Geology of the Zion Beach-Ridge Plain
A Holocene, Migratory, Coastal-Sedimentary System

Michael J. Chrzastowski

Field Trip Guidebook
SEPM/Society for Sedimentary Geology
Great Lakes Section Annual Field Conference
September 14–16, 2001
Illinois Beach State Park
Resort and Conference Center
Zion, Illinois

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Cover Photo: View of beach scarp resulting from storm erosion along the shore in the North Unit of Illinois Beach State Park. Camp Logan headland is in the distance on the horizon. (Photo taken September 14, 1997 by M. Chrzastowski.)
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Field Trip Co-Sponsors
Great Lakes Section SEPM/Society for Sedimentary Geology
Illinois State Geological Survey
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# Table of Contents

**Introduction**  
**Acknowledgments**  
**Geologic Framework**  
  - Morphology of the Zion Beach-Ridge Plain  
  - The Beach-Ridge Plain in Three Dimensions  
  - Watershed  
  - Sediment Characteristics  
**Coastal Processes**  
  - Overview  
  - Waves  
  - Littoral Transport  
  - Littoral Transport Volumes  
  - Lake-Level Changes  
  - Storm Setup  
  - Nearshore Ice  
**Geologic Evolution**  
  - Overview  
  - Lake-Level History  
  - Glenwood Phases: The Root River Delta  
  - Calumet Phase: Erosion, Transport, and Spit Development  
  - Chippewa Phase: An Abandoned Coast and Ravine Erosion  
  - Nipissing Phases: Early Formation of the Beach-Ridge Plain  
  - Algoma and Modern Phases: Migration of the Beach-Ridge Plain  
  - Ultimate Fate of the Beach-Ridge Plain  
**Stop Descriptions**  
  - Stop 1: Pennoyer Park and Simmons Island Park, Kenosha  
  - Stop 2: North Point Marina, South Parking Area  
  - Stop 3: Camp Logan Headland  
  - Lunch Stop: Rooks Restaurant  
  - Stop 4: Dead River and the South Unit Nature Preserve  
  - Stop 5: Cooling-Water Channels at Waukegan Power Station  
  - Stop 6: Waukegan Harbor Entrance Channel  
  - Stop 7: Foss Park, North Chicago  
**References**  
**Appendixes**  
  - A  History of Illinois Beach State Park  
  - B  Topographic Maps/Field Trip Stops
Introduction

This field trip guidebook provides an overview of the geology and geologic history of the Zion beach-ridge plain. This coastal sedimentary features extends nearly 29 km (18 mi) along the western shore of southern Lake Michigan from Kenosha, Wisconsin, southward to North Chicago, Illinois (fig. 1). Land use across the plain includes residential, commercial, industrial, and utility land uses. However, much of the plain is protected land within the North and South Units of Illinois Beach State Park (fig. 2). Within the state park are coastal sedimentary features that have been undisturbed by development. The park also includes the longest reach of shoreline in Illinois free of shore-protection structures.

Beach-ridge systems occur at many locations along the Lake Michigan coast. Many are located within embayed reaches of the shore and were formed during times of lowering lake level. One of the most extensive beach-ridge systems along the Lake Michigan coast extends along most of the Indiana coast. Best developed in the western Indiana coastal area, the beach-ridge system there is as much as 8 km (5 mi) wide (Chrzastowski and Thompson 1992). The Zion beach-ridge plain has similarities to other beach-ridge systems along the Lake Michigan coast and elsewhere in the Great Lakes, but is distinctive because it is a migratory system. Over the past 5,000 years, the plain has been advancing southward along the coast as a result of littoral transport processes. The beach-ridge plain includes a depositional record associated with the lowering of lake level, as in the other systems, and also includes an erosional and depositional history related to the translation along the coast. Also recorded is the change in the geometry of the plain over time as the translation has involved a gradual but persistent elongation and narrowing of the sand body.

The Zion beach-ridge plain presents an opportunity to examine a variety of coastal geologic features that relate to the erosion, transport, and deposition of this plain and provide the record of its fairly short-lived but complex history. The varied land use and the history of land use along the plain provide an opportunity to examine how human activity has interacted with the ongoing processes of coastal change. The human story of building along this coastal reach is one of both successes and failures as greater
or lesser consideration was given to the dynamics of this setting. The stops selected for this field trip and discussed in this guidebook relate to two objectives of the trip:

1. Examine features of the coastal geology of the Zion beach ridge plain that illustrate the evolution of this coastal landform.

2. Examine and review the history of land use along this shore and the interplay of these land uses with the local coastal processes.

The trip is designed for one full day of stops along the beach-ridge plain starting at Kenosha and progressing southward to the harbor entrance at Waukegan. An additional stop is described for Foss Park in North Chicago. This stop provides an opportunity to view the beach-ridge plain from a point about 0.8 km (0.5 mi) south of the plain's southern limit.

**Acknowledgments**

Several members of the Illinois State Geological Survey (ISGS) contributed to the completion of this guidebook. Cheryl Nimz edited the text and oversaw the guidebook production, Daniel Byers created the guidebook layout and page formatting, and Joel Dexter provided digital photographs. In preparation for this SEPM Great Lakes Section Annual Field Conference, C. Pius Weibel (SEPM/GLS Secretary) managed announcements and field trip promotion. Sallie Greenberg assisted in the field trip logistics.

Special appreciation is extended to Robert Grosso, Site Superintendent of Illinois Beach State Park, for access and assistance to several field trip stops within the state park. In particular, his assistance provided limited access into the South Unit Nature Preserve south of the Dead River. Special appreciation is also extended to the management of the Illinois Beach State Park Resort and Conference Center for its gracious hospitality in the use of the Resort and Conference Center for all in-house activities during this Annual Field Conference.

This guidebook draws on a previously published guidebook for this area prepared for one of the Geological Sciences Field Trips conducted by the ISGS (Chrzastowski and Frankie 2000). Information on these biannual field trips is available at the ISGS Web site (http://www.isgs.uiuc.edu/).
Geologic Framework

Morphology of the Zion Beach-Ridge Plain

Beach-ridge plains are coastal landforms that occur worldwide along sandy coasts. Beach-ridge plains consist of linear, generally coast-parallel mounds of sand and/or gravel that have accumulated by wave action and built next to each other to build the coast out into the adjacent ocean or lake. Excellent examples of beach-ridge plains along ocean coasts occur along the Nayarit coast in Mexico and on St. Vincent Island, Florida. The Zion beach-ridge plain is an elongate landform that extends along the Lake Michigan shore for nearly 29 km (18 mi) from Kenosha, Wisconsin, to North Chicago, Illinois (fig. 1). The plain has a maximum width of about 1.6 km (1 mi) opposite Zion, Illinois, and thus has the informal name given to the plain identified with this location. The below-water continuation of the plain extends nearly 1.6 km (1 mi) offshore.

A characteristic of a beach-ridge plain is its “washboard” topography of subparallel ridges and swales. The landform is called a plain because the elevation difference between the tops of the ridges and the bottom of the swales is minor compared with the length and breadth of the overall landform. The ridges and swales of the Zion beach-ridge plain are best seen in the South Unit of Illinois Beach State Park and are best viewed from the air (fig. 3). The difference in elevation between the ridges and swales in Illinois Beach State Park is generally no more than 3 m (10 ft), but, in some cases, sand dunes are built atop the ridges and add to their height. The ridges are typically formed by storm waves that deposit a mound of sediment along the upper part of the beach. Such deposits can have a lateral continuity for great distances along the shore. Although formed a short distance inland from the shoreline, the ridges provide an approximation of former shorelines and shoreline configurations. The ages of the ridges and the shorelines they represent can be estimated by \(^{14}C\) dating of the basal marsh deposits in the swales. The dates provide an approximation of the age of the more lakeward (seaward)
ridge that formed the swale and a minimum age for the more landward ridge.

The Zion beach-ridge plain defines one of the three coastal-geomorphic divisions along the Illinois coast (fig. 4). To the south of the plain is a bluff coast where the shore intercepts end moraines of the Lake Border morainic system. Bluffs along this reach have a crest as much as 27 m (90 ft) above mean lake level. The bluff slopes range from 25 degrees to nearly vertical. The bluffs consist of a gray to brown silty clayey till (Wadsworth Till Member of the Wedron Formation) interbedded with glacial lake sediments of clay, silt, sand, and gravel. Average grain size of the till is 10% sand, 42% silt, and 48% clay (Collinson et al. 1974). South of the bluff coast is the Chicago-Calumet lake plain (or Chicago lake plain), a broad, low-slope surface that was submerged during times of higher-than-present lake levels in early and mid-Holocene times. The lake plain consists of till overlain by glacial-lake silt and clay and elongate sand deposits in relict spits and beaches.

The significance of the bluff and lake-plain coasts to the Zion beach-ridge plain is that both bluff and lake-plain settings are preserved in the upland to the west of the beach-ridge plain. The upland includes a narrow lake plain that was also submerged when a proglacial lake (Lake Chicago) submerged the Chicago-Calumet lake plain. This lake plain near Zion is a bench 6 to 18 m (20 to 60 ft) above present lake level. The lakeward margin of this plain was a bluff coast prior to the development of the beach-ridge plain. Relict coastal bluffs occur along the western margin of the beach-ridge plain that are similar to those present along the shore to the south.

The Beach-Ridge Plain in Three Dimensions

Figure 5 shows a cross section in the Illinois portion of the plain within the area of maximum width. This lenticular body of sands and gravels is thickest near the present shoreline and thins both landward (west) and lakeward (east). The maximum thickness ranges from 9.1 to 10.6 m (30 to 35 ft) (Fraser and Hester 1974). On the western margin, the sediments of the plain pinch out at the toe of the change in slope to the upland bluffs. In this zone, sediments of the beach-ridge plain overlie former beach
deposits from when this was a bluff coast. On the lakeward mar­
gin, the beach-ridge sediments extend more than 1525 m (5000 ft)
offshore and thin to a veneer that becomes indistinguishable from
the veneer of sand and gravel that blanket the lake floor. Along
the Wisconsin shore south of Kenosha, the beach-ridge plain has a
slightly different cross section. Here the plain is not only narrower
but also thinner across much of its extent, about 2 m (6 ft) thick,
and the underlying till is at a slightly higher elevation (Larsen 1985).

