The St. Clair River Delta
A Unique Lake Delta*

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ABSTRACT

Because of long-term and short-term lake level changes, the geomorphology and vegetation patterns of the St. Clair River delta are unique. Marine delta studies and Late Quaternary chronology in the Great Lakes have progressed significantly in the past decade and the delta is investigated from the viewpoint of these developments. Although this delta has a shape similar to the Mississippi River delta, several forms and processes are different.

INTRODUCTION

Since the classical study of Lake Bonneville by Gilbert,1 deltas in lakes, with only a few exceptions, have been largely ignored by geomorphologists. The major deltas of the world are located on continental shelves and have held the interest of geologists and geographers because of petroleum resources, agricultural production, and waterborne activities. Although lake deltas are of smaller size, they share most of the processes characteristic of marine deltas. However, an unique aspect of lake deltas is their dynamic response to relatively rapid changes of base level that not only produce special landforms, but distinctive vegetation zonation as well.

During the past decade the study of marine deltas has progressed significantly. Also, Late Quaternary events in the Great Lakes have been repeatedly reexamined and refined. The St. Clair River delta was investigated from the viewpoint of these more recent developments. The vegetation was the first clue which led us to conclude that this delta

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had landforms or surfaces not found on active marine deltas. Furthermore, our comparative aerial photograph studies and vegetation traverses over time revealed that plant communities do not occupy similar delta landforms through time but respond to changing lake levels. In this investigation the geomorphology of the lake delta, including landform-vegetation relationships, is examined and compared to that of marine deltas.

Located on the international boundary between Ontario and Michigan, the St. Clair delta is the largest delta in the Great Lakes Basin (Figure 1). Considering its recreational significance and commercial importance with regard to Seaway navigation, geographic literature on the area has not been abundant. The first significant investigation was done several decades ago by Cole who determined that the delta was being deposited atop deepwater, proglacial lake clays. More recently, Wightman attempted to establish a Late Quaternary chronology for the delta formation. Detailed investigations by geologists have partially documented the sedimentological composition of the delta's surface, particularly in Muscacomoot and Goose Bays. During the 1950's, engineering studies by the U.S. Army Corps of Engineers preceded construction of the 27-foot Seaway channel through the delta. Although not published, much of these data, in the form of bore records, are on file at the Detroit District Office. Recent environmental studies associated with flooding problems on the shores of Lake St. Clair and dredged spoil disposal site locations have also contributed some useful data for this study.

**LAKE LEVELS, FLOW REGIME, AND SEDIMENT SOURCES**

With the retreat of the Late Wisconsin ice some 13,000 years ago, a series of moraines and lake plains were deposited in the Great Lakes Basin. The outlets of the Great Lakes were changing or even blocked, causing the lake levels to oscillate several tens of feet. Lake Erie established its present level some 4,000 years ago and Lake Huron shortly thereafter. The St. Clair River and its delta came into existence during these changing lake levels.

At present Lake St. Clair has an established elevation of 573 feet above mean sea level at Father Point, Quebec. Hydrographic records, however, reveal that since 1898 the lake level has varied as much as 5.9 feet. Since 1965, the level of Lake St. Clair has fluctuated four feet. These noncyclic short-term oscillations, which are principally related to water budgets in the Great Lakes Basin, are important determinants of delta landforms and vegetation zonation as well.

A second factor determining the delta morphology is the flow regime of the St. Clair River. The river is a strait connecting Lake St. Clair with Lake Huron, not a fluvial system with tributary streams. Therefore, the discharge is relatively constant and averages about 177,000 cubic feet per second. With flow velocities up to two miles per hour, the system is capable of transporting coarse sand. Instead of a spring flood typ-
ical of most rivers, discharge into Lake St. Clair is slightly increased in midsummer when lake levels in Lake Huron are highest (Figure 2). Thus, overbank flow is not an annual event and its occurrence is dependent, in part, upon seasonal lake level conditions.

