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GEOCHRONOLOGY OF CORKSCREW SWAMP SANCTUARY

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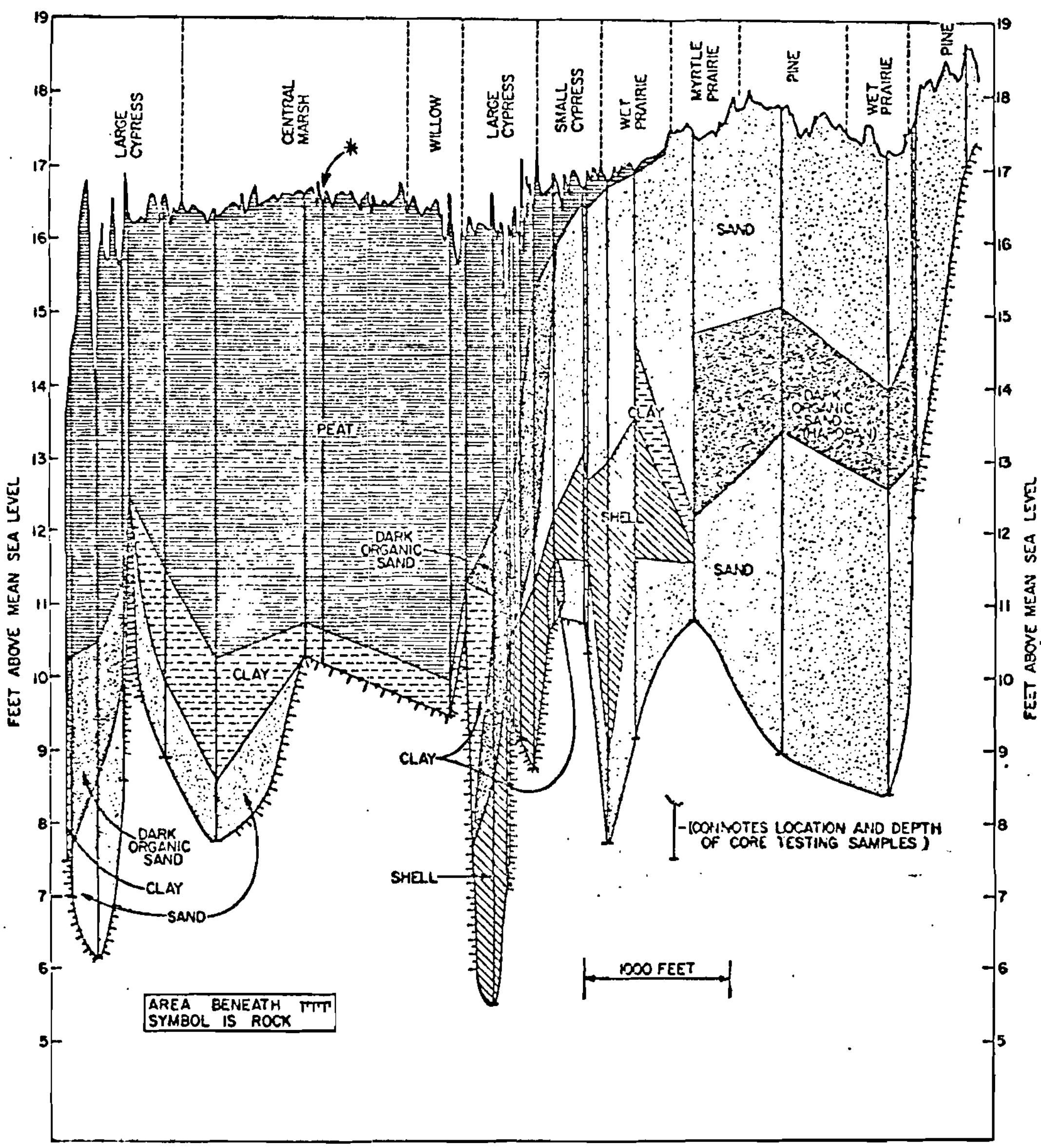
Introduction

A core for radiocarbon dating was taken approximately 5100 feet from the beginning of the Central Marsh transect. In addition, marine shells were taken from a deposit found underlying a hammock, some 2600 feet back from the coring site. The shells were found near the border between the small cypress and the wet prairie. A thin layer of indurated limestone had to be broken through to reach the shells. What this layer represents is not known.