As a means to compare the three­
dimensional geometry of the beach-ridge
plain with the beaches that occur to the
south, figure 5B shows a representative
cross section of the beach and nearshore
deposits at the Highwood Waterworks
located about 13.7 km ( 8.5 mi) south of
the southern limit of the beach-ridge plain.
All of the beach and nearshore deposits
along the Illinois bluff coast are typically
thin (less than 3 m [10 ft] thick) and nar­
row (less than 915 m [3,000 ft] wide)
(Shabica and Pranschke 1994). Similar thin
and narrow beach and nearshore deposits
existed along a bluff coast at the site of the
present beach-ridge plain prior to the plain
advancing southward and superimposing
these deposits.

**Watershed**

The Zion beach-ridge plain is the focus of a watershed that
has an elongate, north-south trend that generally parallels the
shore and reaches to about 0.8 km (0.5 mi) inland (fig. 6). The
westward limit of this watershed approximates the route of Green
Bay Road, which generally follows high ground along the crest of
one of the Lake Border end moraines (fig. 4). The drainage divide
formed by this end moraine separates drainage directed east to the
Zion beach-ridge plain and then into Lake Michigan from
drainage directed westerly and then southerly by way of the Des
Plaines River. This divide is a segment of the eastern continental
divide separating drainage directed through the Great Lakes to the
Gulf of St. Lawrence from drainage directed through the Mississippi River basin to the Gulf of Mexico.

The total drainage area west of the beach-ridge plain is about 96 km² (37 mi²); 46% is in Wisconsin and 54% is in Illinois. West of the beach-ridge plain, the streams occupy a dendritic pattern of v-shaped ravines incised into the glacial sediments. The geologic history of these ravines has yet to be adequately studied, but they likely formed during the Chippewa phase of Lake Michigan lake-level history. This phase occurred from about 10,000 to 5,500 years before present (B.P.) when lake levels were tens to hundreds of feet lower than today. In response to the lower lake levels, erosion occurred along the stream channels draining to the lake. (See Geologic Evolution section.)

**Sediment Characteristics**

The surficial sediments of the Zion beach-ridge plain consist of a broad range of materials that include organic-rich sand, silt, and clay in the marsh deposits of the swales, well-sorted medium sands in the dunes, and localized deposits of concentrated course sand, pebbles, and cobbles. In the subsurface, the sediments are dominated by those deposited below or at lake level as the beach-ridge plain advanced along the coast (fig. 7). The deepest deposits are fine to medium sands with shell material. These are overlain by medium to coarse sand and gravel that accumulated in the nearshore and eventually across the beach. The vertical sequence of offshore, nearshore, and beach deposits mimics the surficial lateral sequence of deposits that is encountered between the beach and that progress offshore across the lake bottom.

The well-rounded pebbles and cobbles distributed across the beach and shallow nearshore are a noteworthy collection representing a variety of rock types that occur in northern Wisconsin, northern Michigan, and southern Ontario, Canada. The lithologies attest to glacial transport; the well-rounded form supports a previous history as glacial-fluvial deposits.
Coastal Processes

Overview

The Zion beach-ridge plain owes its origin and evolution to coastal processes. The areal extent and configuration of Lake Michigan provide a setting in which many of the coastal processes operating along the shore at the Zion beach-ridge plain are comparable with coastal processes operating along many ocean coasts. In contrast to most ocean coasts, in this Great Lakes setting, mean water level can change rapidly because of atmospheric disturbances across the confined water area of the lake. This Great Lakes coast also experiences the dynamics of coastal ice, which is a phenomenon occurring elsewhere only along arctic and near-arctic reaches of ocean coasts.

Waves

Of all the dynamic forces influencing the Zion beach-ridge plain, wave action is the most important. Generated by winds blowing across Lake Michigan, waves (1) provide the energy for the erosion, transport, and deposition of sediment; (2) provide the dynamics to influence the shape of nearshore lake bottom and beach; and (3) play a role in the location and configuration of the shoreline. Because the beach-ridge plain is along a north-south-trending reach of the western shore of the lake, the shore here is exposed to waves approaching from either the northeast or southeast quadrants. Wave generation is dependent on wind speed and direction, wind duration, and fetch, the distance wind can blow over water. For the shore along the beach-ridge plain, the greatest fetch is to the northeast.

Wave data for the shore at Illinois Beach State Park has been evaluated based on a 32-year history of observations along the Lake Michigan shores (Hubertz et al. 1991, Booth 1994). The average wave along this shore has a height of 0.7 m (2.3 ft) and a period (time between the passage of wave crests) of 3.7 seconds. Compared with the average wave intercepting most ocean coasts, this wave setting is relatively small. During storm events, however, waves along this coast can exceed 3 m (9.8 ft), which is equivalent to storm waves along some ocean coasts.
The frequency of waves approaching the Illinois Beach State Park shore from three, 60-degree easterly sectors is shown in figure 8. Considering the occurrence of all waves approaching this shore, regardless of height, the majority of waves (46%) approach from a southerly direction (fig. 8, Sector III). When wave frequency is considered according to wave height, waves from a northerly direction dominate. The northerly direction accounts for half the waves equal to or exceeding 1 m (3.2 ft), nearly three fourths of waves equal to or exceeding 2 m (6.6 ft), and 90% of waves equal to or exceeding 3 m (9.8 ft). The important point is that regional wind patterns are such that the most common winds and waves along this shore are southerly, but the northerly fetch allows waves from this direction to have the greater height, the greater energy, and thus the net influence along this coast.

**Littoral Transport**

Littoral transport refers to the movement of sediment along the beaches and in the nearshore zone under the influence of wave action and wave-induced currents; littoral drift refers to the sediment moved in this process. Waves approaching the shore at an angle provide the driving force for littoral transport (fig. 9). In the nearshore, sediment is moved along the lake floor by a current generated by the incoming waves. As the waves break along the beach, sediment is moved across the beach surface by the swash and backwash.

The littoral transport along this shore can be directed either northward or southward depending on the wave approach at any time. As mentioned in the discussion of waves, the majority of time the waves approach the state park shore from a southerly direction and the littoral transport is northward. However, the largest and most energetic waves approach from the northerly direction, and the transport capability of these waves greatly exceeds their southerly counterpart. Thus, each year sediment is moved both northward and southward along the state park shore (called “gross transport”), but it is southward transport that is the net transport direction.

The net southerly transport along this shore results in the northward direction being referred to as “updrift” and the southward direction being referred to as “downdrift.” This terminology
is also used in referring to the updrift (north) and downdrift (south) side of structures that extend across the beach and into the nearshore. These structures can act as barriers to the littoral transport, trapping littoral sediment on the updrift side and depriving littoral sediment supply to the downdrift side. Examples of such littoral sediment entrapment against shore structures include the higher and wider beaches on the updrift (north) side of shore structures at Camp Logan (Stop 3).

**Littoral Transport Volumes**

The littoral transport volume can vary significantly from year to year because of differences in storm-wave frequency and intensity, lake-level changes, changes in sediment supply, and the influence of human activity in aiding or interrupting the littoral transport. The volume estimates for the littoral transport along Illinois Beach State Park are generally between 56,000 and 73,000 m$^3$ (73,000 and 95,000 yd$^3$) per year (U.S. Army Corps of Engineers 1953, Tetra Tech 1978, Foyle et al. 1998). A volume of 61,000 m$^3$ (80,000 yd$^3$) is often used as a representative or average annual volume. The available data suggest that the long-term average transport rate has not changed much over historical time. What has changed is the contribution to this supply that reaches the Illinois coast from the Wisconsin shore.

Prior to shore protection to armor most of the southern Wisconsin shore, erosion and transport along that reach could contribute several tens of thousands of cubic meters per year to the littoral transport. The combination of shore defense along much of the shore south of Kenosha and the capture, dredging, and removal of littoral sand at the entrances to Kenosha Harbor and Prairie Harbor Marina on the Wisconsin side of the state line has drastically reduced the influx of littoral sediment to the Illinois shore. The estimated volume of littoral transport crossing the state line is only slightly more than 7,600 m$^3$ (10,000 yd$^3$) annually (Foyle et al. 1998). Thus, the majority of the littoral sediment that is in transport past the southern end of the Illinois Beach State Park is derived from erosion of the beach and nearshore in the northern reach of the park. This erosion and its mitigation is a major coastal management issue that is further discussed in the Stop 2 portion of the field trip.
Lake-Level Changes

The level of Lake Michigan varies annually, seasonally, daily, and hourly. On an annual basis, lake level generally changes by about 0.3 m (1 ft) with high water in summer and low water in winter (fig. 10). The seasonal and multi-year fluctuations in lake level result from long-term changes in the overall water budget of the Great Lakes system. Short-term changes over days or hours result from the lake surface responding to winds pushing water toward or away from the shore or result from differences in atmospheric pressure across the lake basin. Since the beginning of official lake-level records for Lake Michigan in 1860, the extreme range of monthly mean elevations is 1.9 m (6.3 ft) between the historical low water in March 1964 and the historical high water in October 1986.

Times of high lake levels have caused severe erosion along the beach-ridge plain and, in some cases, have required emergency shore-protection measures. A common misconception is that coastal erosion is not a problem when lake levels are lower. The lower lake levels do make it more difficult for storm waves to reach sufficiently landward to cause erosion of the upper beach and the foredunes. However, erosional processes are still active at the lower lake levels. The focus of erosion shifts downward and lakeward across the nearshore lake bottom. Erosion can also be more focused around the toe of shore structures such as breakwaters or groins that otherwise would be submerged by deeper water and have greater protection from wave action.

Storm Setup

Setup refers to a temporary rise in lake level caused by winds pushing water toward the shore. Factors that determine the height of the setup include the strength and duration of the wind but also the location along the shore and the fetch that the winds can blow across. The elongate north-south orientation of Lake Michigan...
and the strength of northerly storm winds makes the southern shore of the lake susceptible to the maximum height of setup. Maximum potential setup along the Indiana shore is 0.5 m (1.7 ft). The potential setup diminishes progressing northward along the Illinois shore corresponding to the decrease in fetch. At Milwaukee, Wisconsin, the setup is 0.3 m (1.2 ft) (U.S. Army Corps of Engineers 1978). Based on the intermediate location of the Zion beach-ridge plain relative to the Indiana and Milwaukee locations, maximum setup along the shore of the plain would be expected to be about 0.4 m (1.4 ft). Setup provides a means for the swash of storm waves to reach higher and farther inland.