Figure 1. The St. Clair River Delta.
Based on flow distribution, it is clear that the most active portion of the delta is presently confined to the western side of Lake St. Clair. Much of the flow of the St. Clair River is carried by the large distributaries on the American side of the delta. North, Middle and South Channels account for approximately 95 percent of the flow volume whereas the principal Canadian distributary, Chenal Ecartsé, accounts for five percent. Although North Channel appears to have been the main channel a century ago, construction and continual dredging of the St. Clair Cutoff channel has increased the flow of South Channel.

Because the St. Clair River has few tributary streams, the source area for delta sediments are not solely of fluvial origin. Rather, the principal source appears to be the shorelines of Lake Huron, not incoming streams or river bank erosion. It has been determined that 21,700 cubic yards of sediment, primarily sand size, is transported by littoral currents from the southeastern shore of Lake Huron annually. An undetermined amount of sediment is also derived from moraines and ancient beaches along the western shore of Lake Huron. Size and mineral composition of Muscamoot Bay sediments are similar to the glacial sediment of the southern Lake Huron coastal zone.
The unusual transparency of the river water suggests that most of the material is being carried as bed load, not in suspension. It has been estimated that the total sediment load of the St. Clair River is about 20,000 cubic yards annually. Not only is the sediment load very low, but much of it may be transported through the delta into Lake St. Clair, thus accounting for the lack of present subaerial delta extension. In addition, over the past 55 years maintenance dredging by the Corps of Engineers in the St. Clair River has averaged 80,000 cubic yards annually. Private dredgers have also been extracting sand and gravel for many years, particularly from North Channel. Because dredging removes much of the bed load and since little material is carried in suspension, little subaerial delta growth is occurring.

DELTAIC LANDFORMS

As a lake delta, the St. Clair exhibits several of the landform characteristics of marine deltas, such as active and inactive distributaries, interdistributary bays, and crevasses which lead into interdistributary bays (Figure 3). However, although the St. Clair River delta has a classical bird-foot morphology, as does the Mississippi River delta, significant landform differences are also apparent. Atypical landforms include a premodern surface located at the apex of the delta and unusually wide distributary channels.

The active distributaries, North, Middle, and South Channels, average some 1,500 feet in width and 35

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Figure 3. Landforms of the St. Clair River Delta.
feet in depth. However, widths of 2,000 feet and depths of 80 feet are not uncommon. At the mouths of the distributaries, channel depths decrease abruptly indicating the presence of river mouth bars six to twelve feet below mean lake level. As a depositional basin, Lake St. Clair is relatively small with a maximum depth of 21 feet and a length of 25 miles.

North, Middle and South Channels exhibit shoulder-like features along both the cutbank and point-bar sides (Figure 4). A similar morphology has been attributed to periodic cut and fill associated with slight base level oscillations. Borings obtained from the Corps of Engineers reveal that the distributary channels of the St. Clair River delta are entrenched in lacustrine clays which lie beneath a 10 to 15-foot veneer of coarser deltaic sediment. On the cut-bank side, where flow velocities may be relatively high during high water conditions, an erosional berm usually less than eight feet below the water surface slopes gently from the cutbank towards the channel center. These features may be caused by lateral erosion of the fine, sandy deltaic sediments which overlie the lacustrine clays. On the inside bank, especially along Middle Channel, point bar deposits characterized by ridge and swale topography are conspicuous. Here the distributary shoulders probably represent a fill de-

Figure 4. During the Lower Water Conditions of 1949, the Distributary Shoulders were Evident. The Docks on the North Side of the Channel Delimit the Extent of this Feature.
posit which are colonized by emergent vegetation during low-water periods.

Because the water level fluctuates only 1.5 to two feet seasonally, spring floods are not a normal occurrence within the delta, hence natural levees are scarcely discernible adjacent to modern distributaries. Even though levees are poorly developed, averaging a few inches to 1.5 feet in elevation, flooding and subsequent overbank flow does occur. Overbank flow is associated with breaching of levees in abnormally low areas along a levee. As a levee is breached, crevasse deposits are introduced into the interdistributary bays at right angles to the channels (Figure 5). With continued deposition, the open-water bay will be filled with crevasse deposits and colonized by sedges and emergent aquatics.