Sediments found in the core are typical of the sediments underlying the Central Marsh (Fig. 1). Fresh water peat is present, varying in thickness from 1.5 to 3 m in situ. The peat is underlain by a layer of clayey marl. The peat-marl boundary is characterized by an abundance of Helisoma and other fresh water gastropod shells. The marl is underlain by a thin layer of quartz sand, which overlies bedrock. The sand contains some fragments of marine shell. This layer is relatively unimportant in the easterly part of the Central Marsh, but it thickens considerably toward the westerly part.

It was desired to obtain 1) a general depositional history, 2) rates of deposition of peat and marl, and 3) to tie in the geochronology of the Sanctuary with pollen studies and other analyses to determine



* indicates location of radiocarbon dating core.

Fig. 1. Central Marsh Transect soil profile.

environmental succession in the Central Marsh. Radiocarbon dating was done to accomplish these goals.

Procedure

Peat samples were taken at approximately equal intervals in sections 4 inches thick in the core CS6. When the core is corrected for compaction (assuming the compaction is uniform), the true depth of samples can be ascertained. Samples of peat were taken from the intervals 7.62-21.51 cm, 56.45-70.40 cm, 105.28-119.23 cm, and 147.74-157.38 cm (Stone, personal communication). The upper two samples were treated with sodium hydroxide to remove humic acids and hydrochloric acid to remove carbonate contamination. The lower two samples, however, were found to have particles that were extremely fine. Treatment with sodium hydroxide tended to keep the particles in suspension indefinitely, so this treatment had to be abandoned. All samples were treated with hydrochloric acid.

Marl samples were taken from the top and basal sections. The top sample, just below the peat boundary, was taken between 157.38 and 163.80 cm, and the basal sample from 256.93 to 263.36 cm. No cleaning method was used, but these samples were strained to remove gastropod shell fragments and pieces of bedrock, the latter being dead with respect to carbon-14 radioactivity.

Helisoma shells (probably _Helisoma scalare_) were taken from the bottom of the peat and the top of the marl. These shells were cleaned in a ten percent solution of hydrochloric acid to remove recrystallized surface carbonate.

The salt water shells were culled through for whole shells with hard shiny surfaces and no evidence of recrystallization. The sample chosen for dating was predominantly (at least 85%) Transenella conradia. The vast majority of shells were no longer than 1 cm; therefore, as many as one hundred shells were dated as one individual sample. The shells were treated in a hydrochloric acid leach to remove recrystallized carbonate.

All samples were run at the University of Miami Radiocarbon Lab, which uses a liquid scintillation system as described by Noakes, Kim, and Stipp (1965). All samples were converted to benzene, and mixed with inactive toluene containing the scintellators PPO and POPOP. The results were calculated using the Libby half life of 5568 $\pm$ 30 years.

Results and Discussion

The ages of the various materials are listed (Table 1). Both the AC number and the University of Miami Geochronology Lab number (UM number) are given. Most of the samples were collected over a depth interval. These intervals are listed, along with the mean depth of each of the samples. The exceptions are the Helisoma, which were taken from both the peat and marl layers, and the marine shell samples, which were taken at a depth of about 4 feet or 121.92 cm. All samples, except the Helisoma, shell, and marl samples, have been corrected for C^{13}/C^{12} ratio. None of these dates have been dendochronologically corrected.

