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Late Holocene Sea-Level Change and Delta Migration, Apalachicola River Region, Northwest Florida, U.S.A.

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ABSTRACT

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Late Holocene environmental changes in the lower Apalachicola River region of northwest Florida appear to be a consequence of deltaic lobe-shifting and sea-level change. Sedimentological, archaeological and seismic evidence all indicate a major eastward shift in deltaic deposition approximately 6,000 years ago, when construction of the modern Apalachicola Delta began. The effect is observed in the mid-region of the modern delta as a pronounced change from estuarine to freshwater conditions during the mid- to late Holocene.

Enclosing the modern delta and estuary is a barrier island chain which began to develop about 4,000 years ago. A change in depositional pattern over time is evident in the barriers, possibly as a response to the continuing eastward shift of the delta. Archaeological evidence from the barriers indicates a minor higher-than-present sea level during the late Holocene. The timing of the high stand is consistent with evidence from other locations in the Southeastern United States.

ADDITIONAL INDEX WORDS: *Sea level, Holocene, geoarchaeology, Gulf of Mexico.*

INTRODUCTION

The history of sea-level change during the Holocene has had a multitude of interpretations. Even when the focus is narrowed to a limited region such as the Southeastern United States, published sea-level curves vary greatly in their shape. Nonetheless, there is general agreement on certain facts: beginning from a low stand of approximately −90 meters during the late Wisconsinan, approximately 17,000 years ago, sea level rose rapidly until about 6,000–7,000 years ago. Between that time and the present, sea level either rose slowly or fluctuated, at times perhaps rising above the modern level (KIDSON, 1982).

Sea-level change during the middle and late Holocene has had a significant influence in the Apalachicola River coastal region of northwest Florida. Changes in sea level have exerted an influence on the location of the river's delta. The migration and progradation of the delta in turn affected human settlement during prehistoric time, as evidenced by the patterns of archaeological sites. The distribution of sites over time and the stratigraphy at individual sites are consistent with geological studies of the sea-level history of the region and the Holocene history of the Apalachicola Delta.

The Apalachicola River and its delta have exerted a major influence on the sedimentology of the coast and shelf of the northeastern Gulf of Mexico since early Tertiary time (RIGGS, 1980; SCHMIDT, 1984). The distinctive cuspate shape of the regional shoreline was described by GORSLINE (1963) as the product of deltaic sedimentation by the Apalachicola River during the Late Tertiary and Pleistocene. KOFOED and GORSLINE (1963) identified relict Apalachicola deltas from Panama City to the Ochlockonee River (one example is shown in Figure 7). Paleo-deltas as old as mid-Miocene, and extending as far north as the Florida-Georgia border, were described by GREMILLION *et al.* (1964) and TANNER (1966). SCHNABLE (1966) mapped a paleo-delta approximately 20 km northwest of the city of Apalachicola (Figure 1), describing it as a late Quaternary position of the Apalachicola River mouth. DONOGHUE and

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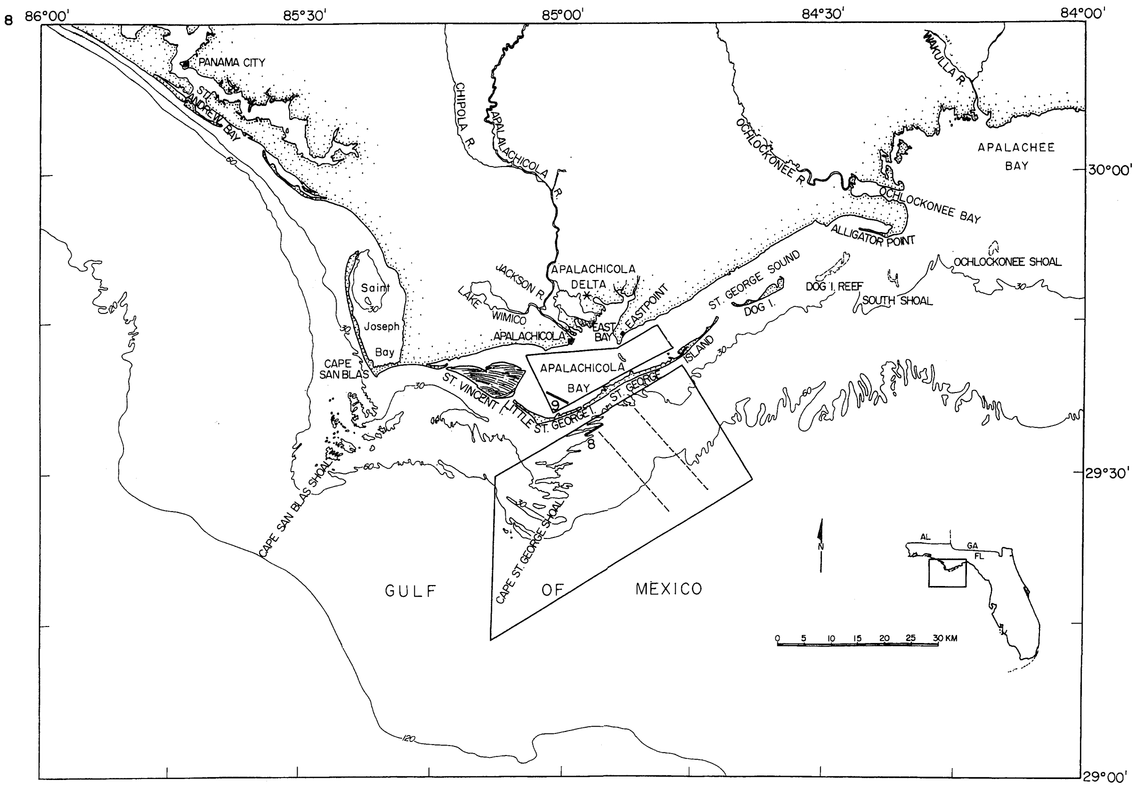

Figure 1. Apalachicola Delta region. Bathymetry in feet. Outlined areas are locations of high-resolution seismic surveys. Pattern on St. Vincent Island shows general trend of beach ridge sets. Dashed lines show trend of large Apalachicola paleochannel system, as described in text. Locations of seismic lines in Figures 8 and 9 are indicated by numbers. Location of Van Horn Creek shell midden is shown by symbol under Apalachicola Delta label.

