*Cyperus gigantus*), southern bulrush (*Scirpus californicus*), and big cordgrass (*Spartina cynosuroides*) involved over 2,000 ha. in western Calcasieu and Cameron Parishes in 1960 and 1961.

The objective of the transect study was to document plant succession after a catastrophic die-off of vegetation. Later, the study included the extent, probable causes and effects of the die-off and effects of the subsequent succession on ducks.

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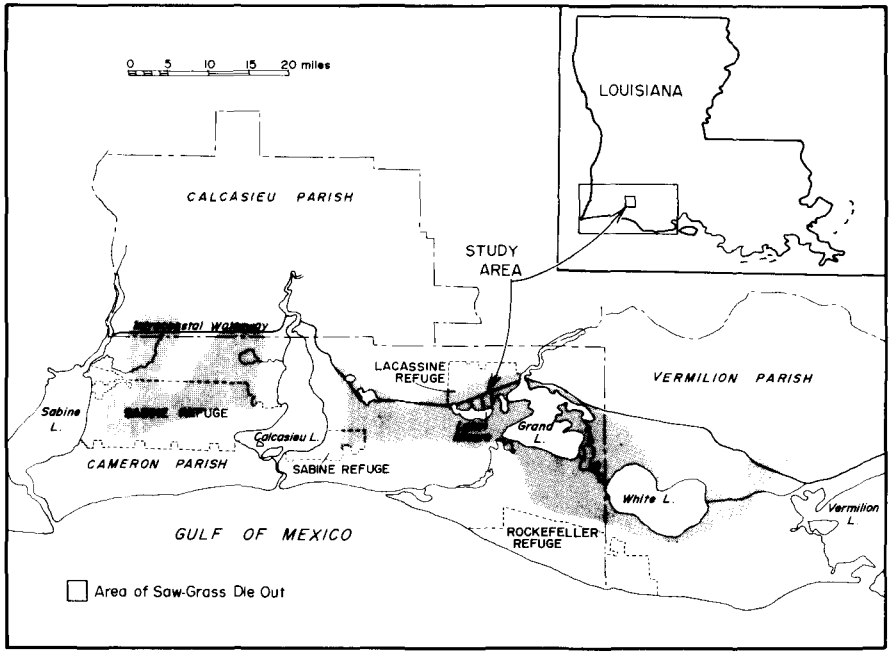

Figure 1. Location of study area and saw-grass die-off (1957-1961) in southwestern Louisiana.

STUDY AREA AND METHODS

The saw-grass marsh was in the fresh to slightly brackish zone of the Chenier Plain (Fig. 1). The Chenier Plain marshes lie between Sabine Lake and Vermilion Bay, extend inland 24 to 45 kilometers, and total 485,830 hectares (Chabreck 1970).

The Lacassine Refuge study area is within the Mermentau River Basin, a Corps of Engineers project, which contains 2,300 square kilometers of marsh and water in eastern Cameron and Vermilion Parishes (Gunter and Shell 1958). The Corps limits the admission of salt water from the Gulf of Mexico and controls water levels for navigation, flood control, and irrigation. Fresh and intermediate marsh constitute 75 percent of the marshes in the Mermentau Basin, and brackish and saline marsh 25 percent. The Cameron Parish marshes west of the Basin contain 57 percent fresh and intermediate marsh with 43 percent brackish and saline (Adapted from Chabreck 1972).

Three marked transects totaling about 5.9 kilometers were arbitrarily spaced about 2.4 kilometers apart on the lake Misere Marsh (2,226 hectares), Lacassine National Wildlife Refuge, Cameron Parish, Louisiana to determine plant succession. When transects were established in July 1958, the marsh appeared devoid of vegetation. The line-intercept method was used to measure cover percentages of dominant and associated plants. In the final tallies, however, only cover values for dominant plants, open water, and bare ground were recorded. Transects were run each year (1958-1967, 1972, and 1974) during July or August when most plants had reached maturity. Nomenclature for the most part follows Thieret (1972).

Water depths taken at 50 foot intervals across the marsh were correlated to a water gauge located four miles from the study area. A cross-section of marsh elevations was constructed from water depth measurement (Fig. 2).