Crevasse channels, locally known as "highways", are operative for several years. However, deposition into the bays is not rapid. A comparison of navigation maps reveals that such features may be part of the delta landscape for over a century. This suggests that crevasse channels are active intermittently and transport little sediment into the interdistributary bays.

During the winter and early spring when Lake St. Clair is frozen, pack ice accumulates at the mouths of distributaries forming ice jams. Channel flow is then diverted into crevasses and some overbank flow may occur. However, because the dominant grain size is sand, little
suspended sediment is transported from the deep distributaries into the interdistributary bays. Thus, in the St. Clair delta the filling of interdistributary bays and delta growth is a slow process.

In the Mississippi delta, in contrast, crevasse deposits rapidly convert open interdistributary bays into mud flats which are subsequently colonized with marsh grasses. During flood stage, the crevasse channels are scoured deep enough to be maintained and rapid deposition will occur. In the past 135 years, crevasse deposits have transformed the open interdistributary bays of the modern delta of the Mississippi River into a complex of marshy subdeltas.16

Beaches on the present delta shoreline are poorly developed and appear transgressive in origin. On the Canadian side, where the beaches are somewhat better developed, the berms may reach three to four feet in height and are colonized with sumac and small trees. Our borings reveal that the principal constituents of these beaches are coarse sand or fine gravel (−1.5 phi) separated by layers of sand and organic materials including rafted logs, bulrush stems and other debris. Coarse sands and fine gravels are not evident, and storm berms seldom exceed two feet in elevation. Characteristic vegetation of these shoreline features are either sedge marsh or a complex community of grasses, thistles and other non-woody species.

Within the interdistributary marshes, especially on lower Dickinson and Harsens Islands, are ar-}

Figure 6. Chematogan Channel, Cutting Through the Premodern Surface, is Almost Abandoned. In this Area, the Snow-Covered Natural Levees are Well Defined and Cultivated.
tinct differences. On the Canadian side, Chenel Ecarté and Johnson Channel are narrow, shallow distributaries which do not carry a significant portion of the volume of the St. Clair River. Moreover, open interdistributary bays are few and are colonized by marsh vegetation. Delta extension has ceased and maximum delta accretion is now occurring to the west as evidenced by the active digital distributaries of North, Middle and South Channels and Chenal a bout Rond. In the past, Chematogan and Bassett channels were approximately 1500 feet in width, comparable to the modern distributaries, but have been alluviated and colonized with aquatic plants as abandonment occurred (Figure 6).

In most deltas with large fluvial systems, lateral migration of the delta occurs because of the changes in the course of the river upvalley. The premodern lateral displacements of the Mississippi River delta originated within the alluvial valley, several miles from the Gulf Coast. Such a diversion process is evident in some lake deltas as well. Several older deltas of the Omo River, for example, have been identified which are related to the former position of the river within its alluvial valley.

However, the St. Clair delta has no comparable alluvial valley and delta migration has occurred from east to west at the shoreline of Lake St. Clair. As the Canadian distributaries degenerated, new distributa-

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Figure 7. A Cross Section of the St. Clair Basin. Source: Bore Data Furnished in Part by the U.S. Army Corps of Engineers.
ies were created on the western side of the delta.

DELTA STRATIGRAPHY AND GEOMORPHIC CHRONOLOGY

A series of borings, cores, and exposures indicate that in cross section the St. Clair delta is a thin and sandy deposit. An east-west cross section reveals that above the shale bedrock, lacustrine clays have been deposited over a thin deposit of glacial till (Figure 7). The coarse deltaic deposits, having a maximum thickness of 20 feet rest upon blue lake clays.

