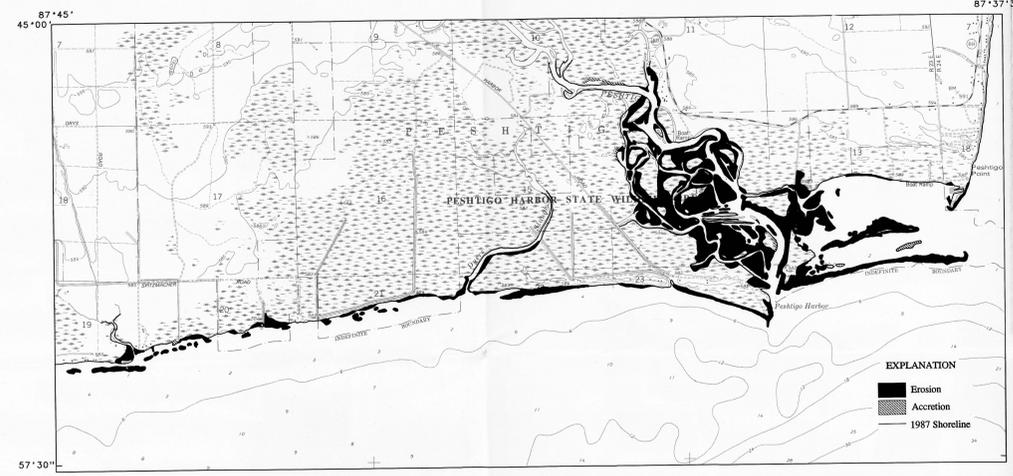
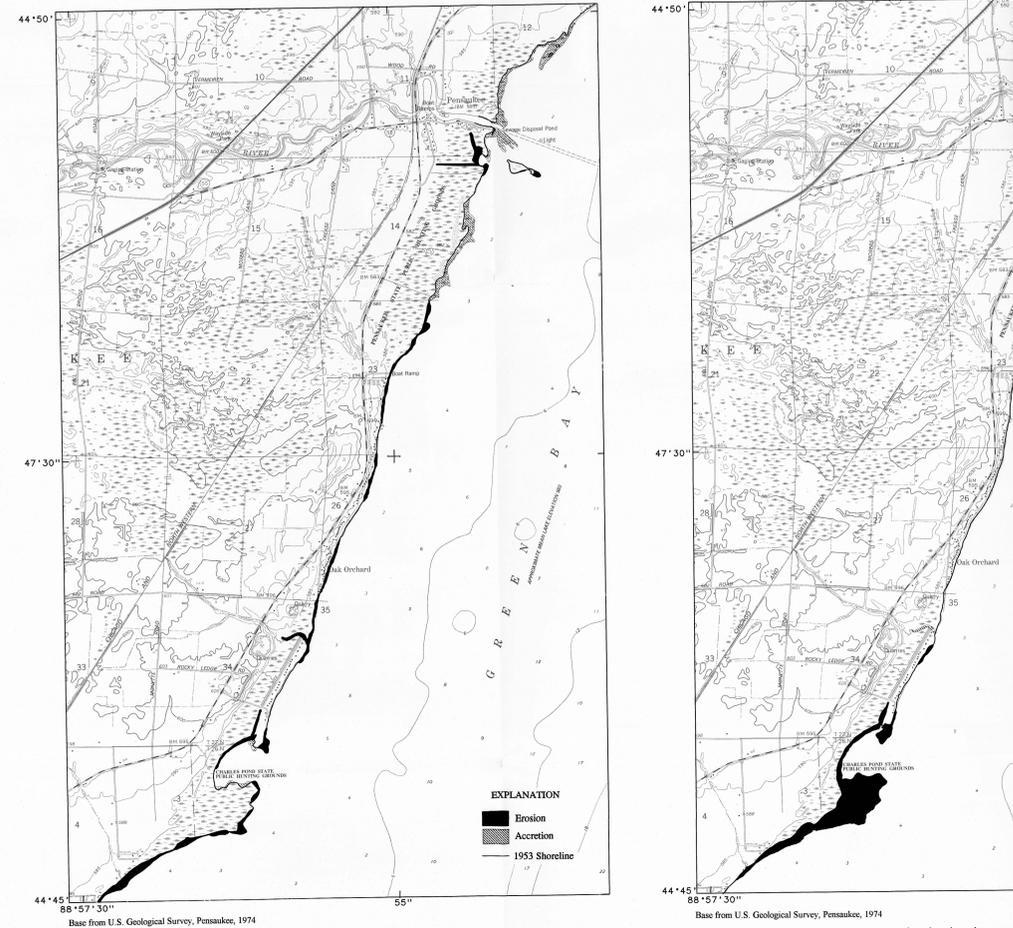