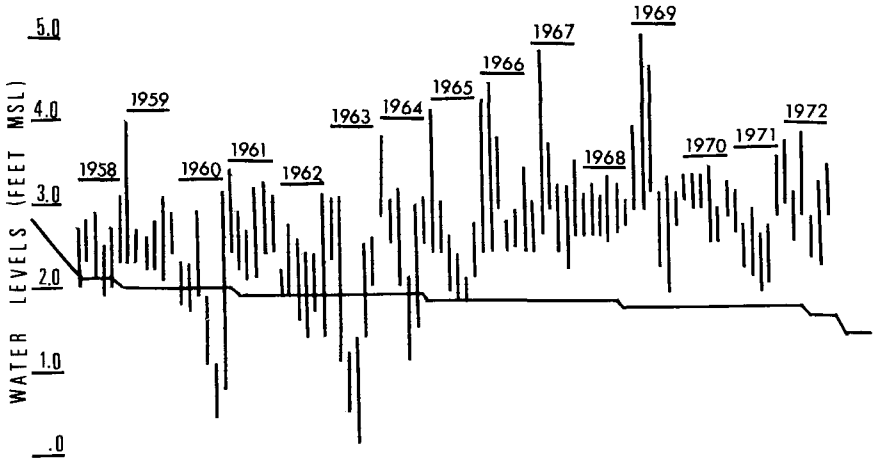

Figure 2. Water fluctuations (highs and lows) as indicated on the Mermentau River gauge, Lacassine Refuge, for months March through August 1958 through 1972. The horizontal line is a diagram of the marsh floor elevations.

The map of the saw-grass marsh in southwestern Louisiana (Fig. 1) was drawn from aerial and ground observations of the marsh (1960-1964) during and after the die-off. Water salinities were determined by a modification of the Mohr titration method.

RESULTS AND DISCUSSION

Present in small amounts in 1958 were bulltongue (*Sagittaria lancifolia*), alligatorweed, waterprimrose (*Ludwigia* spp.), saw-grass, pickerelweed (*Pontederia cordata*), Walter millet (*Echinochloa walteri*), gooseweed (*Sphenoclea zeylanica*), waterhyacinth (*Eichhornia crassipes*), buttonbush, mudbank paspalum (*Paspalum dissectum*), bladderwort (*Utricularia* spp.), white waterlily, and black willow. Squarestem spikerush (*Eleocharis quadrangulata*) and jointed spikerush (*Eleocharis equisetoides*) appeared by 1960 (Table 1).

From 1958 to 1961 open water or bare ground occupied the greater portion of the transects. Several moist-soil plants, particularly gooseweed, Walter millet, and mudbank paspalum became fairly abundant during the drought of 1960 but on 54 percent of the combined transects the ground was bare. During other drought periods (1962-1965) the above annual plants and cyperus (*Cyperus odoratus*) and baldrush (*Psilocarya nitens*) increased. Cyperus occupied 28 percent of all the transects in 1962 and mudbank paspalum 23 percent in 1963.

Bulltongue was present in 1958 in clones or as scattered plants. The rate of increase was fairly steady over the years and in 1974 this plant occupied 71 percent of the combined transects. In most areas, plants associated with bulltongue were jointed spikerush, squarestem spikerush, pickerelweed, and water spikerush (*Eleocharis elongata*).

Bladderworts were the most abundant submerged aquatics, but fanwort (*Cabomba caroliniana*), nitella (*Nitella* sp.), common hornwort (*Ceratophyllum demersum*) and ducklettuce (*Ottelia alismoides*) were also present. White waterlily and big floating heart (*Nymphoides aquatica*) were slow to spread, probably because of the severe droughts. American lotus (*Nelumbo lutea*), watershield (*Brasenia schreberi*), waterlettuce (*Pistia stratiotes*), mosquito fern (*Azolla caroliniana*) and duckweeds (*Lemna perpusilla* and *Spiradela polyrhiza*) were present but not common.

Table 1. Open water, bare ground, and cover by plant species (given as a percentage of 5,904 meters of transect line) on three transects on the Lacassine National Wildlife Refuge, Louisiana, 1958-1967, 1972, and 1974. Only the more commonly occurring species are listed.