The north-south cross section from the apex of the delta into Lake St. Clair illustrates the near-surface stratigraphy (Figure 8). Topographically however, this cross section reveals two distinct levels, a modern and the equally obvious premodern surface. The premodern surface, standing about five feet above Lake St. Clair, consists of coarse, oxidized sand and is confined to the apex of the delta complex. It has been dissected by long, sinuous channels which have been alluviated. Occasionally during high lake levels these channels have been reoccupied, particularly in areas such as Dickinson Island, where human interference has been minimal. As this higher surface is topographically and sedimentologically distinct, it is a surface which was deposited during a pre-existing higher lake level. The modern delta with its finer sediment (2 to 3.35 phi) is located at present mean lake level and is represented by the active crevasses and interdistributary marsh deposits.¹⁸

Figure 8. Stratigraphy of the St. Clair River Delta. Source: Data from the U.S. Army Corps of Engineers, Wightman, op. cit., Footnote 3, p. 77, and Field Borings.
Based on the chronology of the proglacial Great Lakes, field data, and available C14 data, the relative geomorphological events of the St. Clair delta may be determined (Figure 9). Since the retreat of the Late Wisconsin ice, the outlets of the Great Lakes, and hence lake levels in the St. Clair basin, have oscillated sufficiently to construct two deltas. Compared to other proglacial Great Lakes, Lake St. Clair was a less permanent feature as the lake bottom was exposed to subaerial modification due to the fluctuating ice sheet which determined the outlets to the north and east.

One C14 date retrieved from the upper portion of the lake clays, but beneath the premodern delta, indicates that both deltas are less than 7,300 ± 80 years old. Based upon older proglacial Great Lakes chronology, the premodern delta may have been deposited during the latter stage of Algonquin time. With the subsequent retreat of ice during the Lake Stanley low-water stage, an outlet for the Lake Huron basin to the St. Lawrence was created via North Bay, Ontario. Quite possibly during this stage the premodern sands of the St. Clair delta may have been exposed, oxidized, and dissected. Following the Lake Stanley low-water stage, Lake Huron once again rose to the Nipissing stage and drained into the lower Great Lakes via the St. Clair River.

As determined by the more re-
cent chronology, the premodern delta may have been deposited during Nipissing time some 3,500 to 5,000 years before the present and not during Algonquin time.\textsuperscript{21} The premodern delta was deposited during a higher than present lake level and the subsurface sediments range in age from 7,300 to 9,300 years before the present. It is suggested that following the Lake Stanley stage (i.e., Nipissing stage), the St. Clair River once again flowed south into Lake St. Clair and the premodern delta was deposited at an elevation slightly higher than the modern delta (Table 1).

On many coasts, evidence for lower than present sea levels is determined by depositional surfaces which dip beneath younger sediments.\textsuperscript{22} Had the premodern delta been deposited during the Algonquin stage and the subsequent early Lake Stanley stage, evidence of that event as a depositional surface beneath the modern delta or a paleosol should be apparent. Numerous borings by us and others suggest that the premodern delta does not plunge beneath the modern sediment. Since the stratigraphy implies that lake levels were lower than present only once, a Nipissing stage is favored for the deposition of the premodern delta. Organic deposits, commonly composed of large wood fragments (probably red ash) lie beneath both deltas. Assuming that the peat accumulated from organic growth above the water table, it probably was deposited during a low-water period prior to the Nipissing stage (Lake Stanley?).

Following the Lake Nipissing high level, Lakes St. Clair and Huron fell to their present levels. The premodern channels were slightly entrenched and the premodern surface oxidized during the last 3,500 years. Towards the apex of the premodern delta, beyond the areas of flooding,

\begin{table}
\centering
\caption{Interpretation of the Events Related to the Origin of the St. Clair River Delta}
\begin{tabular}{lcc}
\hline
Approximate Dates B.P. & Lake Stage & Event \\
\hline
3,500 to Present & Modern Lake St. Clair and Algoma Phase & Flow of Lake Huron continues southward. Deposition of modern St. Clair River delta and dissection of premodern surface. \\
3,500 to 5,000 & Lake Nipissing & Deposition of premodern delta approximately 5 feet above present mean lake level. \\
5,000 to 10,500 & Lake Stanley & Lake St. Clair basin exposed; outlet for upper Great Lakes via North Bay, Ontario. \\
10,500 to 12,500 & Lake Algonquin and Post-Algonquin Phases & Valders Maximum. \\
\hline
\end{tabular}
\end{table}
a mix of hardwoods has colonized the oxidized soils and evidence of drowning of a pre-Lake Stanley delta by Nipissing high water levels is lacking. With the fall to the approximate present lake level, the modern delta was deposited in Lake St. Clair.