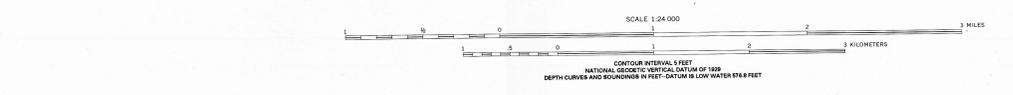
MAP A. Peshigo Harbor locality showing changes 1954-74.



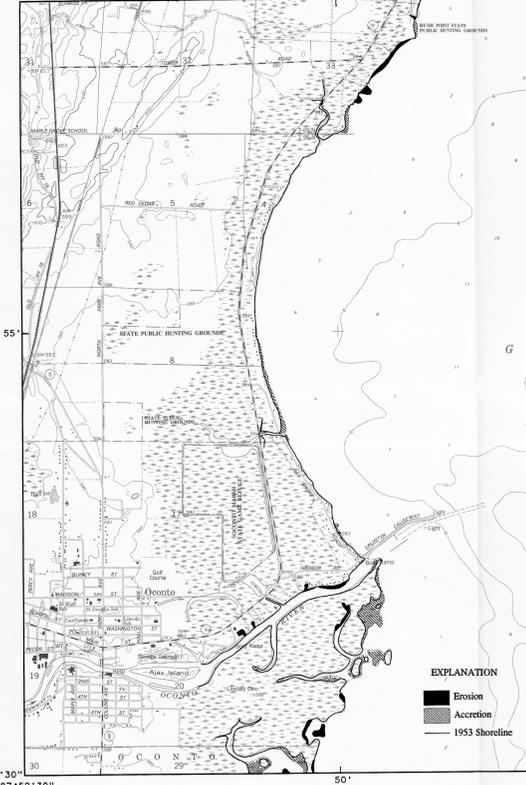
MAP B. Peshigo Harbor locality showing changes 1974-87.



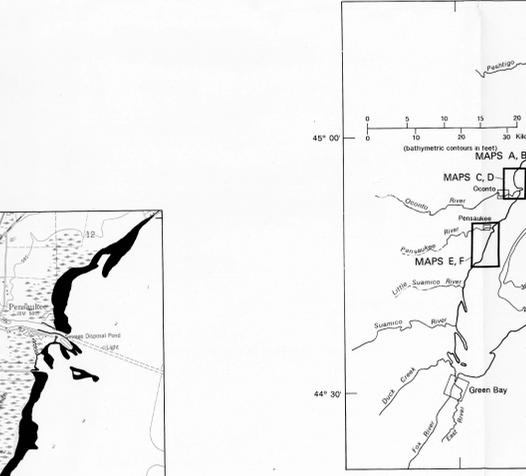
MAP E. Pensaukee locality showing changes 1953-74.



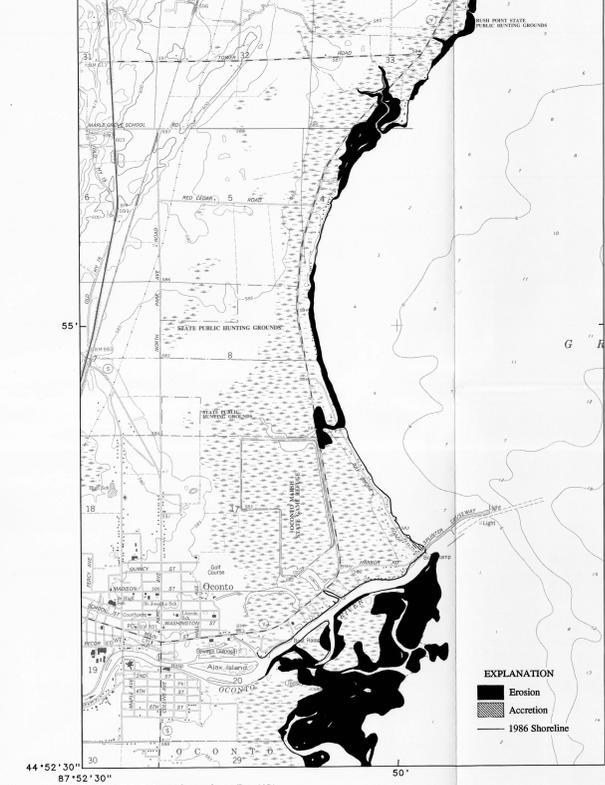
MAP F. Pensaukee locality showing changes 1974-86.