**Nearshore Ice**

The winter development of ice along the Lake Michigan coast is one of the key factors distinguishing the coastal dynamics here from that of most ocean coasts. The role of ice in the dynamics of this coast was often ignored or misunderstood in years past, but recent research efforts by the U.S. Geological Survey and other researchers have shed new light on the role that ice plays in shaping the lake bottom and in the redistribution of coastal sediments. Often thought to be a process that “locks up” the shore and prevents erosion, ice has now been documented to induce nearshore erosion and often to contribute to the permanent loss of nearshore sand.

Conditions can favor the development of ice along this shore from December to March, but the ice history from year to year can be quite variable. Whether or not ice forms and how long any ice development persists depends on the duration of air temperatures at or below freezing, the lake-water temperature, and the duration and degree of wave activity. Some winters have only a minimal presence of ice, but other winters have extensive ice development that can extend several meters offshore. Most winters have multiple events of ice formation, breakup, and redevelopment. Wave action is responsible for the breakup. Rarely is the breakup a result of ice melting.

Figure 11 shows a diagram of the typical components of coastal ice that may form along the state park shore. The entire ice feature is called a nearshore ice complex. The process of formation begins on the beach, which freezes and forms the ice foot. As waves break against the ice foot, the wave splash can freeze and build an ice ridge. The ice complex then grows lakeward as
sequential, shore-parallel ice ridges form against one another. Sometimes a sequential ridge forms a short distance lakeward of its predecessor, and the ridges are separated by a short distance by a shore-parallel segment of congealed, low-relief ice called an ice lagoon. Ice volcanoes are common along the ice ridges, and the ridge crests and volcano summits can rise as much as 2 m (6.5 ft) above the lake level.

When the ice ridge is present along the shore, waves intercepting this ridge behave like waves impacting a bulkhead or breakwater, and, as occurs at those types of engineered structures, some of the wave energy is directed downward to cause lake-bottom erosion. Profile data and diver observations have documented that on the Illinois coast an erosional trough develops lakeward of the ice as much as 0.5 m (1.6 ft) deep and 2 to 3 m (6.5 to 9.8 ft) wide. Some of the eroded sediment is moved alongshore, but some is caught in the wave turbulence to be thrown up and incorporated into the ice ridge. As a result, sand-ridden ice (or "dirty ice") is a common feature along the ice ridges (Barnes et al. 1994, Kempema 1998).

The incorporation of this sediment into the ice becomes an important factor in the dynamics of beach and nearshore sediments. Breakup of the ice allows the sediment to be rafted away under the influence of winds and currents. Along the Illinois shore, observations have shown that most of this ice-rafted sediment moves southward, but some also moves offshore. Does ice rafting account for any sizable transport and loss of sediment from the beach and nearshore at Illinois Beach State Park? Data specific to the state park are lacking, but an extrapolation based on ice studies at Wilmette suggests that the annual volume of sediment that could be ice rafted from the state park coast could be as high as 1,400 m$^3$/km (3,000 yd$^3$/mi) of shoreline (Kempema 1998). For the approximate 8.8 km (5.5 mi) of shoreline in the North and South Units of Illinois Beach State Park, this process could result in the permanent loss of 12,600 m$^3$ (16,500 yd$^3$) annually of beach and nearshore sediment.
GEOLOGIC EVOLUTION

Overview

The Zion beach-ridge plain is a product of geologic processes that have occurred since the waning of the last glaciation. Beginning about 14,500 years B.P., the Lake Michigan lobe of the continental ice sheet was receding and formed a proglacial lake (Lake Chicago) in the southern Lake Michigan basin. Once the ice margin was just north of Racine, Wisconsin, the shore to the south was never again either covered by ice or marginal to the ice lobe. The lake margin then began to be transformed by coastal processes. These processes that began about 14,500 years B.P. only set the stage for the Zion beach-ridge plain. The plain did not actually begin to form until about 5,000 years B.P.

Much geologic work is needed to fully reconstruct the geologic evolution of the Zion beach-ridge plain, but current knowledge indicates that this coastal landform is unique in southern Lake Michigan. The beach-ridge plain has likely had a complex history, and the model for its geologic evolution presented here is certainly simplified. Several characteristics of the beach-ridge plain put time and spatial constraints on its development and evolution and provide a basis for developing this model. These characteristics are as follows:

1. The beach-ridge plain is built lakeward of a relict coastal bluff cut into till. Relief along these bluffs is generally 3 to 6 m (10 to 20 ft) but reaches up to 12 m (40 ft) at several locations at Waukegan and North Chicago where the bluff is cut into high land of the Zion City end moraine (fig. 4). All of the bluff line corresponds to an erosional shore that predates the southward advance of the plain.

2. Most of the land above the bluff crest is lake plain that was submerged during the high lake levels that occurred between 14,500 years B.P. and about 11,200 years B.P. The coastal bluff shore did not come into being until the lake level was below the elevation of this lake plain, which occurred beginning about 5,000 years B.P.

3. The volume of sand and gravel constituting the beach-ridge plain is of such magnitude that it would be difficult to account for through the erosion of clayey till bluffs updrift of the beach-ridge plain. These bluffs contain no more than an aver-
age 10 to 15% of sand and gravel. Development of the beachridge plain required a large, sand-rich deposit as a source area from which wave erosion and littoral transport could readily obtain sediment and redistribute it downdrift.

4. The oldest beach ridges of the plain between Kenosha, Wisconsin, and the Camp Logan area in the North Unit of Illinois Beach State Park have an orientation that projects across the present-day shoreline into open water. The ridges indicate the former existence of a much broader beach-ridge plain along this reach. The oldest of all preserved beach ridges just south of present-day Kenosha Harbor point to a former shoreline lakeward of Kenosha.

**Lake-Level History**

Lake-level history since late glacial time is crucial to a model for the development of the beach-ridge plain. Beginning about 14,500 years B.P., northward recession of the Lake Michigan ice lobe resulted in an open-water area in the southern part of the Lake Michigan basin. The ice blocked a northward outlet for this proglacial lake—Lake Chicago. End moraines ringing the southern margin of the lake basin acted as a dam to hold the lake water at levels as much as 18 m (60 ft) higher than at the present day. Between about 14,500 and 10,000 years B.P., as the ice sheet fluctuated and ultimately receded from the Great Lakes basins, wide fluctuations in lake levels occurred as movement of the ice margin opened and closed different outlets and as outlet channels eroded downward (Hansel and Mickelson 1988). A lake-level history can be constructed based on the stratigraphy and sedimentology of relict beach deposits (Chrzastowski and Thompson 1994), but the lake-level history presented here is the “classic” lake-level record based primarily on the morphology and elevation of these deposits.

During the Glenwood phases (14,500 to 12,200 years B.P.), the ancestral Lake Michigan lake level was as much as 18 m (60 ft) higher than it is today. During the Calumet phase (11,800 to 11,200 years B.P.), lake level was as much as 12 m (40 ft) higher than it is today (fig. 12). During these two phases, in the vicinity of present-day Zion, Illinois, the shoreline was in the present upland areas near or west of Sheridan Road. The processes that would eventually lead to the formation of the beach-ridge plain
were then occurring along the ancestral Lake Michigan shoreline near present-day Racine, Wisconsin, 26 km (16 mi) north of the Wisconsin-Illinois state line.

**Glenwood Phases: The Root River Delta (?)**

The Glenwood phases of high lake level were the first of the high water events and occurred between about 14,500 and 12,200 years B.P. Evidence for a short-lived event of lower lake level divides the Glenwood into two distinct subphases, Glenwood I and II. The maximum lake levels during the Glenwood phases were as much as 18 m (60 ft) above the historical mean lake level, which placed the shoreline as high as the 195-m (640-ft) contour above mean seal level (AMSL) along the present uplands. A gradual decline in lake level likely occurred during the Glenwood phases (Chrzastowski and Thompson 1992).

Between Kenosha, Wisconsin, and North Chicago, Illinois, the uplands between the 195- and 192-m (640- and 630-ft) contours preserve ancient shoreline features associated with this time of extremely high lake level. At Racine, the present-day coast is dominated by till coastal bluffs. Atop these bluffs is an arcuate series of topographic features that rise above 640 ft (195 m) and are suggestive of a grouping of ancient barrier islands similar to those of the present-day Mississippi River delta. The nearby Root River presently occupies an incised channel, but, during the Glenwood lake levels, the river would have entered the lake at Racine at an elevation about 195 to 192 m (640 to 630 ft). At that time, the Root River would have been a major glacial meltwater stream, deriving meltwater from much of the ice margin in southeastern Wisconsin and transporting and dumping this sediment into ancestral Lake Michigan at Racine. The result would have been the development of delta of glacial outwash sediments (fig. 13, map 1). South of Racine and all the way to the Indiana shore, no other river of such size emptied into the lake or could have been responsible for such a sediment discharge to the lake.
The ancient delta of this model has been lost to erosion. The coastal bluffs at Racine provide a cross-sectional exposure of the till that was beneath and landward of the glacial delta deposits. During the formation of the delta, a prime factor in preventing the river-supplied sediments from being dispersed southward along the coast was that the glacial ice to the north prevented any significant fetch...
from this direction. The open water of southern Lake Michigan only provided a fetch for wave action from southeasterly waves.
Calumet Phase: Erosion, Transport, and Spit Development

The Calumet phase occurred between about 11,800 and 11,200 years B.P. Lake level was as high as 12 m (40 ft) above the historical mean. The ice margin was beyond the limits of the Root River drainage basin, so no additional meltwater discharge occurred along this river. The ice margin across Lake Michigan was sufficiently far enough to the north to allow an open-water area to the north of Racine and to allow the coast at Racine to be influenced by northerly waves. The relict Root River delta would have been a readily erodable source of sand and gravel, and these eroded sediments were transported southward. The process of erosion, transport, and redeposition resulted in the removal of much of the former delta sediment and redeposition along a more elongate coastal depositional feature (fig. 13, map 2).