**COMPARISON WITH MARINE DELTAS**

A unique aspect of a delta’s geomorphology is related to its changing base levels. The base level of all marine deltas appears to have been eustatically stable over the past 5,000 years. In the Mississippi delta, because of the stable sea level, the ancestral streams deposited a series of delta lobes along the Louisiana coast. In the St. Clair changing base levels have produced two distinct deltas at different levels, the pre-modern and the modern. Examples of this base level change are apparently rare.\(^{23}\)

Marine deltas are often characterized by subsidence due to sediment loading. Geosynclinal downwarping and sediment compaction in response to sediment accumulation in the Mississippi River delta has allowed up to 400 feet of deltaic deposits to accumulate since the termination of the Lake Wisconsin glacial age.\(^{24}\) With continued sedimentation and subsidence, the shifting delta lobes overlapped, burying older deltaic environments. Therefore, the traditional sedimentological units, top-set, fore-set, and bottom-set beds, identified on the margins of Lake Bonneville by Gilbert, do not occur in the Mississippi River delta complex.\(^{25}\)

The bore data reveal that the St. Clair River delta is stable. Sediments accumulating in the delta are not of sufficient thickness to allow any significant downwarping to occur. Our borings on several beaches suggest that the base of these depositional features is at approximately low water datum. Apparently the beaches have not subsided like the cheniers have on the flanks of the Mississippi River delta.

Isostatic rebound in the St. Clair basin, due to the waning of Wisconsin ice following the Valders maximum some 10,500 to 12,500 years ago, has been minimal. Pertinent zero isobases since the Valders maximum are the Algonquin and Nipissing hinge lines which are oriented east-west and located in the central portion of Lake Huron. Therefore, crustal displacement due to regional glacial rebound or localized sedimentation does not appear to have directly influenced the vertical and horizontal morphology of the St. Clair River delta. The St. Clair River delta has, in fact, extended itself across an essentially rigid platform.

Although structural stability and minimum subsidence characterize the St. Clair delta, significant changes in the level of Lake St. Clair in the past few millenia have contributed to the morphology of the delta. Based upon a structural framework, deltas may be deposited in one of three geologic environments: a subsiding area, a stable area, or an elevating area.\(^{26}\) The Mississippi River delta with its thick accumulation of recent sediments, is a classic example of a subsiding delta. Although the Lake St. Clair basin is
geologically stable, the effect of a lower lake level on the delta complex is similar to elevating the land. Since base level in Lake St. Clair has dropped in the last 4,000 years, the focus of deposition has shifted lakeward creating the modern St. Clair River delta.

The configuration of deltas is related to offshore slope, relative wave power in the nearshore zone, and riverine influence. A delta such as the Mississippi with its digital distributaries and marshy embayments, is dominated by its river since its offshore slope is flat to convex and the nearshore wave power is low. Although long-term wave data have not been recorded for Lake St. Clair, wave energy must be considered to be low since the maximum fetch for wave generation for the delta is only 22 miles. The subaqueous delta front is shallow and concave, causing waves generated in the shallow lake to attenuate lakeward of the delta.

Also, marshes have become established on exposed offshore areas between Johnson Bay and the minus six-foot contour, suggesting that low wave energy conditions prevail. Although there may be an occasional dominance of marine processes as evidenced by the presence of transgressive beaches, it must be concluded that the geometry of the St. Clair delta, like that of the Mississippi, is principally dictated by its river.

**LANDFORM—VEGETATION RELATIONSHIPS**

In deltas, vegetation zonation is conspicuous, reflecting subtle variations in relief and edaphic conditions. Elements such as substrate composition, salinity, water depth, and protection from wave action are important variables determining plant distributions. The vegetation patterns, in turn, can be used to identify deltaic landforms or depositional environments. In the St. Clair delta, where wave energies are low and calcareous soils prevail, water depth or depth to the groundwater table appears to be the most significant variable. Unlike plant communities in marine deltas, the vegetation associations periodically shift landward or lakeward depending upon short-term lake-level conditions.