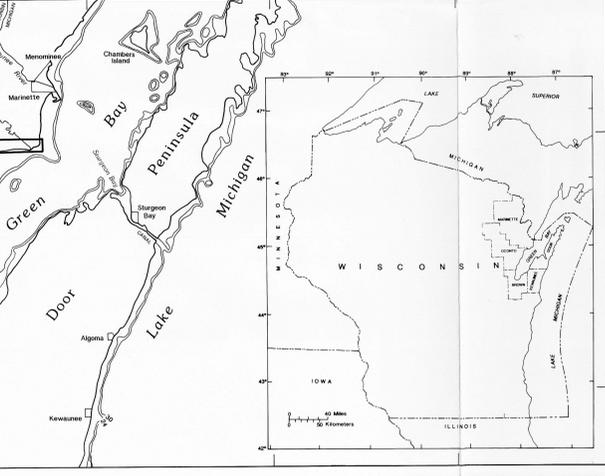
MAP C. Oconto locality showing changes 1953-74.



MAP D. Oconto locality showing changes 1974-86.



MAP E. Pensaukee locality showing changes 1953-74.



MAP F. Pensaukee locality showing changes 1974-86.

Figure 1. Location maps of Green Bay and the three study localities: Peshigo Harbor (Maps A, B), Oconto (Maps C, D), and Pensaukee (Maps E, F).

INTRODUCTION

Coastal wetland ecosystems along the Great Lakes shorelines are extremely valuable natural resources. They provide numerous environmental and recreational benefits, and they serve as critical habitats for fish and wildlife populations. In general terms, wetlands can be defined as lands transitional between terrestrial and aquatic systems; they are characterized by periodic submergence or a water table at or near the surface and a predominance of hydric soils and hydrophytes. Changes in shoreline positions over time result in concomitant changes in the amount of adjacent coastal wetlands. Frequently, resulting in a permanent loss of these valuable resources. In the Great Lakes region, the main natural cause of shoreline changes are lake-level fluctuations that result from two interactive factors. One factor is the glacio-isostatic rebound of the lake basins, which has been occurring since the end of the late Wisconsin glaciation to the present. This crustal rebounding along the Wisconsin shoreline of Lake Michigan is a relatively slow process, with annual rates of about 0.26 foot/year in the southern part of the Great Lakes drainage basin to 1.74 foot/year in the northern part of the basin (Larsen, 1989). The second factor contributing to lake-level fluctuations is climate variability, which controls the amount of regional precipitation and evaporation, storm frequency, runoff, and resulting lake levels. Climate variability can occur over a wide spectrum of time scales; it can range from seasonal variations, to long-term trends of a few years or decades in duration, to trends lasting hundreds or thousands of years. Climatic variations, in connection with glacio-isostatic rebound, have resulted in substantial temporal variability of the Great Lakes shorelines and associated wetland tracts during post-glacial times.