The surficial appearance of this elongate depositional feature would not have been greatly different from that of the southern part of the present-day beach-ridge plain. But, unlike the beach-ridge plain, this depositional feature had open water on three of its sides (west, east, and south) and therefore would be classified as a spit. A remnant of this spit mantles an elongate till ridge that extends from south of Racine to north of Kenosha. The spit partially enclosed an embayment that today is a low area crossed by the Pike River. The southward-directed course of this river as it approaches Kenosha is indicative of the influence the spit deposition has had on the local topography and drainage. During this Calumet phase, all of the downtown area of Kenosha was submerged and was located just south of the distal end of the spit. Farther south, along the extent of the present beach-ridge plain, the shoreline was at the 189-m (620-ft) elevation, which is generally along the top of the bluffs along the western margin of the plain.

The Calumet phase of lake level was apparently important in setting the stage for the eventual development of the beach-ridge plain. Wave erosion and transport resulted in the transfer of a large volume of sediment from the immediate vicinity of Racine to a location just north of Kenosha. The sediment redistribution also resulted in the deposition of a spit platform, a broad submerged mound atop which the emergent part of a spit forms. This spit platform would have likely extended well south of Kenosha and would have formed the slightly elevated lake-bottom surface atop which the beach-ridge plain later began to form.
Chippewa Phase: An Abandoned Coast and Ravine Erosion

Lake level fell to as much as 80 m (260 ft) lower than at present about 10,000 years B.P. when the ice margin receded northward to allow lake drainage through an outlet depressed by the weight of the ice sheet (North Bay outlet). This process began the Chippewa phase of lake history (fig. 12). For the next 4,500 years, lake level gradually rose as isostatic rebound raised the outlet elevation. Through the entire Chippewa phase, the sand and gravel deposits of the former delta and spit between Racine and Kenosha were abandoned coastal features, high and dry and distant from the lake shoreline. This time of lowered lake levels set the stage for the erosion of the ravines that are carved into the upland to the west of the beach-ridge plain. The ravines likely were developed by the process of headward erosion as streams cut into the glacial deposits as they adjusted to the lower lake levels.

Nipissing Phases: Early Formation of the Beach-Ridge Plain

By about 5,500 B.P., lake level had risen to again reach the historical mean, which began the Nipissing phases of lake history. Lake level during the Nipissing phases ultimately rose to about 6 m (20 ft) above the present-day level and then declined. The lake level rise brought a resumption of wave erosion, transport, and deposition along the shore of the relict delta and spit. Storm events would have resulted in pulses of sand and gravel moving southward to be deposited in elongate ridges. These ridges were the beginning of the Zion beach-ridge plain that is entirely at or below the level of Nipissing lake level. These earliest beach ridges formed just south of what is now the downtown area of Kenosha. These ridges are some of the highest ridges on the beach-ridge plain since many formed at the highest lake levels of the Nipissing phases. While these first beach ridges were forming, all of the coast to the south was a bluff coast with waves eroding into the glacial deposits of the upland. The Illinois portion of this bluff coast is preserved as the abrupt change in relief along the western margin of the plain, just west of the Metra/Union Pacific railroad tracks.
Algoma and Modern Phases: Migration of the Beach-Ridge Plain

The past 3,800 years of lake history encompass the Algoma and Modern phases. During this time, there has been continued erosion along the relict glacial delta at Racine and relict spit north of Kenosha, southward transport of these sediments, and deposition of these sediments to form a southward advancing beach-ridge plain. Radiocarbon dating of marsh deposits at the base of swales provides a means to date when different beach ridges were forming along the plain. The first migration of beach ridges across the Wisconsin-Illinois state line occurred 3,700 years B.P. (Larsen 1985) (fig. 13, map 4). Thus, the entire Illinois portion of the subaerial part of the beach-ridge plain is younger than this age. The subaerial beach-ridge plain advanced southward atop a platform that had been formed by submerged deposition that began sometime before 3,700 years B.P.

As the plain continued its southward advance, the northern part of the plain eventually began to erode. This erosion occurred as the coast between Racine and Kenosha receded landward and the southward extension of this recession intercepted sediments deposited in the northern part of the plain. These eroded sediments were transported southward and deposited along the southern margin of the plain. This process of northern erosion and southern accretion continued into historical time. By these means, the northern part of the plain continued to get narrower, and the southern terminus of the plain continued to migrate southward. The long-term migration of the plain along the coast can be likened to the movement of a slinky, a caterpillar, or a tank tread. The sequence of coastal reconstructions in figure 13 illustrates this migration of the beach-ridge plain from its initial formation at Kenosha (map 3) to its present-day extent to North Chicago (map 6).

Ultimate Fate of the Beach-Ridge Plain

Reconstructing the geologic evolution of the plain provides a means to project how this coastal landform would continue to evolve if no human intervention occurred and if present-day lake levels and coastal dynamics persist. With time, the plain would continue to advance southward along the Illinois coast, while erosion would continue along the northern part of the plain. The overall shape of the plain would change with time to an ever more
elongate and narrower form. Eventually erosion would remove the last vestiges of the plain along more and more of its northern segment, and here waves would once again intercept the relict bluffs along the upland. The southward elongation and narrowing of the plain would eventually obscure the beach-ridge plain as a distinct coastal feature, which, instead, would be an extensive sand and gravel deposit contributing to wider beaches along the shore. The ultimate fate for all the sand and gravel of the beach-ridge plain is to be transported southward to accumulate along the Indiana shore. Then, ultimately, the Zion beach-ridge plain would be no more than a migratory and ephemeral coastal feature in the post-glacial evolution of the Illinois coast.
Stop Descriptions

STOP 1  Pennoyer Park and Simmons Park, Kenosha, Map 1 of 8 (Appendix B)

Note: This stop has two parts: (1) a stop in Pennoyer Park to examine the mouth of Pike River and (2) a stop in Simmons Island Park overlooking the small boat basin at the north end of Kenosha Harbor.

Stop Highlights

- An example of stream-mouth deflection caused by littoral transport
- A river channel meander cut off by coastal erosion
- Evidence for former coastal land lakeward of Kenosha

Setting

Stop 1 is just north of the northern limits of the Zion beach-ridge plain, which begins along the shore just south of Kenosha Harbor. The first stop is at the mouth of Pike River in Pennoyer Park (fig. 14). The Pike River originates in the morainal uplands to the west. The river is about 22.5 km (14 mi) long and has a watershed of about 155 km² (60 mi²). Once leaving the morainal upland, the river course is across the lake plain along the topographic low on the landward (west) side of a ridge that directs the river southward to a tangential approach to the lakeshore at Pennoyer Park. The second stop is at Simmons Island Park, atop a knoll that provides an overlook of Simmons Island Marina, which occupies the northern part of Kenosha Harbor basin. On its western margin, the harbor receives inflow from Pike Creek. Kenosha Harbor is a federal harbor maintained by the Detroit District U.S. Army Corps of Engineers (Bottin 1988). The project depth in the harbor
approach is 7 m (23 ft) and 5.5 m (18 ft) between the jetties. Typical depths are often less because of accretion and reduced depth of maintenance dredging. A confined dredging disposal area was used in the past on the south side of the south jetty. This land is now being used for lakeshore recreational development.

**Historical Overview**

One of the hindrances to maritime commerce in southern Lake Michigan at the time of earliest settlement was the lack of naturally occurring harbors. This coast is generally free of crenulations, embayments, and promontories that could provide quiet-water areas for safe anchorage and transfer of goods. As a result, the few major rivers that empty into southern Lake Michigan were identified early in the exploration and settlement for the potential of using the lower river as a harbor. At Chicago, coastal engineering at the mouth of the Chicago River began in 1833 to maintain a channel so that vessels could use the lower river as a harbor. Early settlers also recognized the opportunity for a harbor at Southport, now called Kenosha. Here the opportunity for a harbor was unique because it took advantage of a relict river channel.

**Coastal Geology**

**Pennoyer Park**

The discharge from many of the rivers and streams flowing to southern Lake Michigan was historically insufficient to maintain an open channel to the lake. The mouth of these rivers would be closed off by the robust transport of littoral sand along the shore. Flood stage on the river was necessary to raise water levels sufficiently to overtop the beach deposits and erode a channel to the lake. Such channels were typically short-lived as littoral sediment would again accumulate and close the river mouth.

Most of the larger rivers entering the southern shore of Lake Michigan have been engineered with jetties and dredging to maintain an open connection to the lake. The Pike River in Pennoyer Park is an exception that preserves the natural interplay between the river discharge and the movement of littoral sediment along the shore. Depending on conditions at the time of a visit, one might see the river discharge to the lake or have its mouth blocked by sand accretion, causing the river to end in the back-beach area as a pond. Historical accounts document that the
mouth of the Chicago River behaved similarly in its natural state (Andreas 1884). Occasionally at the mouth of the Pike River, heavy equipment must be used to artificially open a channel to the lake to mitigate flood conditions along the lower river.

The Pike River also provides an example of how many of the streams entering the lake had their mouth deflected in a downdrift direction under the influence of the littoral transport. The degree to which the Pike River demonstrates such stream-mouth deflection differs with time, but often the mouth is deflected to the southern end of the park lakeshore. Reversals in the direction of littoral transport may result in short-lived, northward deflection of the river mouth, but the deflection toward the south is the typical configuration. A similar response occurs at the mouth of Dead River in the South Unit of Illinois Beach State Park (see Stop 4).

**Simmons Island Park**

Simmons Island is a till knoll that reaches an elevation just over 183 m (600 ft) MSL, which is the same as the lake plain upland to the west and similar to the upland along the shore to the north between Pike River and the shoreline (fig. 14). South from Simmons Island, no comparable high points are found, as this area is the lower lying extent of the beach-ridge plain. The Simmons Island Marina, which occupies the northern part of Kenosha Harbor, is an incised feature with as much as 6 m (20 ft) of relief on either side.