TANNER (1992) summarized the known terrace stratigraphy for the region, much of which has resulted from depositional episodes of the Apalachicola River.

HOLOCENE SEA-LEVEL HISTORY

Northeastern Gulf of Mexico

Most of the sea-level curves for the Southeastern U.S. are derived from the northwestern Gulf of Mexico margin (Figure 2). The more detailed sea-level curves for the northern Gulf of Mexico all indicate a rapid rise until approximately 6,000 years ago, followed by episodic rise thereafter. Examples include: CURRAY'S (1960) sea-level data from the Texas and Louisiana shelf; REHKEMPER'S (1969) sea-level curve for the Trinity River region of the Texas coast; and NELSON and BRAY'S (1970) Sabine Bank (Texas) sea-level history (Figure 2).

FRAZIER'S (1974) sea-level history is typical of the episodic sea-level curves for the northern Gulf (Figure 2). Based on peat and shell dates from the Texas-Louisiana shelf, the curve depicts a late Wisconsinan low stand of −88 m between 18,500 and 15,500 yr BP. Sea level rose in a stepwise manner, with stillstands at −53 m (13,500–12,000 yr BP), −42 m (11,000–10,500 yr BP) and −17 m (10,000–7,500 yr BP). A sharp rise occurred during the period of approximately 7,500–6,000 yr BP, from about −17 m to −6 m, followed by a more moderate rate of rise thereafter. Unless stated, all radiocarbon dates herein are given as uncorrected radiocarbon years before present (BP), with "present" referring to 1950 AD. In the case where it was necessary to compare radiocarbon

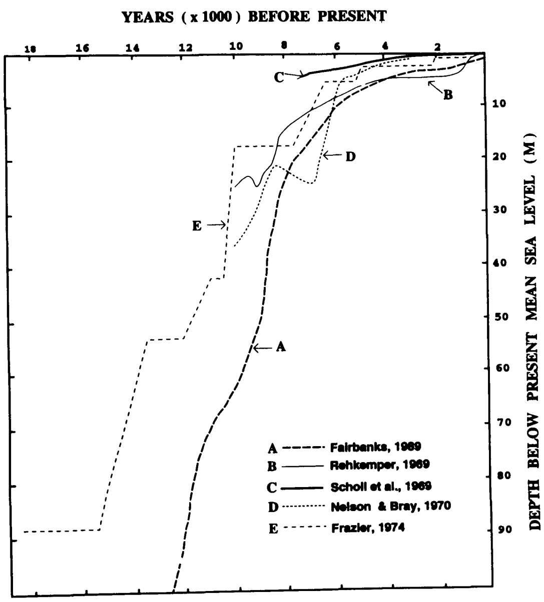

Figure 2. Late Wisconsinan and Holocene sea-level records, Southeastern United States and Barbados.

dates with standard ages for archaeological periods, correction tables given in KLEIN *et al.* (1982) were used.

PENLAND *et al.* (1990) also suggested an episodic late Quaternary sea-level history for the northern Gulf of Mexico. A possible mechanism for episodic rise was proposed by ANDERSON and THOMAS (1991). They noted that ice sheets grounded on the Antarctic shelf have not melted at a steady pace during the late Wisconsinan and Holocene. Surges of rapid melting have probably resulted in many meters of eustatic sea-level rise over periods of a few hundred years. Evidence of such events in the Gulf of Mexico include flooding surfaces in valley-fill sequences, as observed in seismic and core data from the Texas shelf (ANDERSON and THOMAS, 1991).

FAIRBANKS' (1989) sea-level record for Barbados is shown for comparison with the Gulf of Mexico data in Figure 2. That chronology, based on radiocarbon-dated corals, indicates two meltwater pulses centered at 11,500 and 9,500 yr BP. In comparison with the records from the Southeastern United States, the Barbados curve has an increasingly greater depth offset with increasing age and shows little detail for the middle to late Holocene. Nonetheless, the meltwater pulses roughly coincide with the periods of rapid rise recorded in the Gulf of Mexico curves.

The sea-level records for the Southeastern United States shown in Figure 2 cover most of the last deglacial episode. The relatively low resolution makes it difficult to map short-period events of less than 1,000 years duration. For specific areas of the Southeast, more detailed data for the late Holocene provide a clearer picture of the short-period sea-level fluctuations, including possible high stands. These records will be described in the following sections.

Coastal South Carolina

COLQUHOUN and BROOKS (1986), and BROOKS *et al.* (1986) constructed a sea-level curve for coastal South Carolina (Figure 3), based on approximately sixty radiocarbon dates, primarily on basal peat deposits. Their data indicate a rapid Holocene sea-level rise up until about 6,000 yr BP, with a slow general rise thereafter. Superimposed on the late Holocene rise are a series of positive and negative sea-level oscillations of ± 1.5 m or less, fluctuating with a period of about 500 years. Due to compaction and problems in determining absolute elevation, the position of the curve relative to mean sea level is uncertain. Higher-than-present stands of sea level are not precluded by the data.

Mobile Bay

Archaeological midden sites near Mobile Bay have provided radiocarbon-dated evidence of repeated human occupation and subsequent inundation between 4,000 yr BP and the present, with a period of approximately 1,000 years (Figure 3) (HOLMES and TRICKEY, 1974). Human occupations (relative low stands) occurred at approximately 4,100 yr BP, 3,090 yr BP, 2,040 yr BP, and 1,080 yr BP. Estuarine muds separate the cultural horizons, indicating sea-level rise above present during the interim periods. The thickness of the estuarine mud units (15–45 cm) precludes their being storm deposits. The elevations shown for the high stands in Figure 3 are lower limits, representing the elevation of the estuarine muds. Conversely, the depths shown for the low stands are upper limits, representing the elevation of the cultural layers. The timing of the high stands corresponds reasonably well with high stands recorded in South Carolina, although the resolution of the data is poorer.