The objective of this study, which focuses on a critical coastal sector along the Lake Michigan shoreline of Wisconsin, is to conduct an historical assessment to determine trends in shoreline and wetland acreage changes over the last few decades. Establishing past trends is necessary in an effort to predict future trends in coastal-zone behavior, which is essential information for effective environmental and coastal land-use management programs. The critical sector selected for study, the west coast of Green Bay, consists of the most extensive tracts of ecologically important coastal wetlands along the Wisconsin shoreline of Lake Michigan (fig. 1). The total aggregate acreage of wetlands within about 1/4 mi inland of the shoreline in this coastal sector is approximately 6,600 acres, as indicated on 1974 U.S. Geological Survey (USGS) 1:24,000-scale topographic quadrangles. The open-coast type of wetlands along this sector in Marinette and Oconto Counties, Wis., are directly exposed to waves and lake currents. These wetlands are a highly productive waterfowl habitat that lies within a major waterfowl migration corridor and contains several endangered or threatened plant and animal species. The preservation of these wetlands is a high priority of the Wisconsin Department of Natural Resources. Unfortunately, this coastal sector is a relatively flat, low-lying area that is highly exposed to lake-level fluctuations and associated shoreline erosion. Consequently, these wetlands are prone to destruction by natural processes, some effects of which are documented in the present study.

DISCUSSION

Regional Setting

Green Bay, an appurtenance of Lake Michigan, is a relatively shallow elongated water body, about 10 mi long (fig. 1). The maximum water depth in the lower bay offshore from the study localities is about 85 ft east of Peshigo Harbor, and it decreases southward toward the head of the bay. Most of the lower bay adjacent to the localities selected for study is generally less than 20 ft deep. Green Bay is separated from Lake Michigan by the Door Peninsula, a promontory underlain by Silurian igneous and metamorphic rocks and overlain by upper Wisconsin glacial and lacustrine deposits. Structurally, the eastward-dipping Silurian rocks of the Door Peninsula form part of the northwestern margin of the Michigan Basin. The west shore of Green Bay in Marinette and Oconto Counties, including the three localities, is a relatively flat and low-lying coastal sector. It consists of a late Wisconsin lacustrine plain, which is buttressed on the west by terrain of higher relief underlain by till and outwash deposits (Larsen and others, 1983). The Quaternary deposits along this west shore coastal sector are generally less than 50 ft thick (Trotta and Cotter, 1973) and overlie Ordovician dolomite beds (1-2 decades) climate-controlled lake level fluctuations. During the time interval indicated by this study, hydrographic charts (U.S. Dept. of Commerce, 1987) above normal precipitation during the 1953-55, 1973-74, and 1985-86 periods. The maximum monthly mean water levels, in ft above mean water level at the 1955 International Great Lakes Datum, during these three periods are as follows: 1953-55 (58.95 ft), 1973-74 (58.15 ft), and 1985-86 (58.65 ft). This was the highest level in over a century, and it caused extensive flooding and erosion along the Lake Michigan shoreline. In addition to lake-level fluctuations, the west shore of Green Bay is also influenced by stream runoff. Three rivers enter Green Bay along this segment of the coast and substantial wetlands are developed in the floodplain areas. The general physiographic, biotic, and cultural features of the rural uplands and the localities discussed in this report have been summarized by Hensdorff and others (1981). In general, the three localities are characterized by flat open space and agricultural land with no significant land-use changes have occurred over the time interval covered by this study that would affect shoreline and wetland conditions.

Peshigo Harbor Locality

The Peshigo Harbor locality, Marinette County, is located in the Peshigo Harbor 1:24,000-scale topographic quadrangle (Maps A, B). The total aggregate acreage of wetlands within about 1/4 mi inland of the shoreline, as indicated on the USGS 1974 topographic quadrangle, is approximately 2,834 acres. Much of the Peshigo Harbor, has been designated as a State Wildlife Area. The east-west trending shoreline at the site is comprised of coastal wetlands directly exposed to bay waters, as well as some wetlands protected by local sand beaches and barrier spits. At the east end of the site (Peshigo Point), the east-west orientation of the shoreline changes abruptly and trends northward.

Oconto Locality

The Oconto locality, Oconto County, is in the Oconto East 1:24,000-scale topographic quadrangle (Maps C, D). The total aggregate acreage of wetlands within about 1/4 mi inland of the shoreline, as indicated on the 1974 topographic quadrangle, is approximately 2,250 acres. Included in the locality is the mouth of the Oconto River, along which an extensive coastal wetland tract is developed. Various parts of the wetlands at this locality have been designated as State public hunting grounds and a game refuge. The wetlands extend northward from the river mouth along a curvilinear shoreline, and are directly exposed to bay waters with no significant protective features such as sand beaches or barrier spits.