The marine shells were dated twice, once at $>$36,380 years before present (BP), and once at $>$35,980 years BP. These ages agree with

Table 1. Central March Transect ratiocarbon-dating core profile.

UM Number	AC Number	Depth cm	Mean Depth cm	Age	Description of Material
952	1055	7.62 - 21.57	14.6	525±135	Peat
953	1056	56.45 - 70.40	63.4	1153±116	Peat
954	1057	105.28 -119.23	111.2	3028±82	Peat
955	1058	147.74 -157.38	152.56	5686±210	Basal Peat
956	1059	157.38 -163.80	160.59	6620±105	Marl
957	1060	~157.38	~157.38	7005±235	*Helisoma*
958	1061	256.93 -263.36	260.14	10,600±180	Basal Marl
959A	1071A	~121.92	~121.94	>36,380	Marine Shell
959B	1071B	~121.92	~121.94	>35,980	Marine Shell

findings at Lake Okeechobee (Gleason and Stone, 1975) in which Chione cancellata and Rangia cuneata samples were dated between 29,000 and 39,000 years BP. It is believed that this represents the last intrusion of marine water into Lake Okeechobee. If so, then it is possible that Corkscrew Swamp Sanctuary also was intruded by salt water at this time. The shell, along the Central Marsh Transect, is always underlain and overlain by quartz sand; this overlying layer of sand is at least several feet thick. This layer no doubt represents deposition after the shell deposition, but it is impossible to put an age range on the deposit. Whether this shell represents actual water level, or whether it represents a tidal channel or estuary, is open to discussion. The shell layer is not limited to the deeper cracks in the bedrock. The question of a hard water effect does arise if the shell layer is assumed to be an estuary. The hard water effect refers to the flow of water over limestone bedrock, picking up dead carbon (C^{12} enriched) from the bedrock. An organism using this water for carbon to build a shell, or the recrystallization of carbonate from this water on an already deposited shell, will cause the apparent age of the shell to be older than it really is. The C^{13}/C^{12} ratio of the shells, however, indicates an enrichment of C^{13} by .58 parts per mil, or an enrichment in C^{14} of twice that amount. If there was a hard water effect, C^{13} would be depleted. The hard water effect, therefore, is negligible if it is a factor at all.

The prospect of a higher sea level from 29,000 to 39,000 years BP gains credence when sea level curves are examined. The sea level curve suggested by Emiliani (1966) from his paleotemperature work supports a high sea level at this time. The curve also indicates very low sea level from about 25,000 to 13,000 years BP. Pollen samples from Lake Annie (Watts, 1975) in Highland County in south-central Florida show a very dry climate for the period of time ending 13,000 years ago. If climate was also very dry near the sanctuary, then it is very possible that the environment surrounding Corkscrew Swamp Sanctuary was one of an erosional envinonment rather than a depositional one. The minor quantity of sand underneath core CS6 could be an erosional remnant of deposition that occurred after the shell was deposited. If extensive deposition did take place, there might have been marine shell deposition on a larger basis than is now found at the Sanctuary. Whatever the case might be, the only sediment at the Sanctuary younger than the marine shell but older than the marl is the quartz sand which is undatable.

The next sediment of note is the clayey marl. Marl is a carbonate sediment which at the Sanctuary was precipitated by periphytic blue-green algae, the algae usually forming mats. Marl deposition is indicative of a fairly wet enviornment, but one that is not as wet as a peat forming enviornment. The surface water (Gleason et al., 1973) would have to be saturated in $CaCO_3$ from the underlying bedrock, but the area would have too short a hydroperiod for peat deposition. Long periods of dryness would inhibit growth of peat forming plants and cause any organic material deposited to oxidize. $CaCO_3$ precipitation would be encouraged. The environment in which marl would be likely to be produced would be a wet prairie.