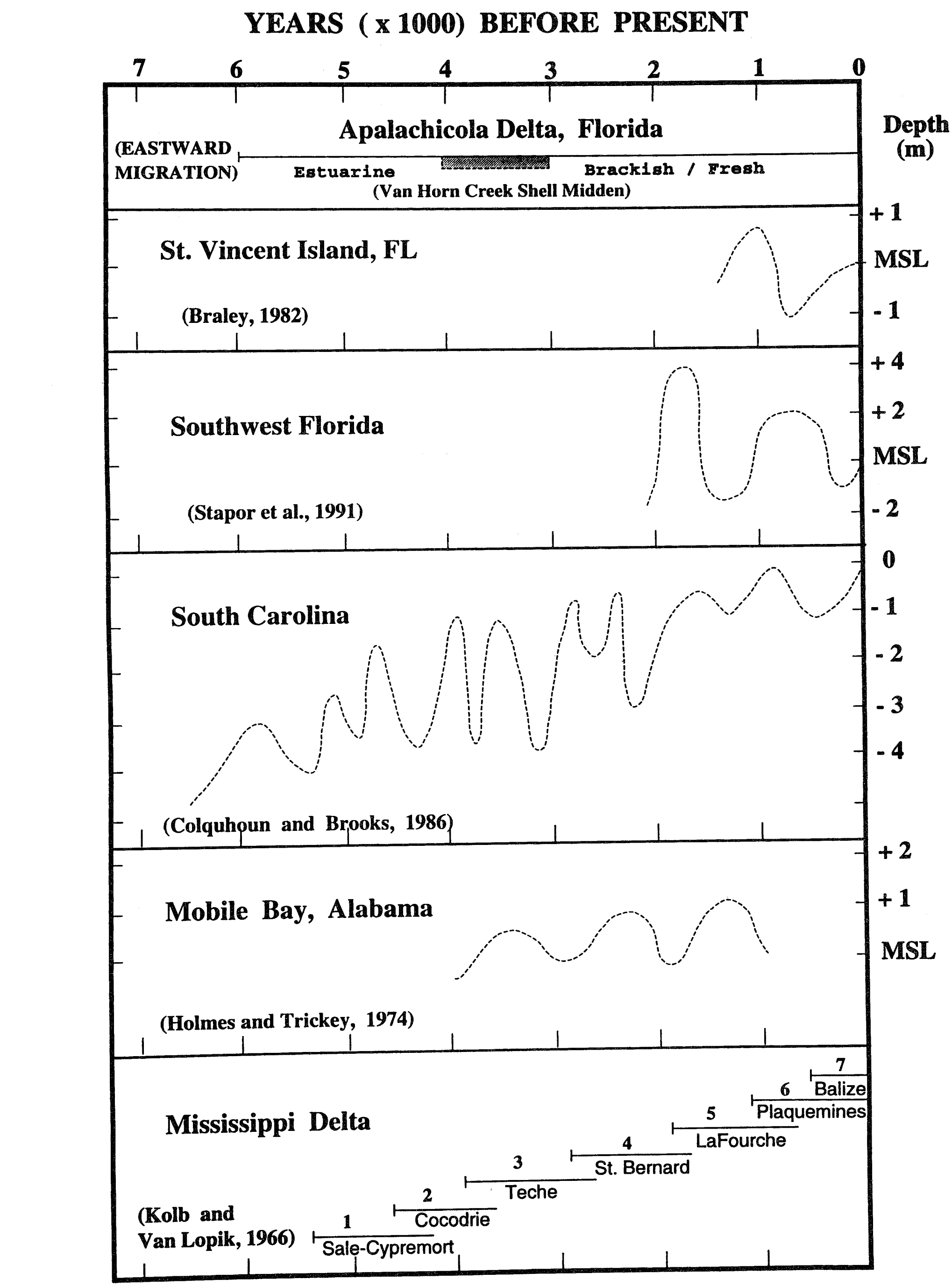

Figure 3. Composite evidence of late Holocene sea-level fluctuations, northern Gulf of Mexico. The Apalachicola Delta chronology indicates the approximate date of initiation of the modern delta. Also shown is the period of environmental transition (stippled pattern) for the vicinity of the Van Horn Creek shell midden (location shown in Figure 1). All sea-level curves are discussed in the text. All dates are in uncorrected radiocarbon years BP. [Notes: (1) The vertical datum for the South Carolina curve is "meters below present high marsh surfaces." Relation to mean sea level is uncertain. (2) The late Holocene deltas of the Mississippi are arranged chronologically; no elevation difference is implied.]

Mississippi Delta

The periods of inundation seen in Mobile Bay generally coincide with periods of deltaic lobe shifting in the Mississippi Delta (Figure 3). TANNER (1991) has suggested that the initiation of a rise in sea level, accompanied by rapid backfilling of delta distributary channels, might be expected to encourage avulsion. Major avulsions occurred at 5,300 yr BP (Sale-Cypremort delta), 4,600 yr BP (Cocodrie delta), 3,900 yr BP (Teche delta), 2,800 yr BP (St. Bernard delta), 1,900 yr BP (LaFourche delta), 1,100 yr BP (Plaquemines delta), and 600 yr BP (Balize, or modern delta) (KOLB and VAN LOPIK, 1966). Shown in Figure 3 are Kolb and Van Lopik's estimate for the approximate date of initiation of delta-building (indicated by a vertical line) and the duration of significant flow in each delta (indicated by a horizontal line). FRAZIER (1967) described a similar, though more complex, chronology for the Holocene Mississippi delta complexes with more detail for individual lobes. Both chronologies depict the initiation of the Plaquemines-modern delta complex occurring about 1,000 yr BP.

The available data on late Holocene sea level change in the Southeastern United States are as yet not detailed enough to adequately test the hypothesis that sea-level rise and lobe-shifting have a cause-and-effect relationship. It can be observed that—within the limits of radiocarbon dating errors—most of the late Holocene episodes of lobe-shifting in the Mississippi Delta occurred during periods when sea level was rising, as recorded at other locations in the Southeast.

South Florida

SCHOLL *et al.* (1969) compiled sea-level data for South Florida, based on radiocarbon-dated peats from the Everglades region. Their curve, shown in Figure 2, indicates that the sea stood approximately 4 meters below present at about 7,000 yr BP. It rose rapidly from that time until about 3,500 yr BP to a level 1.5 meters below present. Submergence then proceeded at a slower rate to its present level. Although the data provide no evidence of high stands, the possibility is not precluded due to the potential compaction of peat and the sparsity of late Holocene dates.