The coastal setting of this area in 1837 is shown in figure 15. For comparison, figure 14 shows the present coastal setting. In
both maps, the mouth of Pike River is shown to the north, and the channel meander is shown at what is now Kenosha Harbor. The 1837 map identifies this meander as an “old bed of Pike River.” Identifying the origin of this feature was likely readily apparent to the early surveyors because the width of the valley was more appropriate to Pike River than to Pike Creek because of the proximity of the meander to Pike River and because of the meander’s geometric similarity to the meanders visible along the lower reach of the Pike River.

The channel meander facilitates a paleogeographic reconstruction of the area that is important to understanding the coastal configuration here at the time that the Zion beach-ridge plain was beginning to form to the south. The first time the Pike River reached this location would have occurred during the lake level decline following the Calumet phase. For the meander to have occurred at Kenosha would have required continued southward deflection of the Pike River south of the present river mouth. Thus, it is likely that either a till ridge was exposed in what is now the open lake area, or a spit developed in the Calumet phase extended south at least to a position parallel with present Kenosha Harbor. The degree of incision along the meander is consistent with fluvial erosion during the extreme lower lake levels of the Chippewa phase. Preservation of the meander to historical time requires that the channel was functional during the Nipissing phases; otherwise, this area would have been a quiet-water sink for deposition. Thus, coastal land existed to the east of Kenosha in the early Nipissing phase. Erosion of this former coastal land beginning in the Nipissing phase provided for the initial sediment supply to the Zion beach-ridge plain.

At the northern end of the beach-ridge plain is a prominent beach ridge that has an elevation and orientation that also supports the existence of this former land area (fig. 14). This ridge has an elevation of slightly more than 183 m (600 ft) AMSL, which is consistent with a ridge development during this time when lake level was at most 6 m (20 ft) above present. The northeast-southwest orientation of the ridge is consistent with the feature being the continuation of a shoreline that originated in what is now the open-water area east of Kenosha.
Coastal Management

Erosion along most of the Kenosha shore has been halted by varied shore protection. The primary coastal management issue is maintenance dredging to sustain appropriate depths in the approach to Kenosha Harbor. Throughout the history of dredging along this channel, dredged material was either disposed of in deep water or placed in the confined disposal area south of the harbor entrance. The permanent removal of sediment from the littoral stream has been a detriment to the downdrift shore.

STOP 2 North Point Marina, South Parking Area, Map 4 of 8 (Appendix B)

Stop Highlights
- Site of highest rates of shoreline recession documented on the Illinois coast
- Feeder beach for nourishment of Illinois Beach State Park
- Ruins and debris from former lakeshore residential housing

Setting

North Point Marina has a 72-acre basin that provides moorage for 1,500 boats, making this marina the largest in the Great Lakes (fig. 16). The marina was built between 1987 and 1989 by the Illinois Department of Conservation, now called Illinois Department of Natural Resources (IDNR). Hydraulic dredging of the marina basin resulted in removal of an estimated 1.1 million m³ (1.5 million yd³) of gravelly sand, which was discharged to the beach area south of the marina. A large fan delta resulted, with the lakeward part rapidly eroding and sediment transported to the south.
Much of the deposit remains and is the high land that supports the south parking area at a height up to 4.5 m (15 ft) above lake level. Prior to the marina construction, the shoreline extended beneath the western part of the parking area. To the south of the parking area is the boundary with the North Unit of Illinois Beach State Park. A feeder beach is maintained here by the IDNR for nourishment of the downdrift shore. Sand and gravel has been brought here by truck from inland pits or from channel dredging at the Waukegan Generating Station (Stop 5).

**Historical Overview**

The land area in the vicinity of North Point Marina had previous land uses that included both industrial and residential development. In 1850, the early settlement on the upland to the west was called Benton Town, later changing to Spring Bluff, and finally to Winthrop Harbor in 1899 when the Winthrop Harbor and Dock Company of Chicago became the major land owner. This company had plans for a major commercial harbor to be constructed in the present area of North Point Marina. No harbor was ever built, but the concept of such a harbor was one reason that Andrew Carnegie considered this area for construction of the Carnegie Steel Mills, which ultimately were built at Gary, Indiana. In the 1920s, land along the shore was platted as the Oakshore subdivision. Roads were built, and a golf course was built in the area now south of the marina, but no residential development occurred. In 1954, a new subdivision named Sherman Shores was developed in the area. About 140 houses were eventually built, many of these located in what is now the footprint of North Point Marina (fig. 17). Severe shore erosion in the 1960s and 1970s was a key factor that led to the state acquisition of the land, clearing of the buildings, and incorporation of the area into Illinois Beach State Park.

![Figure 17 Comparison of a 1958 topographic map of the marina vicinity and the superposition of the present-day marina footprint. Each square symbol represents a house or other structure that was demolished prior to the marina construction.](image)
Coastal Geology

Stop 2 is located along the erosional part of the beach-ridge plain and is the site of the most persistent and highest rates of historical shoreline recession documented along the Illinois coast. Historical maps show that, prior to the construction of North Point Marina, over a 150-year record of change the shoreline in this vicinity receded at an average rate of about 3 m (10 ft) per year (Jennings 1990). Figure 18 shows that the 1872 shoreline was lakeward of the marina’s breakwaters, and, in 1910, the shoreline approximated the position of the south breakwater. The erosion has also involved a change in the orientation of the shoreline. Beach ridges in the area are oriented toward the north-northeast and are truncated by the modern shore. They point offshore to a much broader plain that had a shoreline across what is now open-water area. This lakeward projection is similar to the beach ridge discussed at Stop 1 located just south of Kenosha. Additional truncated beach ridges are discussed at Stop 3.

The residential properties that previously occupied this shore led to this area’s earliest attempts at erosion control. These attempts were not successful in halting erosion, but the existence of this former housing development has had a profound impact on the coast. The remains of house foundations and shore protection have been exposed in the shallow nearshore area just south of the south parking area (fig. 19), and these remnants influence present-day wave dynamics and sediment transport. Sewer lines, water pipes, sidewalks, foundations, and a variety of building materials are exposed by the nearshore erosion, broken by wave action, and washed onto the shore. The beach here includes a variety of housing debris and also some debris that is asbestos-containing material, including pieces of water and sewer pipe, siding, roofing, and floor tile.

The greatest human impact to occur along this shore was the construction of North Point Marina. By early 1989, the stockpile of dredged sediment had translated the shoreline south of the marina farther lakeward than the most lakeward extent of the south breakwater. The northern 150 m (500 ft) of the fan-delta shore was defended with riprap. Erosion south (downdrift) of this riprap rapidly began to transform the shore into a logarithmic-spiral configuration. Nearly 60 m (200 ft) of recession occurred over a 10-month period (Terpstra and Chrząstowski 1992). As
erosion continued and posed a threat to the south parking area, several different phases of shore defense occurred (Chrzastowski 1991). Ultimately, a submerged breakwater was constructed just offshore to “trip” incoming waves and reduce their height and energy, and a rubble-mound revetment was constructed along the shore just lakeward of the parking area to stabilize this shoreline. The location of the submerged breakwater is marked by a series of buoys.

Since 1990, the shore area immediately south of the south parking area has been used as a feeder beach to provide a supply of littoral sand to the downdrift shore. A second feeder beach is located at the north end of the state park South Unit. On average, this feeder beach near the marina has been supplied with about 15,000 m$^3$ (20,000 yd$^3$) per year. The sediment is trucked here from dredging at the Waukegan Generating Station (Stop 5) or from inland sand and gravel pits. In recent years, the nearshore has also been supplied with sand barged to this area from dredging at the approach channel to Waukegan Harbor (Stop 6). Because of a minimal contribution of littoral sediment coming south across the state line and moving lakeward around the marina, this feeder beach is a primary sediment source for the littoral sediment supply along much of the state park shore.

**Coastal Management**

As long as waves and associated sediment transport continue in the marina vicinity, monitoring of beach and lake-bottom conditions is crucial to identify and remediate undesirable impacts. Maintenance dredging is necessary in the marina entrance area, which can act as a sediment trap. Monitoring of the lake bottom along the toe of the breakwater stones is important to ensure that no undermining occurs to cause a shifting of the stone. The major challenge in coastal management is the shore south of the south parking area. Waves approaching this area from the north bring little if any sand, and thus nearly all of the wave energy is capable
of eroding the shore. If the feeder beach is not maintained and if no other remedial action is taken, the shoreline between the south parking area and the Camp Logan headland will erode into an embayed shoreline that could be as much as 500 feet landward of the present shoreline (fig. 20, shoreline B). The logarithmic-spiral recession that occurred in 1989 is a small-scale analog for the recession that could occur south of the parking area.

The feeder beach located just south of the south parking area is the present means by which the IDNR is managing the erosional processes along this shore. This supply of nourishment is slowing but not eliminating erosional trends. Studies indicate that an annual supply of 61,000 m³ (80,000 yd³) would be needed to produce a balanced local sediment budget with no net erosion.

**STOP 3 Camp Logan Headland, Map 4 of 8 (Appendix B)**

**Stop Highlights**
- Beach ridges truncated by present shoreline
- Examples of littoral sediment entrapment by groins
- Development of a headland as a result of shore armoring

**Setting**

Camp Logan was the former military installation that occupied this area prior to the acquisition for the state park. Several former barracks and military buildings are on the western part of the plain and are visible from the road leading to and from the beach. Much of the ridge and swale topography in the area has been impacted by military field excises, but pockets of minimally disturbed ridge and swale areas still exist. The shore has been entirely armored for its protection, which is why a shoreline protrusion occurs at this site.
**Historical Overview**

Land at Camp Logan was used as a prisoner-of-war camp during the Civil War, but no major construction occurred until 1893. In 1912, the camp was used as a rifle range for the state militia. During World War I, the camp was used by the U.S. Navy to supplement the training facilities at Great Lakes Naval Training Station (Center). In later years, Camp Logan was used by the Illinois Emergency Relief Corps, the National Guard, U.S. Army, and U.S. Marine Corps. From 1972 to 1976, the camp was home of the Lake County Sheriff’s Department Work Release Program. The state acquisition of the land in 1974 brought it under management of the Illinois Department of Conservation (now IDNR), and the land was later included in the land parcels collected to form the North Unit of Illinois Beach State Park.