	1958	*1959*	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1972*	*1974*
OPEN WATER	86	76		57	18	T	32	4	11	6	1	2
BARE GROUND			54	T	4	T		13				
PLANT SPECIES												
Bulltongue												
Sagittaria lancifolia	12	15	17	30	28	26	27	32	49	56	74	71
White waterlily												
Nymphaea odorata		T	T	T	T		1	1	5	5	11	12
Alligatorweed												
Alternanthera philoxeroides		T	3	8	10	5	12	16	17	17	6	1
Water spikerush												
Eleocharis elongata					1	1	2	7	1	T	3	2
Big floatingheart												
Nymphoides aquatica				T	T		T	T	3	6	1	1
Jointed spikerush												
Eleocharis equisetoides				T	1	1	1	5	2	4	1	1
Common buttonbush												
Cephalanthus occidentalis	1	1	1	1	3	2	2	2	2	2	1	1
Black willow												
Salix nigra			T	T	1	1	1	1	1	1	1	1
Pickerelweed												
Pontederia cordata	T	T	1	T	7	2	7	7	8	3	T	T
Squarestem spikerush												
Eleocharis quadrangulata			T	T	2	1	1	2	T	T	T	T
Waterprimrose												
Ludwigia spp.	1	7	8	2	2	4	4	1	T	T	T	T
Cyperus												
Cyperus odoratus			1		3	28	T					
Mudbank paspalum												
Paspalum dissectum	T		5	T	5	23	T					
Baldrush												
Psilocarya nitens								9				
Sacciolepis												
Sacciolepis striata											T	3

T = Trace

Waterprimrose and alligatorweed were competitive species, and as alligatorweed increased in abundance, waterprimrose decreased. Alligatorweed was most abundant on clay spoil outwash and on the natural levees of Bayou Misere and Lake Misere. At its peak in 1967 alligatorweed occupied 17 percent of the total transect lines, but dropped to 1 percent in 1974. I attribute this decline to predation by the South American flea beetle (*Agasicles hygrophila*). The flea beetle was first introduced in South Carolina in 1964 to control alligatorweed (Hawkes et al, 1967) and releases were made into southern Louisiana in 1970 (Foret, pers. comm.).

Despite the catastrophic die-off, saw-grass was recorded on one transect from 1960 until 1967. A few saw-grass plants remained at the south end of the marsh in 1974.

During the study emergent plants were subjected to water depths (March through September) ranging from 3.2 feet to below marsh floor level (Fig. 2). Floating heart and white waterlily were dominant only in areas of deeper water, but also grew among other plants, and were able to survive long periods of complete dewatering. Even submergents, such as bladderwort, persisted under moist soil conditions. There was an observed correlation between low water stages and the abundance of gooseweed, Walter millet, mudbank paspalum, baldrush, and cyperus.

Impressive changes in marsh vegetation occurred in southwestern Louisiana during the period 1958 to 1974. The early successional stages during seasonal droughts were highly productive of waterfowl food plants, primarily annual grasses and sedges.

Succession in the area west of the Mermentau Basin, particularly in the brackish marsh, proceeded more slowly and with some different plant species involved. During the pioneer stage sprangletop (*Leptochloa fascicularis*), walter millet, fall panic grass, and cyperus dominated. The perennials were mainly saltmeadow cordgrass, jointgrass (*Paspalum vaginatum*), bulltongue, alligatorweed, and southern bulrush. Considerable open water remained unoccupied by emergent plants, but supported widgeongrass (*Ruppia maritima*) (Valentine, unpub.). Chabreck (1970), comparing vegetated to open areas, found that in southwestern Louisiana, fresh marsh had more cover (77 percent) than brackish marsh (68 percent).

The causes of the plant die-off that occurred between 1957 and 1961 were not documented but circumstantial evidence points to toxic salinity levels. Mortality of saw-

grass in the Mermentau Basin coincided with deep flooding by tides from Hurricane Audrey. In western Cameron and Calcasieu Parishes the die-off was delayed until 1958 or later, but spring and summer droughts concentrated soil water salts to a lethal point for fresh and some brackish marsh plants. Salinities of soil water that I collected in the saw-grass and southern bulrush die-off areas on Sabine in 1961 and 1962 often tested over 16.0 ppt. and one area tested 25.0 ppt. Nutria were at their peak population level in western Cameron Parish in the early 1960's and as the bulrush, big cordgrass, and paper plant died, the nutria dug up and ate the underground parts. In places where impounded water moderated salinities, plants did not die, and nutria only thinned the stands.

Except for small scattered stands in the fresh-water impoundments at Sabine and Lacassine Refuges and in marshes north of White Lake in Vermilion Parish, saw-grass marsh was nearly non-existent in the Chenier Plain in 1974. Chabreck (1970) found only a trace in 1968. Relict stands of saw-grass still persist on canal spoil banks adjacent to marshes where the die-offs occurred. The spoil is mainly clay and is elevated above most tidal waters while adjacent marsh is highly organic and usually flooded. This observation suggests that saw-grass mortality was a function of water and soil chemistry and that changes in soil conditions may delay invasion by this species. Salt water combined with organic soils under drought conditions may have created extreme acid conditions similar to the cat clays described by Neely (1958).