STAPOR *et al.* (1991) constructed a sea-level curve for the southwest Florida barriers, based on shell dates from beach ridges. Their curve shows two higher-than-present stands during the period 3,000 yr BP to the present (Figure 3). Their earlier high stand began approximately 2,000 yr BP, while the latter high stand commenced approximately 1,100 yr BP. Both high stands coincide in part with the periods of high sea level reported in coastal South Carolina by COLQUHOUN and BROOKS (1986) and in Mobile Bay by HOLMES and TRICKEY (1974).

Apalachicola River Region

Evidence for a late Holocene high stand has also been found at an archaeological site on St. Vincent Island (Figure 1) in the northeastern Gulf of Mexico (BRALEY, 1982). Indications of two distinct periods of human presence—separated by a period of inundation—were found in a shell midden site on the northeastern corner of the island. Based upon ceramics and a single shell date, the stratigraphy at the site indicates that an early human occupation occurred about 1,300 yr BP. The evidence indicates that that occupation was terminated by a rise in sea level. An overlying lagoonal mud stratum records a high stand of approximately 0.7 m above present. A subsequent sea-level fall resulted in a second occupation during the late Weeden Island and Fort Walton periods after 1,000 yr BP, a date based on ceramic artifacts overlying the lagoonal muds.

Within the uncertainty limits of the two dates, the sea-level record from St. Vincent Island (Figure 3) agrees reasonably well with the more recent portion of the coastal South Carolina sea-level history and does not conflict with the Mobile Bay chronology (Figure 3). Likewise, TANNER's (1991) chronology of sea level-related changes in beach-ridge height and grain size on St. Vincent Island agrees with BRALEY's (1982) sea-level chronology within the limits of the data. Additionally, the latter higher-than-present stand seen in the southwest Florida data of STAPOR *et al.* (1991), between approximately 1,100 yr BP and 500 yr BP (Figure 3), also overlaps with the high stand identified by Braley on St. Vincent Island.

APALACHICOLA RIVER AND DELTA

Holocene History of the Delta

In the Apalachicola River Delta of northwest Florida (Figure 1), the rate of progradation of the modern delta during historic time has been measured using historic charts dating back to 1896 (DONOGHUE and BEDOSKY, 1985; BEDOSKY, 1987). The average linear progradation rate for the halfdozen distributaries of the modern delta is 2.2 m yr^{-1}. Extrapolating that rate backward in time, the entire modern delta would have formed in about 6,000 years. It is reasonable to make a linear extrapolation because there is no evidence of fluctuating climate in the region during that period. Pollen records for the Southeast indicate that there was little vegetation change in the Gulf Coastal Plain during the Holocene (DELCOURT and DELCOURT, 1981). Moreover, the pollen history for northwest Florida indicates that, while the earliest Holocene was relatively dry, the past 7,700 years have been wet and relatively unchanging (WATTS *et al.*, 1992).

There is some evidence that, prior to occupying its present valley, the Apalachicola River built a delta northwest of the modern one. SCHNABLE (1966) mapped a "late Pleistocene" delta in the floodplain approximately 20 km northwest of the modern delta front. The abandoned delta was described as possessing relatively well-preserved distributary channels and natural levees. No datable material was reported. The feature could represent an earlier Holocene (prior to about 6,000 yr BP) position of the Apalachicola Delta. A Sangamonian age for this feature is also possible. DONOGHUE and TANNER (1992) described beach ridges of a possible Sangamonian age at an elevation of 2 m on the mainland coast.

Archaeological Midden Stratigraphy

The assumption that historical progradation rates can be extrapolated back through the late Holocene is corroborated by archaeological evidence. At the Van Horn Creek shell midden (location shown in Figure 7), on the eastern side of the modern delta, a pronounced shift in the diet of the aboriginal inhabitants is indicated sometime around 3,000–4,000 yr BP, a date based on ceramic artifacts (WHITE, 1991). The midden stratigraphy reveals a shift from consumption of predominantly open-estuarine mollusks (*Crassostrea*) and more-marine fish to fresh/brackish water mollusks (*Rangia*) and more-freshwater fish sometime during that period (Figure 4) (WALKER, 1994).

An upper limit for the age of the transition from estuarine to brackish conditions is given by a radiocarbon date. The date, 3170 ± 60 BP, is from wood charcoal taken from the cultural layer correlated with the deposits at the base of the midden profiled in Figure 4. The evidence confirms that the transition occurred sometime after that date.

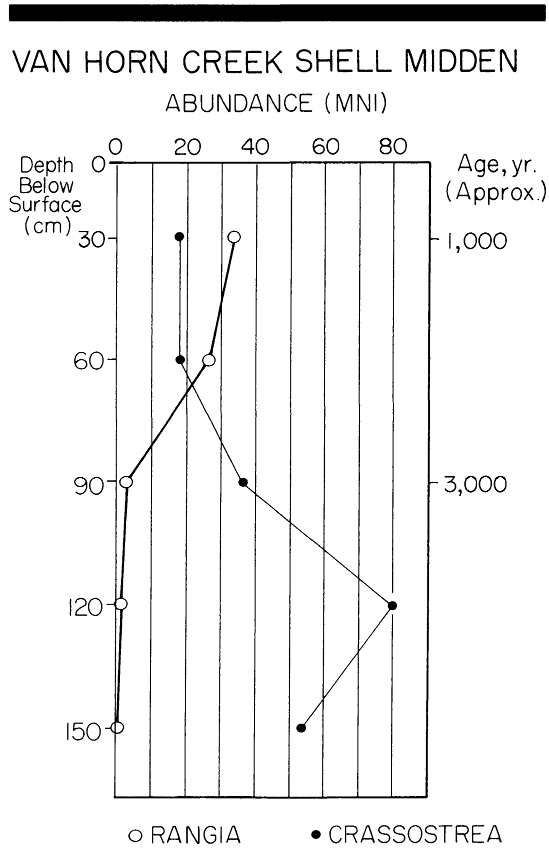

Figure 4. Van Horn Creek shell midden (8Fr744) mollusk abundance profile. MNI = minimum number of individual mollusks per standard 4-liter sample for each 15 cm level. Dates indicated are based on the presence of ceramics of known age. Location of midden site is indicated by "VH" in Figure 7. (Data and figure from K.J. Walker, Florida Museum of Natural History.)

It is assumed that the inhabitants were collecting species present in the environment near the site and that the culturally-produced stratigraphy is thus a record of the changing environment (WHITE, 1994); this is a common and reasonable archaeological assumption. At the present-day rate of advance, 2.2 m yr^{-1}, the delta front would have prograded past the site of the Van Horn Creek midden approximately 3,000 years ago. The change in environments is shown diagrammatically in Figure 3, with the time of transition cross-hatched.