**Coastal Geology**

A headland is a lakeward (or seaward) protrusion of the shoreline. Typically a headland is a high and steep-faced promontory on the coast. The name “headland” is informally given to the shoreline protrusion at Camp Logan because it protrudes so much farther lakeward than the shoreline to either the north or south. This lakeward protrusion of the shoreline is not a natural occurrence. This shore has been stabilized by coastal engineering. Erosional processes have occurred along the shore both north and south of this protected area, and, as shoreline recession occurred in these areas, the protected shore at Camp Logan became a shoreline promontory.

The beach-ridge plain just south of the Camp Logan headland preserves excellent examples of beach ridges that are oriented obliquely to the present-day shoreline (fig. 21). These beach ridges indicate that, during their formation, the beach-ridge plain extended east of the present shoreline at Camp Logan and occupied what is now the nearshore zone between the Camp Logan headland and North Point Marina. The beach ridges near the headland record shoreline positions from about 2,000 to 1,000 years ago and indicate not only the occurrence of substantial erosion here and along the shore to the north, but also substantial change in the shoreline orientation. These coastal changes are part of the process of coastal evolution as the beach-ridge plain has migrated southward with time, becoming narrower and more elongate.
This shore is within the erosional reach of the beach-ridge plain and has receded during historical time. At a minimum, the 1872 and 1911 shorelines were, respectively, about 128 and 76 m (420 and 250 ft) lakeward of the present headland shoreline (fig. 21).

By the 1950s, as shoreline recession became a greater problem, shore protection structures were installed. Several different phases of shore protection occurred as well as several different types of design and material use. A steel sheetpile bulkhead protects much of the southern part of the headland shore. One of the consequences of building such a vertical wall along a shore is that the wall directs some of the incoming wave energy downward, which in turn contributes to the erosion of local beach and nearshore sediments. This process accounts for the absence of a beach along much of this bulkhead. Two steel sheetpile groins that extend lakeward from the bulkhead provide excellent examples of the typical entrapment of littoral sediment that occurs at a groin. These beaches at the Camp Logan groins are quite variable in their height, areal extent, and sediment cover, depending on recent storm events and lake-level changes. At times, beaches may be present on both sides of the groins, but the beach on the north side of the groin will typically be larger in area and higher in elevation because of the greater volume of beach sediment. Such beach morphology is indicative of the north side being the updrift side of the groin and the net littoral transport direction being from north to south. The beach accretion against groins is one of a series of geomorphic indicators used in determining the pattern of net littoral transport along a coast.

The northern part of the shore at the Camp Logan headland is a crescent-shaped beach that provides an example of the type of embayed shoreline that will naturally develop along this shore between erosion-resistant points, also called “hard points.” Figure 20 shows the projection of such an embayed shoreline that would evolve between North Point Marina and the Camp Logan head-
land if no intervention occurred. The embayed shore at the Camp Logan headland is a small-scale version of the same response. The crescent-shaped shoreline results from a combination of incoming waves refracting around the updrift hard point and causing shoreline recession while the downdrift hard point limits the landward extent of this erosion. The greater the distance between the two hard points, the greater is the landward extent of the embayed shore.

Coastal Management

The coastal engineering at the Camp Logan headland illustrates that the shore can be stabilized with structures but that stabilization can have detrimental impacts, such as eliminating all beach in front of a bulkhead or altering the shoreline configuration as along a crescent-shaped beach between hard points. Shore protection structures may be necessary at some locations along the Illinois Beach State Park shoreline in the future, and the challenge is to design and build structures that are functional for shore protection and that also have a minimal negative impact on the visual attributes of this state park coastal setting. The structures at Camp Logan present a challenge in developing a regional coastal management plan. These structures were placed specifically for the protection of this segment of shore, but, as a regional coastal management plan is developed for the entire state park shore, some of the complex of structures at Camp Logan may need to be altered, rebuilt, or removed.

LUNCH STOP   Rooks Restaurant,
Sheridan Road at 31st Street,
Zion, Map 5 of 8 (Appendix B)

Local Geology

Much of the length of Sheridan Road in Zion and Winthrop Harbor follows an early settlement trail that went along the crest of a series of sand ridges. The first road along this route in Winthrop Harbor was even called Sand Road. Depending on their elevation, the sand ridges can be attributed to deposition during either the Glenwood or Calumet lake phases (fig. 12). Rooks Restaurant is located atop a subtle, north-south-oriented elongate
ridge that has an elevation of 188.9 m (620 ft) AMSL. The elevation suggests this beach deposit was formed during the Calumet phase (11,800 to 11,200 years B.P.).

Across the street from the restaurant is Ophir Park. Park land continues on the east side of Sheridan Road about a block south of the restaurant. The park occupies a ravine that is cut 3 to 6 m (10 to 20 ft) below the level of the surrounding land. Across from the restaurant, the ravine approaches Sheridan Road tangentially; east of Sheridan Road the ravine is oriented eastward. The development of this ravine can be attributed to fluvial erosion during the low lake level of the Chippewa phase (10,000 to 5,500 years B.P.) (fig. 12).

STOP 4  Dead River and the South Unit Nature Preserve, Map 6 of 8 (Appendix B)

Stop Highlights

- A nearly pristine setting of ridges, swales, and dunes
- An abandoned channel and mouth of the Dead River
- Location of the beach-ridge plain erosion/accretion null zone

*Note: This stop includes a traverse into the South Unit Nature Preserve on the south side of the Dead River. This area of the park is restricted and requires access permission from the State Park Site Superintendent.*

Setting

The areas of the state park least disturbed by human activity occur in the southern part of the South Unit. Arcuate beach ridges across the South Unit record the translation and progradation of
the beach-ridge plain (fig. 22). Cutting across these ridges is the Dead River, which is the stream providing surface water drainage for nearly all of the South Unit. The Dead River is the continuation of Bull Creek, which originates in the upland to the west of the South Unit (fig. 6). The Dead River was apparently so named because of the typical sand blockage of the river mouth and the resulting ponding of river water. This effect is similar to that observed at Pike River at Stop 1, but the typically lesser discharge of the Dead River makes the blockage here more common.

**Historical Overview**

Some historical accounts indicate that explorer and missionary Pere Marquette made camp at the mouth of the Dead River in December 1674 while traveling by canoe from Green Bay to Chicago. However, it is not certain whether this description refers to the same river that we know today. What is certain is that the unique landscape in this part of the present South Unit is something that has been long recognized. As early as 1907 and into the 1920s, the area was used for filming several westerns, at least one starring Charlie Chaplin. An entire town set was constructed for the film *The Main Trail*. About 1907, a town named Mayville was platted along the banks of the Dead River, but no construction ever occurred.

One of the longest lasting impacts on the area has been the grove of pine trees visible to the south of the Dead River. These trees were planted in the late 1800s by Waukegan nurseryman and naturalist Robert Douglas for the purpose of making a forested park. Although this introduced pine forest has been successful, the natural vegetation at this site is dominated by sand prairie, savannah, and open oak forest. Another less obvious impact has been beach mining of sand and gravel. Historical maps document a railroad spur that once extended across the beach-ridge plain and then split to a terminus adjacent to a loading facility near the beach and a terminus along the beach about 0.8 km (0.5 mi) north of the Dead River mouth, a location once known as Farnum Point.
These tracks were used in the removal of large volumes of sand and gravel excavated from the beach to be used as a building material and in making concrete. Ruins of the railroad are preserved at some locations in the South Unit. In 1997, erosion along the beach exposed the tracks for the first time in several decades (fig. 23).

Coastal Geology

For about a mile to either side of the mouth of the Dead River, the shore is a unique segment along the entire beach-ridge plain. This segment is the transition zone—or “null zone”—between the erosional shore that dominates to the north and an accretional shore that dominates to the south. Through the translation history of the beach-ridge plain, this transition zone has also been translating southward. However, based on the record of shoreline change, throughout historical time the transition zone has essentially been centered along the shore at the mouth of the Dead River. This factor possibly contributes to this spot being most favorable location for the river discharge.

The geologic evolution of the Dead River is a study yet to be done, but numerous landscape features record where channels of the river have been in the past. Abandoning channels and establishing new ones have been recurring events in the river history as successive beach ridges formed as the beach-ridge plain translated and prograded. A short distance upstream from the present river mouth is a slough on the south bank, which was the channel of the Dead River prior to a breach across the dunes to establish the present mouth. A hike southward along this slough for a distance of about 305 m (1,000 ft) leads to a place where the topographic low of this slough turns lakeward and cuts across a beach ridge. This breach would have led to a former river mouth or would have been a place where the river breached this ridge and continued southward in a swale to discharge to the lake at some farther downdrift location. Across the South Unit are a series of breaches in the beach ridge that suggest river crossings. Historical maps of the South Unit area depict Dead Lake, which was likely a river channel prior to a breach allowing a more direct discharge to the
lake (fig. 24). Farther to the south was Little Dead River, which at one or more times was likely the southern continuation of the Dead River. When beach-ridge accretion blocked a northern outlet for the Dead River, the river would flow southward along a swale and temporarily establish a mouth in this downdrift part of the plain. Flood conditions could eventually provide for a breach across a low point in a ridge and allow a new and shorter traverse to the lake.

Coastal Management

The stable shoreline in the vicinity of Dead River has precluded any need for shore defense or beach nourishment. This shore benefits from an adequate supply of littoral sediment. None of the South Unit shore from Dead River southward has required erosion mitigation during historical time. The primary coastal management issue at this locality is the management of park visitors. The Dead River poses a danger to visitors who may be in or near the river at the time a breach develops, allowing flow to the lake. The discharge can be rapid, and high volume and could potentially wash a person into the lake. A caution sign describing this hazard is placed along the trail leading to the river mouth. The state park personnel are also actively involved in educating visitors to stay on trails to preserve the dune and swale plants and to respect the restricted access to the South Unit Nature Preserve.