Pensaukee Locality

The Pensaukee locality, Oconto County, was in the Pensaukee 1:24,000-scale topographic quadrangle (Maps E, F). The total aggregate acreage of wetlands within about 1/4 mi inland of the shoreline at this locality, as indicated on the 1974 topographic quadrangle, is approximately 1,541 acres. The locality contains two significant coastal wetland tracts. One wetland tract is associated with the mouth of the Pensaukee River and extends southward for about 2 mi where it constitutes the Pensaukee State Public Hunting Grounds. This low-lying wetland tract terminates along a small coastal bluff. South of the bluff is the second low-lying wetland tract, part of which constitutes the Charles Pond State Public Hunting Grounds. The coastal wetlands along this north-south trending shoreline are directly exposed to bay waters and are highly constrained in their development by bedrock-controlled coastal topography.

SHORELINE AND COASTAL WETLAND VARIABILITY ALONG THE WEST SHORE OF GREEN BAY, MARINETTE AND OCONTO COUNTIES, WISCONSIN

By
 Gerald L. Shideler
 1994

Although the Oconto locality was predominantly accretionary during 1953-74, there is evidence of local coastal erosion and wetland losses totaling 14.5 acres. These relatively small erosional areas occurred just south of Rush Point in the northern part of the locality, and south of the Oconto River mouth. A few areas of erosion also occurred along the Oconto River channel; they appear to be mainly man induced excavation effects. Significant portions of the coastal sector between the Oconto River mouth and Rush Point showed no net change in shoreline position, indicating areas of relative stability during this time interval.

Shoreline and Wetland Changes (1974-86)

The Oconto locality over the 1974-86 interval can be characterized as a highly erosional site, which experienced a substantial net loss (418.8 acres) of wetlands acreage. During this time period, the 1986 shoreline was inland of the 1974 shoreline throughout most of the locality, reflecting shoreline recession attributable to higher bay water levels (the 1986 water level at the time of photography was about 1 ft higher than the 1974 level). These higher water levels caused the widespread inundation and erosion of coastal wetlands over the 12-year interval and resulted in wetland losses amounting to 420.4 acres. Most of the losses (313.3 acres) occurred south of the Oconto River mouth. Substantial losses also occurred in the vicinity of a crest in the boundary between Tps. 28 and 29 N. (50.8 acres), as well as in the Rush Point area and along the central sector of the locality.

During this period, there were no significant areas of coastal accretion and resulting wetland gains. The only accretionary site during this time was a small area (1.6 acres) immediately adjacent to the causeway at the mouth of the Oconto River and is probably attributable to the presence of the causeway structure. A few coastal sectors north of the Oconto River showed no net change in shoreline positions, thus indicating areas of coastal stability.

Pensaukee Locality

The Pensaukee locality, Oconto County, was in the Pensaukee 1:24,000-scale topographic quadrangle (Maps E, F). The total aggregate acreage of wetlands within about 1/4 mi inland of the shoreline at this locality, as indicated on the 1974 topographic quadrangle, is approximately 1,541 acres. The locality contains two significant coastal wetland tracts. One wetland tract is associated with the mouth of the Pensaukee River and extends southward for about 2 mi where it constitutes the Pensaukee State Public Hunting Grounds. This low-lying wetland tract terminates along a small coastal bluff. South of the bluff is the second low-lying wetland tract, part of which constitutes the Charles Pond State Public Hunting Grounds. The coastal wetlands along this north-south trending shoreline are directly exposed to bay waters and are highly constrained in their development by bedrock-controlled coastal topography.

Shoreline and Wetland Changes (1953-74)

During the 1953-74 interval, erosional areas slightly exceeded accretionary areas in the Pensaukee locality. This resulted in a small net loss (8.4 acres) of wetland acreage during this 21-year period. The position of the 1953 shoreline was predominantly bayward (east) of the 1974 shoreline throughout much of the southern two-thirds of the locality, indicating shoreline recession and the resulting loss of wetland acreage. The total loss of wetlands during this 21-year interval amounted to 50.1 acres. Much of the loss (25.7 acres) was in the vicinity of the Charles Pond State Hunting Grounds area in the southern part of the locality. The remaining erosional areas were mainly along the central coastal sector. A small amount of erosion also occurred just south of the mouth of the Pensaukee River, some of which appears to be man-induced excavation effects.