At another site 10 km to the west of the modern delta, Depot Creek shell mound (Figure 1) on the south shore of Lake Wimico, the inhabitants apparently subsisted on a diet of *Rangia* and other fresh- or brackish-water fauna throughout the late

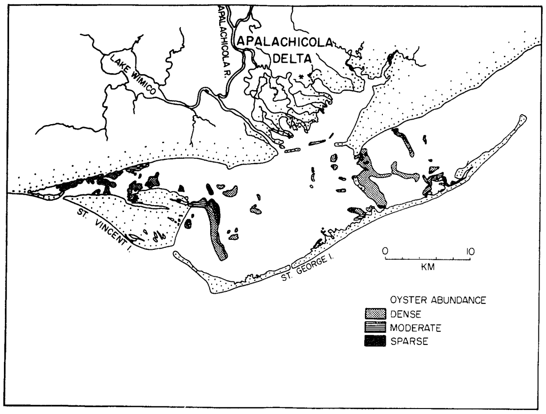

Figure 5. Present-day distribution of oyster bars in Apalachicola Bay (LIVINGSTON, 1983). Location of Van Horn Creek shell midden is indicated by asterisk.

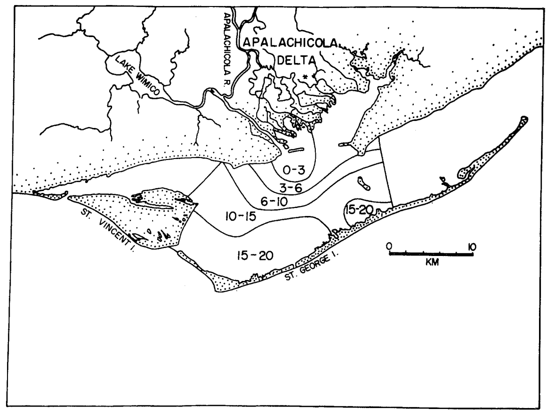

Figure 6. Annual average surface salinity in Apalachicola Bay. Contours are in parts per thousand. Averages are from 1972–1979 (LIVINGSTON, 1983). Location of Van Horn Creek shell midden is indicated by asterisk.

Holocene (WHITE, 1994; WALKER, 1994; WHITE, *in press*). This implies that the area adjacent to the modern delta on the west was already an established fresh/brackish environment and not affected by the migrating delta front during the late Holocene. The oldest known age of the Depot Creek site is Lake Archaic, based on ceramics and an associated radiocarbon date (uncorrected) of 2,970 ± 80 yr BP. The initial occupation of the site may have been earlier than that time. A possible Early Archaic site has also been investigated on the north shore of the lake. If the age of that site is confirmed, the implication would be that the lake was established some time prior to 4,000 years ago.

There is reported evidence that the Depot Creek area was estuarine at some time prior to the earliest known human occupation of the site. SCHNABLE (1966) noted that sub-bottom profiles in Lake Wimico (Figure 1) indicated the presence of buried oyster bars under the lake bottom. This implies that the Lake Wimico region was estuarine either earlier in the Holocene or during Sangamonian time.

Since the inception of the barrier-island rim 3,000 to 4,000 years ago, circulation in the Apalachicola estuary has by necessity diminished. Average salinities in the northern parts of the estuary must have decreased as a consequence. The average salinities of the modern delta are such that *Crassostrea* are not present in the vicinity of the present-day delta front. Oysters are presently found only in open-estuarine salinity conditions (6–20 ppt) in the outer estuary (Figure 5). The modern delta front is a zone of fresh to brackish water (0–6 ppt), which is conducive to *Rangia* growth (Figure 6).

To summarize, the pronounced stratigraphic change in the faunal remains at the Van Horn Creek site about 3,000–4,000 years ago, presumed to reflect a change in the type of environment exploited by the inhabitants, can be attributed to the influence of two geologic factors. The first was the continuing progradation of the delta front, pushing the estuarine region further southeastward. The second was the initiation of the barrier-island chain, with the resulting decrease of circulation in the delta-front area. The result was conversion of an open-estuarine, *Crassostrea*-dominated environment into a fresh-to-brackish, *Rangia*-dominated environment.

Distribution of Archaeological Sites

A further example of the congruence of the geological and archaeological records is observed by compiling data on the age of the oldest artifacts at each of the known and dated human occupation sites in the region of the modern delta. The data reveal no evidence of occupation prior to the Early Archaic (approx. 7,000 yr BP). Maximum ages of the archaeological sites become younger seaward, following the southeastward direction of delta progradation during the latter half of the Holocene (Figure 7). All of the known archaeological evidence indicates that the region of the mid- to