Figure 24  Comparison of 1908 (left) and 1993 (right) topographic maps for the segment of beach-ridge plain between the state park lodge and Waukegan Harbor. Note Little Dead River on the 1908 mapping, which has been lost to industrial development. (From U.S. Geological Survey Waukegan Quadrangle, 1:62,500, 1908, and Zion and Waukegan Quadrangles, 1:24,000, 1993.)
STOP 5  Cooling-Water Channels at Waukegan Power Station, Map 7 of 8 (Appendix B)

Stop Highlights

- Unique coastal engineering to ensure cooling water inflow and discharge
- Proposed construction of a sand trap to establish a sand-recycling program

Setting

Stop 5 is along the accretional part of the Zion beach-ridge plain about 2.7 km (1.7 mi) south of the mouth of the Dead River and the associated erosion/accretion null zone. Sand is in surplus at this site. Trying to maintain an open channel across a shore where there is a net influx of littoral sediment is a coastal engineering challenge but is accomplished at the Waukegan Generating Station out of necessity to maintain a flow of cooling water to this coal-fired plant.

Historical Overview

The Waukegan Generating Station was built in 1938 by Public Service Company of Northern Illinois and, in 1953, was acquired by Commonwealth Edison Company through merger. In the mid-1990s, the plant was bought by Midwest Generation and the Edison International Company. The 200-acre site for the plant was originally chosen for access to abundant cooling water and for the land available for coal storage. The plant has storage for over 750,000 tons of coal. On average, the plant consumes 8,000 to 9,000 tons of coal daily (ComEd, Waukegan Station information brochure).

To the north of the power station is land of the former Johns-Manville plant, built in 1922 for the manufacture of various building products that incorporated asbestos. The plant is now abandoned and the property is a superfund site. The hills visible to the north of this stop are stockpiles that contain asbestos-containing material (ACM).
Coastal Geology

The Waukegan Generating Station requires an uninterrupted supply of cooling water. Lake Michigan provides the source of this water, and the system for inflow and outflow between the lake and the power plant is designed to work with the natural coastal processes along this shore. A steel-sheetpile jetty separates intake and discharge channels (fig. 25). Water is taken in on the south (downdrift) side of the jetty and returned to the lake along the north (updrift) side. The discharge current is sufficient to prevent any major sand accumulation that would otherwise occur against the north side of the jetty. To prevent ice from entering the intake channel during winter, a steel ice barrier extends from the jetty, across the intake channel, and over to the south shore.

The water area on the south side of the jetty is protected from the direct influence of northerly waves. Because of this protection, the area is prone to deposition of littoral sediments. The accumulation of sediment reduces water depth, which can restrict inflow to the cooling channel. In winter, the problem can become acute if ice becomes grounded on the shallow bottom to form a barrier to the water flow. Maintenance dredging is therefore necessary to maintain depths sufficient for the year-round water flow into the intake channel. Maintenance dredging removes about 30,500 m³ (40,000 yd³) per year from this area or half of the 61,000 m³ (80,000 yd³) per year that approaches from the north. The remaining 30,500 m³ (40,000 yd³) per year moves past the power plant facility and continues southward toward Waukegan Harbor. Sand removed in the dredging is stockpiled just landward of the beach area on the south side of the power plant property.

Notable shoreline change has occurred in this area in historical time. In 1872, the shoreline was about 200 m (600 to 700 ft)
east of where the power plant is located (fig. 24). Since that time, the shoreline has shifted nearly 400 m (1300 ft) lakeward. Most of this accretion is due to the natural accumulation of sediment along this depositional part of the beach-ridge plain. Some of this accretion, however, can be attributed to the updrift influence of jetties and breakwater at Waukegan Harbor a little over 0.6 km (1 mi) to the south (Stop 6).

**Coastal Management**

Although the routine maintenance dredging at the Waukegan Generating Station has been an effective means of managing the sand surplus, it has long been recognized that reducing or eliminating this need would be beneficial to the plant's operational costs. A proposal has been suggested to construct a groin on the updrift (north) side of the discharge channel that could trap littoral sand before it reaches the discharge and intake channels (Bridges and Ettema 1999). This entrapment could then be a sediment supply to be excavated and trucked or barged northward to be placed on the feeder beaches or in the nearshore of the state park. Such a procedure of sand recycling or "backpassing" would reduce the need to purchase nourishment sand from inland sources. Before such a backpassing program could be implemented, the long-term governmental and private sector commitments and responsibilities need to be resolved. In the meantime, maintenance dredging will continue at the intake channel and sand will be stockpiled onshore.

**STOP 6  Waukegan Harbor Entrance Channel, Map 7 of 8 (Appendix B)**

**Stop Highlights**

- Shoreline changes caused by construction of harbor-entrance jetties
- Site of most pronounced shoreline offset in southern Lake Michigan
- Consideration of beach-ridge plain evolution if Waukegan Harbor had not been built
Setting

Waukegan Harbor is located about 3.2 km (2 mi) north of the southern terminus of the Zion beach-ridge plain, but the coastal engineering that has occurred here has essentially made this area the terminus for all littoral sediment moving southward along the plain. Waukegan Harbor is a federal harbor project maintained by the Chicago District U.S. Army Corps of Engineers (Bottin 1988). Project depth is 7.0 m (23 ft) in the approach channel and 5.5 m (18 ft) between the jetties and into the main basin. Typical depths are often less because of accretion and reduced depth of maintenance dredging. On the south side of the harbor complex is the Waukegan Marina operated by the Waukegan Port District. Industrial and commercial land uses dominate the area surrounding the northern part of the harbor (fig. 26). The inner harbor has a long history of contamination from industrial waste. A former slip in the northwest corner of the inner harbor is now a sealed containment for sediment with PCBs.

Historical Overview

First settled in 1778 and originally called Little Fort, the town’s name was changed in 1852 to Waukegan, which is a Native American word for “little fort.” Transport of lumber from the Waukegan area led to the construction of two private piers that were in use in the 1850s, but these lacked protection from wave action. By 1883, the U.S. Army Corps of Engineers constructed timber cribs to form a small harbor. Entrapment of littoral sediment against the structures and within the harbor basin was an immediate problem that required lengthening of the jetties and harbor dredging. The footprint of this early engineering structure is entirely within the present harbor basin (fig. 27). Construction of the present-day Waukegan Harbor results entirely

Figure 26 Aerial photo of the Waukegan Harbor area (Illinois Department of Transportation photo, March 1997). Note the degree of shoreline offset to the north and south of the harbor. This offset is a result of both the predevelopment shape of the beach-ridge plain and littoral sand entrapment against the harbor north jetty and north breakwater.
from construction in the 20th century that occurred in two phases. The first phase was from 1902 to 1906, when the jetties were built to their present length and the north breakwater was built along its northwest-southeast segment. At that time, the north breakwater was an offshore (detached) breakwater. The second phase was from 1930 to 1932. A breakwater extension was built to connect the original breakwater to the shore to better restrict sand accretion near the entrance channel.

**Coastal Geology**

Jetty construction for Waukegan Harbor introduced a nearly total barrier to littoral transport and thus resulted in rapid and extensive shore accretion. Figure 28 shows the record of shoreline change on the updrift side of the Waukegan Harbor between 1839 and 1991. The shoreline accretion between 1839 and 1872 predates any coastal structures for Waukegan Harbor. The 1906 and 1910 to 1911 shorelines show how the accretion on the north side of the north jetty resulted in a shoreline segment that had a north-south orientation. Subsequent accretion against the north jetty built the shoreline closer to the jetty end and facilitated transport of sand into the entrance channel. To halt this accretion, in 1930 a breakwater segment was built to close the gap between the offshore breakwater and the beach. The 1937 to 1991 shorelines show the beach accretion that occurred on the north side of this breakwater extension. Since the 1930s, the shoreline between the breakwater extension and the north jetty has shifted with changes in lake level but has not had any major accretion. The influx of littoral sediment from the north now migrates along the north side of the north breakwater and is directed into the harbor entrance channel. Most of this sediment accumulates in the outer part of the approach channel. Some littoral sediment gets past the harbor entrance and continues in southward transport.
Waukegan Harbor has a long dredging history that begins in 1889 and has been an intermittent maintenance requirement ever since. In general, dredging has occurred every one or two years. As a long-term average, the dredging has involved approximately 30,500 m$^3$ (40,000 yd$^3$) per year (Chrzastowski and Trask 1995). The dredging history is divisible into two overlapping phases. In the initial phase, sand dredged from the harbor entrance area was barged to a deep-water disposal area located 4.0 km (2.5 mi) due east of the harbor entrance. This practice of offshore disposal spanned a total of 93 years (1889 to 1982) and resulted in the deep-water dumping of 1.6 million m$^3$ (2.1 million yd$^3$) of sand. Beginning in 1977, dredged sand was disposed of in the nearshore area south of the harbor. Offshore disposal occurred again in 1982, but, beginning in 1984, a designated disposal area was used located 610 m (2000 ft) south of the entrance to Waukegan Marina. This disposal area originally had depths in the range of 3.6 to 4.6 m (12 to 15 ft) lower water datum. Because of a lack of sediment dispersion, by the mid-1990s, shoaling in the area posed a navigation threat. As a result, in recent years, the dredging from the entrance channel has been barged northward to be disposed of in the nearshore close to the North Unit feeder beach (Stop 2). For the entire history of dredging at the harbor entrance, only about one fourth of all dredged sediment has been returned to the nearshore. The remainder has been disposed of in deep water and is permanently lost from the littoral system.

The construction of Waukegan Harbor has been the most profound human impact on the entire Zion beach-ridge plain. This construction influenced a change in shoreline configuration that would not have occurred naturally, it essentially halted the south-
ward migration of the plain, and it resulted in the deprivation of littoral sediment supply to the downdrift area. Survey comparisons document that between 1910 and 1974 the shallow lake bottom on the downdrift (south) side of the harbor lowered as much as 0.9 to 1.8 m (3 to 6 ft) as lake-bottom sand eroded in response to the deprived sand supply (Chrzastowski and Trask 1995). What would have occurred along this coastal reach if Waukegan Harbor had not been built? It is possible to project how this shore would have evolved if it were free of any coastal engineering.

Components in making this projection are the pre-development (1872) shoreline along the southern part of the plain and the beach-ridge configuration, age, and spacing. Based on these data, the natural-state average rate of southward shoreline advance along this part of the beach-ridge plain was about 10 m (33 ft) per year (Chrzastowski and Trask 1995). Using this rate, figure 29 shows a projection of selected shoreline positions in the Waukegan Harbor vicinity to the year 2200 assuming the absence of the harbor. The southward migration of the plain would continue as sand would be deposited south and east of the harbor. This advance of the beach-ridge plain would eventually contain the entire footprint of the present-day harbor.