In the northern third of the locality, the 1953 shoreline position was predominantly inland from the 1974 shoreline, indicating marshy shoreline progradation and accretion along this coastal sector. Coastal accretion resulted in a total wetland gain of 41.7 acres, most of this gain was in the northern coastal sector, although a small amount (1.2 acres) also occurred in the Charles Pond area. A few coastal sectors that showed no net change in shoreline positions were intermittently distributed along the locality, indicating areas of relative stability.

Shoreline and Wetland Changes (1974-86)

The Pensaukee locality during the 1974-86 time interval can be characterized as an erosional site that sustained a substantial net loss (183.1 acres) of wetlands acreage. During this time period, the 1986 shoreline was inland of the 1974 shoreline being further inland than the 1974 shoreline over most of the locality, reflecting substantial inundation and erosion of wetland areas (the 1986 water level at the time of photography was about 1 ft higher than the 1974 level). Total wetland losses amounted to 183.5 acres. The most extensive erosion occurred in the northern third of the locality, with losses of wetland acreage both north of the Pensaukee River mouth (42.2 acres) and south of the river mouth (59.9 acres). A second extensive area of erosional wetland loss (83.4 acres) was in the vicinity of the Charles Pond State Hunting Grounds in the southern third of the locality.

During this time period, there were no significant areas of coastal accretion and gains in wetland acreage. Only two small channel-fill accretionary sites occurred, which amounted to 2.4 acres. The central sector of the locality consists of a small coastal bluff that separates the relatively low lying northern and southern wetland tracts; this topographically higher sector showed no net change in shoreline positions, thus indicating an area of coastal stability.

SUMMARY

An assessment of shoreline positions and coastal wetland areas along the west shore of Green Bay indicates substantial variability over the 1953-87 time interval. Observed trends reflect lake-level fluctuations and associated coastal erosion and accretion processes. At three specific localities, predominantly erosional shorelines resulted in substantial net losses of wetland areas, with most losses occurring during the 1974-87 period mainly as a result of climate-induced high lake levels. The total net losses of coastal wetland areas at the three study sites over the 33-year time interval are 653 acres at the Peshigo Harbor locality, 380 acres at the Oconto locality, and 192 acres at the Pensaukee locality. The trends of wetland area losses outlined in this study could be partially mitigated in the future as a result of a trend of lower lake levels since 1986 and the possible rejuvenation of former wetland areas.

ACKNOWLEDGMENTS

The author expresses his gratitude to the staff of the Wisconsin Department of Natural Resources (WDNR) for their assistance in identifying critical coastal wetland problem areas along the Wisconsin shoreline of Lake Michigan. Special appreciation is extended to R.L. Fauscholder of the WDNR Lake Michigan District Office in the City of Green Bay for accompanying the author on field visits to the Peshigo Harbor, Oconto, and Pensaukee localities. Appreciation is also expressed to B.D. Simon and L.J. Stoecker of the WDNR office in Madison for providing information needed in prioritizing wetland problem areas for conducting site-specific studies.

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Table 1.—Summary of coastal wetland areal changes, west shore of Green Bay, Marinette and Oconto Counties, Wisconsin

Time Interval	Areal Changes (in acres)	Peshigo Harbor locality
1954-74	Erosion 35.2 Accretion 39.7 Net change 4.5 gain	
1974-87	Erosion 365.3 Accretion 7.5 Net change 357.8 loss	
1954-87	Total net change 353.3 loss	
Oconto locality		
1953-74	Erosion 14.5 Accretion 53.3 Net change 38.8 gain	
1974-86	Erosion 420.4 Accretion 418.8 Net change 1.6 loss	
1953-86	Total net change 380.0 loss	
Pensaukee locality		
1953-74	Erosion 50.1 Accretion 41.7 Net change 8.4 loss	
1974-86	Erosion 185.5 Accretion 183.1 Net change 183.1 loss	
1953-86	Total net change 192.5 loss	

CONVERSION FACTORS

From	To
hectares (ha)	2.471 acres
square meters (sq m)	0.0002471 acres
square kilometers (sq km)	247.1 acres

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