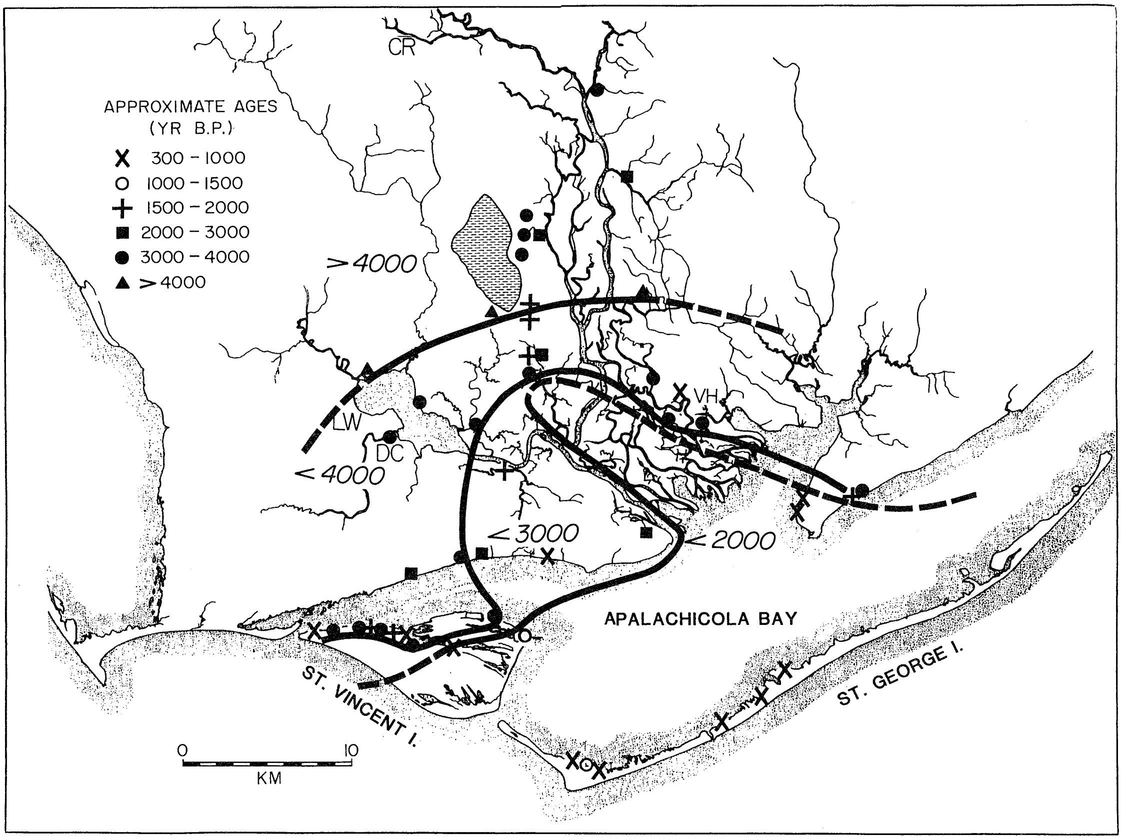

Figure 7. Age distribution of archaeological sites in the lower Apalachicola River valley. Symbols indicate approximate known age of oldest artifacts found at all dated sites within the lower watershed. Contours show maximum age of enclosed sites, indicating close connection between delta migration and human settlement pattern. Contours are dashed where uncertain. Abbreviations: (CR) Chipola River, (DC) Depot Creek shell midden, (LW) Lake Wimico, (VH) Van Horn Creek shell midden. Patterned area northwest of modern Apalachicola Delta is "late Pleistocene" delta, as mapped by SCHNABLE (1966).

late Holocene Apalachicola Delta, from lake Wimico eastward to East Bay, was an open embayment and thus not habitable prior to the Early Archaic.

Although the dated evidence is sparse in the active region of the delta, it can be observed that a large region—including all of the present-day delta—contains no human sites known to be older than Late Archaic (approx. 4,000 yr BP). This observation is in agreement with the measured historic rate of progradation of the modern delta into the northern part of Apalachicola Bay (East Bay).

The archaeological evidence reveals a coherent pattern of human occupation on the barrier-island rim as well. The oldest known cultural sites are found on the oldest parts of the island chain—the northernmost beach ridges of the St. Vincent Island beach-ridge plain. The youngest ridges are in the southeastern portion of the island. The oldest ridges are approximately 3,000–4,000 years old, based on the presence of Late Archaic artifacts and a few radiocarbon dates (STAPOR, 1973, 1975). All archaeological sites on the other islands are younger (Figure 7).

The ridge sets that make up this well-developed beach-ridge plain (approximately 180 ridges) have changed orientation and shape over time (STAPOR and TANNER, 1977). The oldest set strikes nearly east–west and is not tapered, indicating that offshore sand was moved directly onshore without significant longshore transport. Younger sets, beginning about 3,000 years ago, were developed with a more northwest-southeast orientation and taper toward the northwest, implying longshore transport from the southeast. STAPOR (1975) interpreted this change in orientation and geometry as being the result of the development of an island nucleus (the present-day Little St. George Island) on the inner part of the Cape St. George Shoal (Figure 1). This event had a direct effect on the sand supply to St. Vincent Island. Both the development of Little St. George Island and the changes recorded in the St. Vincent Island beach-ridge plain appear to be related to the evolution of the Apalachicola Delta during the late Quaternary. Cape St. George Shoal has been interpreted as a late Wisconsinan or early Holocene Apalachicola Delta (DONOGHUE, 1993). The shoal has been the likely source of sand to the barrier islands throughout their history.

Archaeology of the Upper River

In the modern Apalachicola Valley and Apalachicola Delta no cultural materials known to be older than Early Archaic (approx. 7,000 yr BP) have been discovered. Artifacts from the Paleo-Indian period, some as old as 12,000 yr BP and representing the earliest human inhabitants of the region, have been found in abundance west of the modern river. The Paleo-Indian sites are located in the valley of the Chipola River (Figure 1), the largest tributary of the Apalachicola (WHITE and TRAUNER, 1987). This observation is consistent with a continuing eastward migration of the river and delta during the early and mid-Holocene. Prior to the Early Archaic, the main channel of the river is inferred to have lain to the west of its present position.

Seismic Evidence

Some corroboration for an eastward shift of the Apalachicola delta about 6,000–7,000 yr BP comes from subsurface seismic data. Seismic records were collected from Apalachicola Bay and the inner shelf adjacent to the barrier islands. High-resolution seismic surveys were carried out within the areas outlined on Figure 1 (DONOGHUE, 1993). The seismic data indicate a concentration of fluvial paleochannels in the near subsurface. The channels are found to be concentrated almost exclusively to the west of the modern river and delta. A major paleochannel system runs northwest–southeast in the subsurface west of the city of Apalachicola and east of Cape St. George (Figure 1). The channels lie under the western part of Apalachicola Bay and pass beneath the western portion of the modern barrier chain. As noted, archaeological and radiocarbon dates from the modern barriers indicate that the chain is less than 4,000 years old. The trend of the paleochannel system, indicated by the paired dashed lines in the figure, is offset approximately 10 km west of the trend of the modern river.

The bases of the larger channel lie at a mean depth of about 16–18 meters below modern sea level, approximately the position on Frazier's sea-level curve where sea level began a rapid rise about 7,500–6,000 yr BP (Figure 2). They should have been active channels up until that time. They follow a trend which passes through the Jackson River and Lake Wimico (Figure 1). The Jackson River appears to be a relict channel. Its cross section is approximately equal to that of the modern Apalachicola River, but it carries minimal freshwater flow at present (DONOGHUE, 1993).