The basal marl was dated at 10,600 ± 193 years BP, and the top of the marl was dated at 6620 ± 91 years BP. The age of the basal peat compares with ages of 13,160 ± 190 years BP (Brooks, 1974) and 12050 ± 210 years BP (Gleason and Stone, 1975), and the top of the marl compares with a date of 6470 ± 120 years BP under Kreamer Island in Lake Okeechobee (Gleason and Stone, 1975). The dates for the top of the marl agree within one sigma. Modern periphyton has been dated and it has dated modern, so no problem exists with respect to the hard water effect. The lack of drainage indicated by marl deposition rules out any chance of severe contamination by material being brought in from outside.

There is 99.55 cm of marl between the two mean depths of the samples. This is a very large amount of marl compared with other places. The limestone bedrock surface is irregular, and the marl was cored in somewhat of a depression. The spot is still valid to use as a point to determine rate of marl deposition, because the earliest deposition of marl would occur in depressions where the water level would be just high enough to initiate deposition in some small areas.

A sedimentation rate of 2.50 cm/century is obtained using the dates for the top and the basal sections of the marl. This rate could actually be anywhere from 2.19 to 2.92 cm/century, taking the two sigma value of each date into account. This is assuming a uniform rate of sedimentation. The only other calculated figures for marl deposition decreased with time, starting with a rate of 2.8 cm/century from 4000 to 5000 years BP and decreasing to 1.2 cm/century from 0 to 1000 years BP. It has been reasoned that this increase is due to a decrease in the aerial exposure of limestone as marl and peat began to cover more and more of the limestone, the source of carbon for the marl (Gleason et al., 1974).

This provides evidence that the rate of marl production in the Sanctuary is not constant. This evidence is further substantiated when the relative distribution of <u>Helisoma</u> is taken into consideration.

From a depth of about 170 cm down to basement rock, Helisoma and other fresh water gastropods are only occasionally encountered. From 170 cm up to the marl boundary, and even into the peat, Helisoma are encountered in great numbers (a total distribution of from 170 cm to 148.55 cm in depth). It is unlikely that the Helisoma experienced a sudden population explosion. Rather, they may represent an age span when marl deposition slowed down considerably, and may even represent the period of time between the end of marl deposition and the beginning of peat deposition. The data on the Helisoma, however, do not bear this out.

Helisoma shells (probably Helisoma scalare) were taken from both the basal peat and the upper marl. This was necessary to have a sufficient sample for dating. The shells dated at 7065 $\pm$ 235 years BP. This is somewhat older than expected, the shells being mixed in a layer of marl dated at 6620 years BP. Part of the discrepancy can be explained, taking into account numerous factors. The ages are not that far off, being within two sigma of each other. Second, the sample when counted appeared to be slightly quenched (some disintegrations were not recorded) as indicated by an external standard ratio of 1.113. The contribution of quenching, if it did occur, would be minimal. A hard water effect is possible. Helisoma shells have been reported as deficient in C^{14} in the Everglades. This is according to a C^{13}/C^{12} ratio of -3.8 parts per mil. Tamers (1970), however, reports that fresh water gastropods frequently give erroneous dates. They may use carbon from bedrock to use in the making of their shells, giving an older age than in reality, and they may exchange their carbon with the atmosphere, giving a younger than expected age. Tamers also points out that the C^{13}/C^{12} method of correction is not useful unless the type of shell had been studied, which is not the case here. Radiocarbon dating of modern Helisoma in a similar environment could give a good idea as to how Helisoma will fractionate the carbonate in the ground water it lives in. Lastly, the life style of the Helisoma is not really known. The Helisoma could burrow down several inches, and obtain their carbon from a different region than that in which they were found. If late marl sedimentation occurred slowly, then a few centimeters in depth could make a considerable difference in age. It must be recognized that in dating fresh water gastropods of any kind, often many individual factors are dated, not just the shell.