The vegetation of the St. Clair delta occurs, in broad, arcuate zones which extend from the apex near Algonac south into Lake St. Clair (Figure 10). Five major plant associations have been identified using aerial photography and verified in the field. Although significant cultural modifications such as residential development and clearing of land for cultivation have occurred on the delta, sufficient plant communities do remain and may be used to reconstruct the natural vegetation cover.

Landform-vegetation relationships observed in the delta are indicated in Table 2. The vegetation type on high ground consists of stands of oak-ash hardwoods distributed over premodern deltaic remnants of Dickinson, Harsens, Walpole, Squirrel and Ste. Anne Islands which range in elevation between three and ten feet. Once extensive, these hardwood stands are now discontinuous as a result of
Figure 10. Natural Vegetation and Land Cover of the St. Clair River Delta Based on 1972 Data.
TABLE 2
Landform-Vegetation Relationships in the St. Clair River Delta

<table>
<thead>
<tr>
<th>Landform</th>
<th>Associated Vegetation Type</th>
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<tbody>
<tr>
<td>Premodern Delta</td>
<td>Oak-Ash Hardwoods</td>
</tr>
<tr>
<td>Transition Zone</td>
<td>Dogwood Meadow and Aspen Stands</td>
</tr>
<tr>
<td>Modern Deltaic Surface</td>
<td></td>
</tr>
<tr>
<td>Inactive Beaches</td>
<td>Sedge Marsh and Dogwood Meadow</td>
</tr>
<tr>
<td>Actively Eroding Shorelines</td>
<td>Sedge Marsh</td>
</tr>
<tr>
<td>Natural Levees</td>
<td>Sedge Marsh</td>
</tr>
<tr>
<td>Interdistributary Bays</td>
<td>Cattail and Bulrush Marshes</td>
</tr>
<tr>
<td>Abandoned Channels</td>
<td>Bulrush and Aquatic Communities</td>
</tr>
</tbody>
</table>

Clearing for agricultural use in the late 1800's and early 1900's.\(^31\) Based on the size and abundance, the major species are swamp white oak (Quercus bicolor), red ash (Fraxinus pennsylvanica), and shagbark hickory (Carya ovata). Except where abandoned channels have dissected the premodern surface, the soils are comprised of oxidized, well-drained sands with pH values ranging between 7.0 and 8.0.\(^32\)

Lakeward of the hardwoods is a complex of communities referred to as the dogwood meadow (Figure 11). Geomorphologically, this zone occupies the broad contact between the premodern and modern delta.

Figure 11. Well-Defined Contact Between the Dogwood Meadow in the Foreground and the Transition Zone now Colonized by Aspens and Hardwoods. Because of Recent Cultivation, Few Dogwood are Present in this Meadow.
and is referred to as the “Transition Zone.” Abundant species, in terms of area covered, are bluejoint grass (*Calamagrostis canadensis*), red dogwood (*Cornus stolonifera*), and gray dogwood (*C. racemosa*). Areas within this vegetation type which were previously cultivated or mowed for hay are now being invaded by quaking aspen (*Populus tremuloides*) or reverting to dogwood meadow. In Ontario, because of continued expansion of commercial cultivation, the dogwood meadow is sporadically distributed.

A linear vegetation zone located between the dogwood meadow and the cattail marsh is the sedge marsh. This community is dominated by the sedge *Carex stricta* var. *strictior* which forms tussocks in response to a fluctuating surface water table. Bluejoint grass grows commensally in the tussocks with the sedge. The sedge marsh is distributed along river channels on low natural levees, as well as on actively eroding shorelines, as well as on relict shorelines now stranded in the cattail marsh. The preferred substrate appears to be calcareous sands and silts rather than peats and clays. Because natural levees of the defunct distributary channels, such as Chematogan Channel, are barely discernible, they can be readily identified on the basis of parallel strips of sedge marsh. Similarly, relict beaches identified in the cattail marsh can be mapped because of their association with sedges.