An example of one of the paleochannels in western Apalachicola Bay is shown in Figure 8. The seismic data also reveal the existence of deltaic deposits beneath Cape St. George Shoal (Figure 9), which might be a remnant of an earlier—early or pre-Holocene—position of the Apalachicola Delta. The age assignments in Figures 8 and 9 are based on coastal borehole data which indicate that the paleochannel system beneath Apalachicola Bay is late Wisconsinan or younger (SCHNABLE, 1966; DONOGHUE, 1993).

Combining the seismic and archaeological evidence, it can be inferred that the modern Apalachicola Delta was initiated during the Early Archaic period, 6,000–7,000 yr BP. Prior to that time, the river and its delta lay further to the west. The delta may in fact have been located offshore from the present coast, near the location of Cape St. George Shoal. The principal channel of the river flowed through Lake Wimico, Jackson River and west of the city of Apalachicola (DONOGHUE, 1993). The region adjacent to the east was probably an open embayment, and as such was not habitable until some time after the lobe-shifting event about 6,000 yr BP.

CONCLUSIONS

Geological and archaeological evidence indicate that the Apalachicola River and Delta have undergone an eastward and southward migration during the Holocene, punctuated by retreats, possibly in response to periods of rapid sea-level rise. The suggested Holocene history of the lower Apalachicola River is as follows:

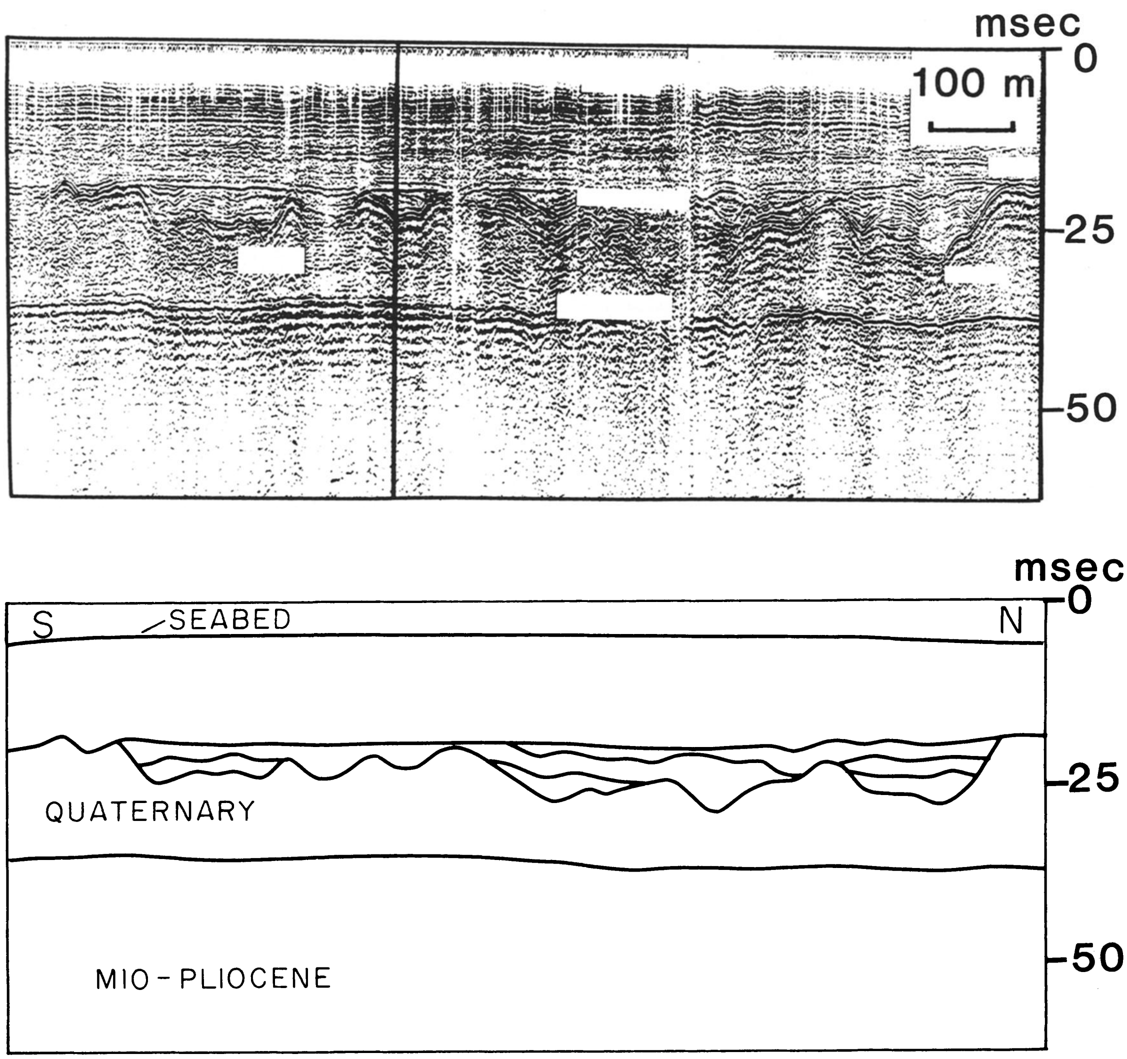

Figure 8. Sub-bottom seismic data from western Apalachicola Bay, showing a paleochannel of the late Holocene Apalachicola River. Two-way travel time in milliseconds is shown at right. Full vertical scale is approximately 60 meters. Location of profile is indicated in Figure 1.

(1) During the earliest Holocene, the Apalachicola River mouth lay considerably further south of its present location. As sea level rose from a position approximately 20 meters below present level at the beginning of the Holocene (FRAZIER, 1974), the river mouth retreated up its valley. The river's path during the early Holocene is marked by large paleochannels observed in the subsurface beneath western Apalachicola Bay, Little St. George Island (Cape St. George) and the inner continental shelf. The modern-day Lake Wimico and Jackson River were at that time part of the lower reaches of the early Holocene Apalachicola River. Evidence of possible early Holocene deltas is found in the sub-bottom seismic records of the modern inner shelf. The region of Cape St. George Shoal was probably an early Holocene paleo-delta location (DONOGHUE, 1993).