About 12 ha. of marsh grew back into saw-grass after the die-off on the Sabine Refuge, but died out again in 1969. Another reestablished stand was killed in 1972, after high tides measuring 14.7 ppt. salinity (Ivy, pers. comm.) flowed into the area. Despite reversals and extensive alterations to the marshes by canals, levees, and water control projects, there are vast acreages in southwestern Louisiana that are basically saw-grass habitat.

WATERFOWL MANAGEMENT SIGNIFICANCE

The dense saw-grass marsh attracted few ducks, but after the die-off these marshes, while in the open and pioneer stages of succession, held the major duck populations in Louisiana (Lynch, pers. comm.). Crissey (1961) stated that the improved habitat conditions in the coastal marshes of southwestern Louisiana resulting from Hurricane Audrey were reflected in high counts of gadwall, American wigeon, green-winged teal, blue-winged teal, northern shoveler, and northern pintail. Until 1957, less than 25,000 blue-winged teal wintered in the United States, mainly in Florida (Bellrose 1976). The opening of the dense vegetation apparently resulted in over 100,000 blue-winged teal remaining in southwestern Louisiana through the winter of 1957-1958 (Smith 1961). Blue-wings now (1960-1974) average 190,000 during winter surveys (Bellrose 1976). The numbers of gadwalls on Louisiana mid-winter surveys rose from 127,000 in 1955 to 1,152,000 in 1965 (Bateman, in Bellrose 1976). Since then, winter gadwall numbers in Louisiana have ranged between 570,000 (1972) to 938,000 (1969) (Bellrose 1976).

Duck food-habits studies in southwestern Louisiana prior to the die-off indicated that rice (*Oryza sativa*) and rice field weed seeds (Dillon 1957), or seeds of perennial marsh plants ranked high in preference or availability (Chamberlain 1959, Kimble and Ensminger 1959). The die-off opened about 160,000 ha. of marsh to invasion by annual grasses and sedges. Mallard crops collected in 1961 near or in the die-off area by Glasgow and Junca (1962) contained high percentages by volume of wild millets (*Echinochloa* spp.), paspalums, fall panic grass (*Panicum dichotomiflorum*), and giant foxtail (*Setaria magna*). Northern pintail, blue-winged teal, and green-winged teal shot in the same areas fed abundantly on fall panic grass, sprangletop, wild millets, and giant foxtail (Glasgow and Bardwell 1962).

The Lacassine transects show that annuals were abundant in the Mermentau Basin, where water levels are controlled, only during severe spring droughts. Food-habit studies (Valentine, unpubl.) in the Lacassine Refuge area suggest that during dry years, annual grasses and sedges were available and eaten more than during wet years. In 1960, with a dry growing season, mudbank paspalum and baldrush seeds were the major foods by volume of 36 mallards. Rice and rice field grass seeds were the main foods of 39 mallards shot in 1961, a wet year. Stomachs from four pintail and a mallard collected on the

Lacassine transects in 1965, a dry growing season, contained by volume 69 percent baldrush and 29 percent saw-grass achenes.

From 1966 through 1974 the study area marsh was flooded during the growing season, and few annual plants were present. This absence of annual seed plants was reflected in the feeding behavior of certain puddle ducks. The main roost of northern pintails, blue-winged teal, and green-winged teal (up to several hundred thousand) in southwestern Louisiana is the Lacassine Refuge Pool, a 6,480 ha. impoundment. Tamisier (pers. comm.) found during the 1973-1974 winter season that these ducks roosted on the pool during the day, flew northward at nightfall to feed in rice fields, and returned at daybreak to the refuge.

The saw-grass die-off and moist soil conditions during the late 1950's to mid-1960's produced an abundance of annual grass and sedge seeds preferred by certain puddle ducks. Large populations of northern pintail, blue-winged teal, green-winged teal, and others were believed short-stopped in their winter flights farther south. In the study area, plant succession has now progressed from the bare moist soil and open water stages, through the pioneer annual stage, to a nearly closed cover of marsh perennials. In the brackish marshes of western Cameron Parish, succession has been slower and large areas remain in open water.

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