Where permanent inundation occurs and water depths exceed 10 to 12 inches, the sedges are replaced by a cattail marsh (mostly *Typha glauca*). An ecotone of mixed sedge and cattail occurs along the edges where water depths range from six to ten inches. Growing seven to ten feet in height, the hybrid cattail (*T. glauca*) thrives in dense colonies and shades out the tussock sedges. The lower portions of Dickinson, Harsens and Walpole Islands, which represent the modern deltaic surface, are colonized by cattail marsh. Water depths within this marsh average 0.5 to 3.0 feet and the preferred substrate consists of peats and organic-rich clays. Scattered shallow-water openings and muskrat lodges are common in this marsh and are useful for aerial photo interpretation of cattail colonies.

Where water depths exceed one to two feet and the substrate sediments are more sandy, the cattails appear to be less competitive and may be replaced by hard-stem bulrush (*Scirpus acutus*). Although only small colonies of hard-stem bulrush occur in the delta, they are fairly widespread in St. Johns Marsh, in the partially silted, abandoned channels, and in open-water areas on Dickinson Island. On exposed sand shoals in Muscamoot Bay and Anchor Bay colonies of this bulrush are also common.

Several other plant communities are conspicuous, though of insufficient density to map in detail. Thick colonies of reed grass (*Phragmites australis*), usually less than an acre in extent, occupy the distributary shoulders along South, Middle, and North Channels. In the abandoned river channels, which appear as partially-filled, elongate lakes, emergents such as yellow pond lily (*Nu-
phar sp.), hard stem bulrush, and water smartweed (*Polygonum amphi-

The landform-vegetation relationships provide important clues to the geomorphic history of the delta. In general, the premodern surface can be identified and mapped by the presence of upland hardwood vegetation and numerous old channels. In contrast, the extent of the modern surface is indicated by the cattail marsh.

Both the upland hardwood vegetation and ancient channels are clues to base level change. With the exception of natural levee areas, upland vegetation normally does not occur in deltaic environments. The abandoned channels, clearly visible on aerial photographs, are entrenched into the premodern surface and disappear in the marshlands of the modern surface (Figure 12). One abandoned channel, north of Goose Lake, trends westward across the premodern surface of the Canadian side of the delta. Such a feature suggests that in the past the base level of the St. Clair River dropped as much as 10 feet, causing entrenchment of the distributaries. At the same time, the delta shifted westward as flow ceased on the Canadian side allowing the ancestral channel to cross the upland surface without capture.

This interpretation is corroborated by the shoreline features isolated in the cattail marsh, especially on Dickinson and Harsens Islands. As these features are regressive

Figure 12. An Abandoned Channel on the Premodern Surface of Harsens Island Colonized by a Variety of Emergent Aquatics. Paralleling the Channel Margins is a Sedge Marsh.
beaches, they may represent shorelines as the base level dropped slightly and the western portion of the delta underwent accretion. Partial oxidation of the fine sands, which lie beneath the cattail marsh, to a depth of two to three feet indicate the maximum extent of base level lowering.

In addition to long-term base level changes, modern or short-term lake level changes are a significant cause of vegetation shifting in the delta as well as on other Great Lakes' shorelines. Over the years the level of Lake St. Clair rises and falls sufficiently enough to cause a displacement of the vegetative zones. Traverses taken in 1972 and 1974 reveal the vegetation shifts which have taken place as communities adjusted to higher water levels (Figure 13). As expected, the most extensive changes are evident in the modern delta. Nearly continuous during low-water periods, large tracts of cattail marsh in St. Johns Marsh, and along lower Dickinson, Harsens, and Walphole Islands have reverted to open water. Also, in response to increased water depths, a landward shift of the sedge marsh has occurred. The cattail marsh invaded the sedge marsh which, in turn colonized the dogwood.