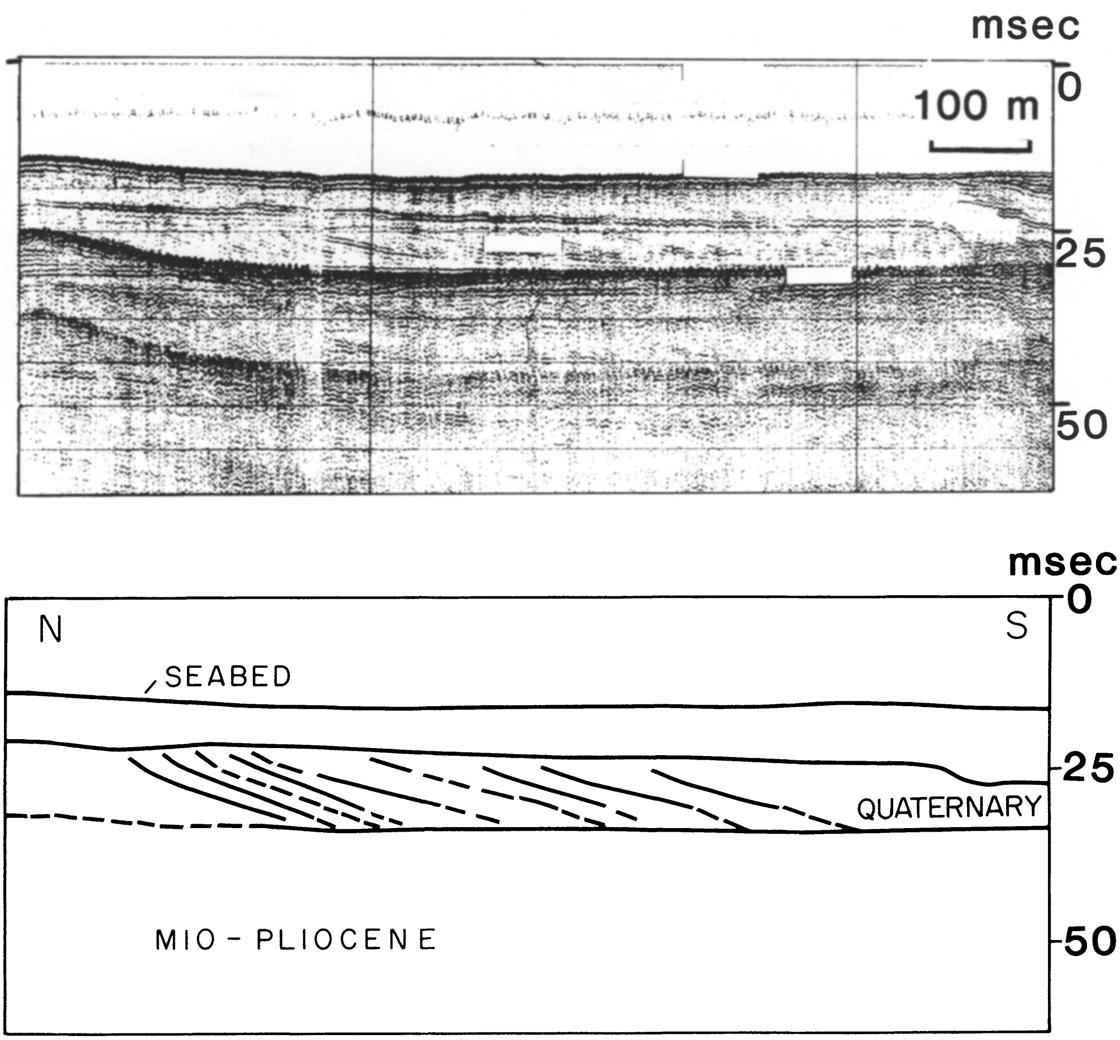

Figure 9. Sub-bottom seismic data from east side of Cape St. George Shoal, showing paleo-deltaic deposits of the Apalachicola River. Two-way travel time in milliseconds is shown at right. Full vertical scale is approximately 60 meters. Location of profile is indicated in Figure 1.

(2) The rapid early Holocene rise of sea level up until about 6,000–7,000 years ago caused the shoreline to retreat to the north of Lake Wimico. The Lake Wimico area may have been estuarine for a time, if the report of seismic evidence of oyster beds beneath the lake is correct (SCHNABLE, 1966). Sparsity of age information leaves much of the history of Lake Wimico uncertain. The stratigraphy of the Depot Creek midden site (Figure 7) on the south shore of the lake, containing artifacts as old as Late Archaic, reveals that the lake has been fresh/brackish since at least 3,000 years ago and possibly earlier (WHITE, *in press*). Additionally, the presence of a possible Early Archaic habitation on the north shore of the lake suggests that the present lake shore may have been established earlier than 4,000 years ago.

(3) During the mid-Holocene, the paleo-Apalachicola River migrated to the east of the Lake Wimico-Jackson River area. The abandoned

delta mapped by SCHNABLE (1966) 20 km northwest of the city of Apalachicola may have been a mid-Holocene river-mouth deposit, although a Sangamonian age is also possible, in the absence of geochronological data. The distribution of archaeological sites (Figure 7) suggests that the region south and east of that feature was an open embayment and not habitable until at least Late Archaic time (approximately 4,000 yr BP).

(4) Approximately 6,000 years ago, the Apalachicola began constructing its present delta. The evidence for this conclusion comes from multiple sources: the distribution of archaeological sites (Figure 7); the stratigraphy of the Van Horn Creek midden site (Figure 4); the measured rate of southeastward progradation of the modern delta front (DONOGHUE and BEDOSKY, 1985; BEDOSKY, 1987); and subsurface seismic evidence of an abandoned fluvial-deltaic system of probable early- to mid-Holocene age to the west and south of the modern delta.

(5) A pulsating sea-level history for the latter half of the Holocene has been reported for coastal South Carolina (BROOKS *et al.*, 1986) Mobile Bay (HOLMES and TRICKEY, 1974), and southwest Florida (STAPOR *et al.*, 1991). The timing of the penultimate high stand given in these chronologies ranges a few hundred years on either side of 1,000 yr BP. This is also the date of initiation of the Plaquemines-modern Mississippi delta complex (KOLB and VAN LOPIK, 1966; FRAZIER, 1967). As noted, there exists on St. Vincent Island some archaeological evidence of a sea-level high stand in the Apalachicola River region between about 1,300 yr BP and 1,000 yr BP (BRALEY, 1982). The archaeological, geologic and seismic data provide a coherent history, which is consistent with the emerging picture of episodic Holocene sea-level change in the Southeastern United States.

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