Above the marl is a thick layer of peat. Peat consists of various organic remains which have been compressed. The transition of marl to peat indicates a wetter environment, with much less seasonal drying which would oxidize any organic material deposited. The peat is fibrous for the first 50 cm or so, then grades to an organic sediment for another 50 cm or so, and finally grades to a mucky peat for the last 57 cm. Dates of 525 $\pm$ 135, 1153 $\pm$ 116, 3028 $\pm$ 82, and 5686 $\pm$ 210 were obtained (Fig. 2). From 5686 to 3028, peat deposition occurred slowly, at a rate of 1.62 cm/century. Considering the two sigma values for these dates, the range possible is from 2.07 cm/century to 1.32 cm/century. From 3028 to 1153, the rate was 2.55 cm/century with a range of 3.23 cm/century to 2.10 cm/century. From 1153 to 525, the rate was 7.77 cm/century with a range of 38.70 cm/century to 4.32 cm/century. This implies that the rate of peat formation was initially slow and is increasing with age. Peat deposition occurs the fastest during the latest time interval. This is a good sign for the Sanctuary. It takes much less

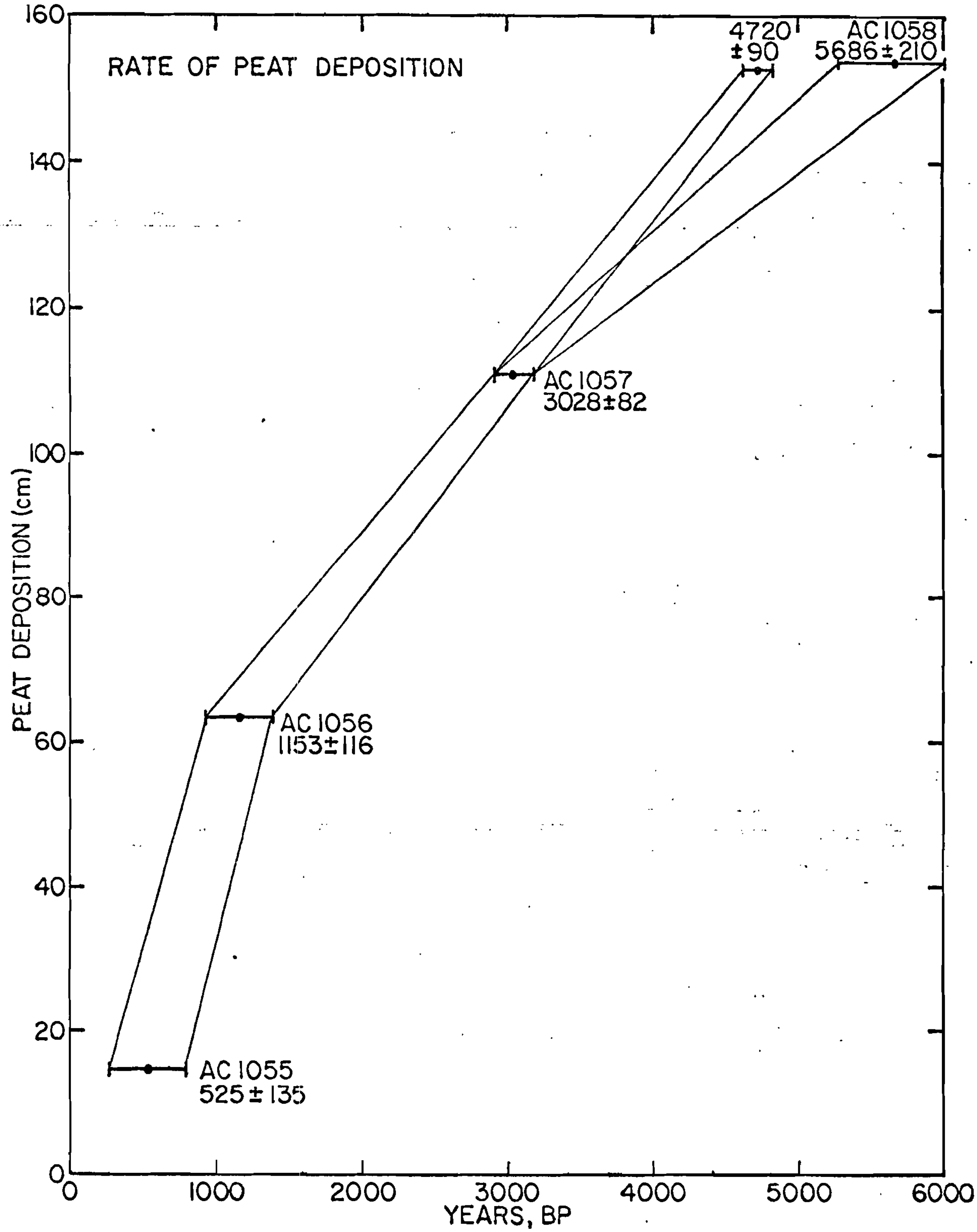


Figure 2. Rate of peat deposition.

time to destroy peat than it takes to create it. Drainage is particularly adept at destroying peat formations, as it has in some parts of the Everglades.

The only date open to question here is that of the basal date, 5686 ± 210 years BP. If this date were to be true, it would have to be one of the oldest peat formations in south Florida. The oldest peat date in south-central Florida so far is that of 5490 ± 90 years BP under Kreamer Island in Lake Okeechobee (Gleason and Stone, 1975). These dates overlap within one sigma. But the basal peat in the Sanctuary had been dated only a few meters away at 4720 ± 90 years BP (Duever, personal communication). This does not overlap with the latest value for the basal date. There may be several reasons for the difference. First, the peat sample dated at 4720 ± 90 was a sample consisting of the basal 4 inches in the core, or the basal 14 cm in actual length in situ. What was dated, then, was actually not the basal date but a mean date somewhere near the middle of the 14 cm. This mean would be exactly at the middle if sedimentation and compaction were at uniform rates. For example, if 