A DELTA PERSPECTIVE

Because of its bird-foot shape, it may be assumed that the processes governing the formation of the St. Clair delta are similar to marine deltas of like morphology. A study of the morphology of marine deltas reveals that river regime, coastal processes, structural behavior, and climatic factors including vegetation,
control delta formation. A morphological comparison of the St. Clair and Mississippi River deltas has revealed that factors such as flow regime and structural behavior of the depositional basin are indeed different. The only similarity between the two deltas is the offshore profile which partially controls the marine wave energy (Table 3). Delta morphology is basically a function of the relative influence of river depositional processes versus coastal processes and submarine topography. Because of the short fetch, wave energies of many lake environments are low, resulting in prograding deltas with a digital shape.

Low wave energy combined with depositional basin stability and base level changes characterize lake deltas such as the St. Clair delta. However, even as a lake delta, the St. Clair is atypical in that its river is not a true fluvial system. As such, the delta lacks the seasonal flow variation, an alluvial valley and other common deltaic landforms such as well-developed natural levees. The wide distributaries and distributary shoulders created as channels attempt to meander while eroding into proglacial clays are also unusual. Because dredging operations remove much of the sediment the St. Clair River is transporting, little delta accretion has occurred during the past century. Thus the delta appears to be in quasi equilibrium, with neither depositional nor erosional processes dominating. Since the St. Clair delta comprises the largest wetland

### TABLE 3

Factors Influencing Lake and Marine Delta Morphology

<table>
<thead>
<tr>
<th>Factors</th>
<th>Characteristics</th>
<th>St. Clair Delta</th>
<th>Mississippi Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geomorphic:</td>
<td>Base level</td>
<td>Long-and-short-term variations</td>
<td>Stable</td>
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<tr>
<td>Flow Regime</td>
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<td>Seasonally constant</td>
<td>Seasonally variable</td>
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<tr>
<td>Channel Diversion</td>
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<td>Downstream (spring ice jams)</td>
<td>Within alluvial valley (spring floods)</td>
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<td>Structural Behavior of</td>
<td></td>
<td>Stable</td>
<td>Sediment compaction and significant subsidence</td>
</tr>
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<td>Basin of Deposition</td>
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<td></td>
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</tr>
<tr>
<td>Dominant Sediment Size</td>
<td>Fine to coarse sand</td>
<td></td>
<td>Clay to silt</td>
</tr>
<tr>
<td>Relative Rate of</td>
<td>Slow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedimentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine:</td>
<td>Relative Wave Energy</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Offshore Profile</td>
<td>Flat and gently sloping</td>
<td></td>
<td>Flat and gently sloping</td>
</tr>
<tr>
<td>Vegetative:</td>
<td>Vegetation Morphology</td>
<td>Deciduous trees to freshwater marsh</td>
<td>Predominantly fresh to brackish to salt marsh</td>
</tr>
<tr>
<td>Control of Vegetation</td>
<td>Short-term lake level changes</td>
<td></td>
<td>Salinity, substrate composition and tidal range</td>
</tr>
<tr>
<td>Distribution</td>
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</tbody>
</table>
environment in the Great Lakes and is part of an important navigational link, these geomorphic considerations may provide useful input for a management strategy. Clearly many of the process-response concepts applicable to marine deltas cannot be applied to the St. Clair delta.

Although the St. Clair delta does not illustrate dynamic Late-Recent changes in geomorphology as do marine deltas, its vegetation does. Shifts in vegetation zonation every few years of other lake deltas has not been documented in detail and therefore cannot be evaluated in a broader setting as the geomorphology can. Significant losses in coastal marshland due to flooding and severe erosion problems in the Great Lakes do suggest there is an urgent need for such studies. Only then can current problems such as wetland management, be clearly identified and placed in proper perspective.

REFERENCES AND NOTES

19. Wightman, op. cit., footnote 3, Appendix. Additional C14 Dates have been obtained by Mandelbaum, op. cit., footnote 4, p. 295. The dated materials range in age from 6100 ± 80 to 9300 ± 200 years. These organic materials do not appear to be in situ and they have not been included in our interpretation. However, even if the latter dates were used they would not detract from our argument. Pezzetta, op. cit., footnote 4, p. 2 also has radiogenic data that reveal that the minimum age of the delta sediments is 4,300 years before the present.
34. Morgan, op. cit., footnote 28, pp. 31-35.