Construction of Waukegan Harbor has clearly altered the shoreline configuration at this location, and the offshore disposal of dredged sand has been a permanent loss to the littoral system. However, caution is needed in examining shoreline accretion maps such as figure 28 and concluding that the harbor construction was a factor in depriving the Illinois shore to the south of great volumes of littoral sand. The harbor is built into the leading edge of a migrating beach-ridge plain, and the majority of the sand trapped on the updrift (north) side of the harbor complex and that dredged from the harbor entrance would have been deposited in the vicinity of the present-day harbor as part of the continuing southward migration of the beach-ridge plain.

**Coastal Management**

The industrial activities surrounding Waukegan Harbor have led to contaminants being incorporated in the bottom sediments. Dredging in the inner harbor can intercept sediments containing PCBs, metals, and other contaminants, and such dredged sediments would require disposal at an appropriate containment site.
Dredging in the approach channel removes sand that has nearly all moved southward along the beach-ridge plain and has been distant from industrial activity. However, analysis of this material is necessary to ensure it meets state and federal standards for use in beach nourishment.

The sand dredged at the Waukegan Harbor entrance is going to continue to be one of the key issues in the management of sand resources along the Illinois coast. This sand was primarily derived from erosion along the Illinois Beach State Park shore. Returning sand northward is a recycling effort that helps to conserve the sand resources of the park and helps to alleviate erosional trends there. The detriment is that this recycling prevents a sand contribution to the shore south of Waukegan Harbor to help feed the sand-depleted beaches of the North Shore. If the dredged sand is transferred to the downdrift shore, the state park will require the import of equivalent sand volumes from inland. This is a high-cost alternative to backpassing that will increase in cost as inland supplies are further depleted and are in greater demand.

Stop 7  Foss Park, North Chicago,  
Map 8 of 8 (Appendix B)

Stop Highlights
- View of the southern edge of the Zion beach-ridge plain
- Till exposure along the bluff coast

Setting

Foss Park is a municipal park of the City of North Chicago. The major part of the park is an upland area atop the bluffs and about 24 m (80 ft) above lake level. However, the park includes the bluff area and the adjacent beach. The park road leading to the beach provides access to the North Chicago water filtration plant. The park is a contrast to the neighboring industrial land to the north and west and the Naval Training Center, Great Lakes, Illinois, located to the south. The northern boundary of Foss Park
is shared with land used by the Naval Training Center and several federal agencies for training in the use of firearms (the shooting is directed out over the lake).

Foss Park is located about 0.8 km (0.5 mi) south of the southern limit of the Zion beach-ridge plain. The lakeshore at the park provides a vantage point for viewing the southern edge of the beach-ridge plain, which is private property. The park also provides an opportunity to examine exposures along the coastal bluffs that have yet to be fronted by the plain and are thus still impacted by coastal processes.

**Historical Overview**

The southern end of the Zion beach-ridge plain visible from Foss Park was the site of former industrial land dominated by a U.S. Steel plant. The land is now cleared awaiting future redevelopment.

**Coastal Geology**

**Southern end of Zion beach-ridge plain**

The two narrowest segments of the Zion beach-ridge plain occur along its northern reach between Kenosha and the Wisconsin-Illinois state line and along the southern reach south of Waukegan Harbor (fig. 6). The difference between these two narrow segments is that the northern segment is the result of an advanced stage of erosion, and the southern one is the result of an early stage of deposition.

South from Waukegan Harbor the beach-ridge plain extends another 3.2 km (2 mi). Progressing southward, the width of the plain remains about 305 m (1,000 ft) until it tapers out along the southern 914 m (3,000 ft). Historical shoreline comparisons indicate that shoreline position and overall configuration of this reach of the plain has been stable through historical time, largely because of the armoring of the shore for industrial land uses. Fill has been added to raise the elevation of the land surface, but no significant lake filling has occurred.

This southern end of the plain contrasts with the greater width along the rest of the Illinois portion of the plain and the projection of previous greater width along the Wisconsin part of the plain. It could be assumed that the sand plain south of Waukegan Harbor
is a feature unrelated to the Zion beach-ridge plain and was in the process of being coalesced into the Zion beach-ridge plain as it advanced southward. However, along the western margin of the plain within the South Unit of the state park are beach ridges that suggest that such a finger-like projection has occurred in the past (fig. 30). This feature apparently is a shoreline configuration on the leading part of the plain that intermittently develops as the plain advances along the coast. The factors leading to the development of such a projection likely include sediment supply, wave dynamics, and the local lake-bottom profile.

Coastal bluffs at Foss Park

The coastal bluffs at Foss Park are about 24 m (80 ft) above the shore and vary in slope from nearly vertical to about 25 degrees. The bluffs are cut into part of the Zion City moraine, which is the youngest of the Lake Border morainic system (fig. 4). The exposure along the bluffs is primarily a gray, silty clayey till with lenses and beds of silt, sand, and gravel. These deposits are part of the Wadsworth Member of the Wedron Formation (Willman and Lineback 1970).

Rates of bluff recession along the Illinois shore have been evaluated by Larsen (1973), Collinson et al. (1974), Berg and Collinson (1976), and Jibson et al. (1994). The work by Jibson et al. (1994) has been the most comprehensive study to date. Using historical maps and aerial photography for the vicinity of Foss Park, this study determined a long-term average bluff recession (1872 to 1987) of 22 cm/yr (8.6 in/yr) or about 22 m (72 ft) per century. Processes contributing to bluff recession have been wave erosion at the toe of the bluff and precipitation, providing both runoff across the bluff face and water moving through the bluff sediments. The bluff face typically fails in a sheet-like fashion along localized translational and rotational slides. Slides that incorporate the entire bluff face from top to bottom are rare or nonexistent (Jibson et al. 1994).
The bluff exposures at Foss Park provide an example of the bluff exposures that would have occurred along what is now the western margin of the beach-ridge plain prior to its southward advance. Along much of this margin, the bluffs were not quite as high as at Foss Park, but the bluff materials, bluff slope, and bluff dynamics were similar. The bluff erosion was the prime source of beach sediment along the shore prior to the advance of the beach-ridge plain. Because of the clay dominance of the till, of the bluff sediment that eroded, only about 10 to 15% was sand and gravel that could be retained on the beach. The silt and clay was transported offshore to ultimately be deposited in deep water.

**Coastal Management**

Shore erosion has not been a major problem at Foss Park, primarily because of the wide beach resulting from littoral sediment entrapment updrift of the lakefill protrusion of the water plant and parking area for the park beach. Erosion along the bluffs has required mitigation. A project underway as of 2001 is the construction of a series of terraces along the bluff face built from clean fill obtained from inland construction. Although this effort will provide some stabilization of the bluff, the primary objective is recreational. The terraces will be developed for picnic use and as lake and beach overlook areas.

**References**

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APPENDIX A
HISTORY OF ILLINOIS BEACH STATE PARK

Illinois Beach was legally designated as a state park on July 13, 1953; thus, the 50th anniversary of this park will occur in 2003. Prior to designation, the land now occupied by the park had a diverse history and underwent a variety of land uses. The initial designation as a park was for what is now the South Unit. The North Unit has existed for only about 30 years and resulted from land acquisitions in the 1970s.

The land that makes up the South Unit never underwent widespread development, but documents indicate that a community called Mayville was once platted for land along the Dead River. About 1902, a railroad track had been built across the ridges and swales to a point along the shore just north of the Dead River. Along the beach, vast quantities of sand and gravel were then being mined and hauled away by rail car. The remains of the abandoned tracks can still be found in some places. The scenery of what is now the South Unit led to using the area for the filming of several westerns beginning in 1914 and continuing into the 1920s.

The northward advance of Waukegan industrial land along the lakeshore prompted the Illinois Dunes Park Association to lease some land in the present South Unit area in the 1930s. The association hired caretakers and charged visitor fees. Then, in 1943, the Illinois General Assembly approved the purchase of 182 hectares (450 acres) of land for park use, but, following the purchase, the land was turned over to the U.S. Army for temporary use during World War II. After the war, the land reverted to the state, which then purchased another 252 hectares (623 acres). Land acquisition in the South Unit continued into the 1950s.

The North Unit of the park occupies land that has had a history of much more intense and extensive development than the South Unit. The Camp Logan area of the North Unit was a former U.S. Army training camp. Land here has been subject to tank maneuvers, gun and artillery ranges, and the varied building and infrastructure of an army base. To the north and south of Camp Logan, residential housing developments existed in the 1950s and 1960s. Many homes were built along the shore but later suffered severely from shore erosion. Some structures actually fell into the lake. The erosion problems along this reach allowed the state to acquire this residential land in the 1970s. The closing of Camp Logan also allowed acquisition of this former base. What is now the North Unit of Illinois Beach State Park formally became part of the park between 1971 and 1982. The North Unit originally extended along the shore all the way to the Wisconsin-Illinois state line. The construction of North Point Marina resulted in a separate parcel of lakeshore land, managed by IDNR, but separately from the state park.

The combined North and South Units give Illinois Beach State Park a total land area of 1683 hectares (4,160 acres). The state park ranks as the fifth largest in Illinois. On May 9, 2000, the North Point Marina and Illinois Beach State Park were formally dedicated as the Cullerton Complex in honor of William J. Cullerton, Sr. William Cullerton, Sr. is a decorated World War II hero, a Chicago-area radio personality, and a highly successful sporting goods businessman. He has been a long-time advocate of Lake Michigan conservation, fishing, and boating.
APPENDIX B
TOPOGRAPHIC MAPS/FIELD TRIP STOPS

(From U.S. Geological Survey, Kenosha Quadrangle, 1:24,000; photo revised 1971.)
No stops this map section

(From U.S. Geological Survey, Kenosha Quadrangle, 1:24,000; photo revised 1971.)
(From U.S. Geological Survey, Kenosha Quadrangle, 1:24,000; photo revised 1971.)

Map 3 of 8
(From U.S. Geological Survey, Zion Quadrangle, 1:24,000, 1993.)
(From U.S. Geological Survey, Zion and Waukegan Quadrangles, 1:24,000, 1993.)