4720 ± 90 were indicative of a date 7 cm above the actual basal peat, then the real basal age would be somewhere near 5100 years, obtained by extrapolating the curve. Assuming the sigma stays the same, the two basal dates will overlap at the sigma. Sample AC 1058 of basal peat was a smaller sample taken over a range of 7 centimeters or so, not 14, so the sampling is more indicative of a true basal date. This is not meant to try to push the previous basal date closer to the age now obtained, it is rather to establish the true basal date given two extremes.

Further, it is normal for initial peat deposition to occur very slowly. In the Everglades, near Belle Glade, Florida (McDowell et al., 1969), it was calculated that the initial 7.6 cm of basal peat required 500 to 1000 years for deposition. The transition from a marl producing environment to a peat producing environment does not happen overnight. Cores have been found where the marl and peat occur together, or may alternate in layers signifying changing environments. During various environmental transitions, early peat deposits may be oxidized, removing part of the depositional history. If the 4720 ± 90 figure is to be accepted, it would give a rate of deposition of the first 43 cm of peat equal to that of the second 50 cm. If the true basal date were older, the rate of deposition for the first 43 cm would be less, as one might expect.

What, then, is the true basal age? It would be older than 4720 and younger than 5686, for previously stated reasons. An extrapolated figure of 5100 years is not unreasonable. Pollen studies by Watts (1975) indicate that at about 5000 years BP modern flora and climate began in Lake Annie. Certainly, somewhere close to this age peat sedimentation must have begun.

The results of this project as described give valuable information as to peat and marl deposition in southwest Florida. Although there have been many radiocarbon dates from south Florida, southwest Florida has been somewhat neglected, especially the interior of southwest Florida. An approximate depositional history is now known for the Corkscrew Swamp Sanctuary. Hopefully, this can be combined with pollen and other studies to determine succession within the Central Marsh and possibly all of the Sanctuary.

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