

Ice Age

National Scientific Reserve
Wisconsin

Department of Natural Resources
State of Wisconsin
National Park Service
U.S. Department of the Interior



The mural depicts the scene at Kettle Moraine 10-12,000 years ago when the Ice Age was ending. The glacier was

stagnant and melting northward. The landscape was basically tundra. Two ice lobes were drawing farther

apart. The lobe at left is mostly covered with debris. The lobe in the background lies exposed.

The woolly mammoth became extinct 8-10,000 years ago. Snowshoe hares (foreground) and loons (overhead) still live

in this region. The musk oxen (by lake) no longer live in this area but are still found in Alaska and other northerly areas.

This outwash plain gives rise to the ancestral Milwaukee River. Today's Jersey Flats, near the Kettle Moraine Visitor

Center, are the result of such braided stream and outwash plain deposits. A stranded ice block, either partially or wholly

buried, has melted, leaving a depression this kettle lake now fills. Eskers, as the shape suggests, formed inside the tunnels

Reconstruction painting by Roy Andersen

created by streams that ran beneath the glaciers. When materials fell or were washed through holes in the ice, kames

built up beneath the glacier. Unlike most hills, kames were not thrust up, but plunked down!

Each year we see the northern United States altered by the cycle of the seasons, but this has not always been so. During a recent geologic period this land did not undergo seasonal changes. Great areas lay under thick layers of ice. For more than a million years, in at least four major periods of glacial advances, ice covered much of Canada and the northern United States. These four glacial stages, Nebraskan, Kansan, Illinoian, and Wisconsinan, are named for their most southerly advances.

The Wisconsinan stage covered much of the northern United States from the Atlantic coast to the Rocky Mountains as recently as 12,000 years ago. Nowhere is the evidence of the glaciers better preserved than across Wisconsin. As you drive around the State you can see many lakes and ponds, forested hills and ridges, and gently rolling farmlands that remind us of the glacier's visit. The Ice Age National Scientific Reserve was established in 1971 to preserve select glacial landforms and landscapes. The Reserve, part of the National Park System, consists of nine units administered by the Wisconsin Department of Natural Resources.

In southeastern Wisconsin, certain distinctively shaped hills and ridges occur repeatedly and in patterns that rule out the possibility of random distribution. These recurring landforms are mementos of the Wisconsinan glaciation, the most recent major episode in Earth's geological history. Because each landform was shaped by the ice sheet under a special set of conditions, it is fairly easy for observers of glacial geology to recognize them. And with the help of the information below, you should

be able to recognize them too. Besides that, you will see much of Wisconsin's great scenic beauty in these interesting glacial landforms. The great sequence of events that did so much to shape the northern half of North America and Europe spanned perhaps 1.5 million years. The Wisconsinan stage, the latest series of glacial advances and retreats, began possibly 70,000 years ago and ended only 10,000 years ago. In fact, we can't even be certain that we are not in fact still in the Ice Age and merely enjoying a warm period between two glacial advances.

This knowledge, strangely, is only about a century old. Until the mid-19th century no one could account satisfactorily for drumlins, kames, eskers, kettles, moraines, and other such phenomena. It was the great Swiss naturalist Louis Agassiz who announced to a skeptical world the bold new theory of continental glaciation. Today it is universally accepted and is the focus of a whole branch of geologic investigation. The areas protected as the Ice Age National Scientific Reserve give you a good on-the-ground introduction to Ice Age geology.

Variations in topography and snowfall caused the massive ice sheet to move across the land at an uneven pace. The glaciers moved easily down river valleys and drainages, but massive hills slowed their movement. Higher upland areas caused the ice sheet to separate into tongues or lobes of ice moving outward from the main mass. Four major lobes of the Wisconsinan Glacier are recognized across the State: Superior, Chippewa, Green Bay, and Lake Michigan lobes.

We can only speculate about what Wisconsin looked like before the glaciers moved across the land. Undoubtedly, much of it was well drained land like the southwestern portion of Wisconsin, an area so virtually untouched by glaciers that it is known today as the Driftless Area. As glacial ice advanced southward, hills and bluffs were often sheared off right down to bedrock. As the glacial front retreated, however, glacial debris suspended within the ice was deposited, filling depressions and leaving undrained, rolling lands. This layer of debris, varying from a few centimeters to a hundred meters or more, is the legacy of the glaciers.

The glaciers did not advance and retreat in one continuous movement. During a period of thousands of years the glacial ice moved slowly forward, stopped, retreated, and moved forward again. Suspended material would be deposited at the glacier's outer edge as the front melted and slowed. During periods of glacial advance much of this same material was lifted and pushed into ridges or moraines. Materials were deposited at the leading edge of the ice sheets, forming end moraines—bands of hills marking the farthest points of the glacial advance across the State. Although the end moraine is no longer a continuous band of hills because of erosion, it is useful for studying glacial movements. Many of these landforms remain. Some were destroyed when the ice or water quickly eroded them. Other landforms have been destroyed as people removed the commercially valuable water-sorted sands and gravels that they contain.

Huge lakes were formed when the glaciers, with the bulk of their ice and deposits, blocked natural drainages. As the glaciers retreated northward, many of these lakes drained, leaving broad, flat lake beds that are now rich agricultural lands. Large marshes providing rich habitat for birds and other wildlife have developed in other old lake beds. Thousands of years of gradually warming climate forced the glaciers to retreat to northern latitudes. Plant and animal life driven southward by the glacial advance again began moving northward. Today, relict populations of plants associated with cooler northern climates persist in some deep gorges and valleys.

As plants and animals again reclaimed the land, nomadic man arrived. Small groups followed the game and foraged for plants. Over the years their numbers grew and tribes evolved. The extensive waterways left by the glaciers provided relatively easy transportation routes. The wetlands also provided homes for fish, fowl, and fur-bearing animals, a combination that attracted early explorers. The first permanent settlements were located along waterways. Forests spread across the land, and soon timber was harvested and shipped east via the waterways. The relatively flat land left by the glaciers was fertile and readily adapted to farming. Soon much of Wisconsin became farmland. Today, recreationists enjoy the rich glacial legacy of waterways and wetlands.

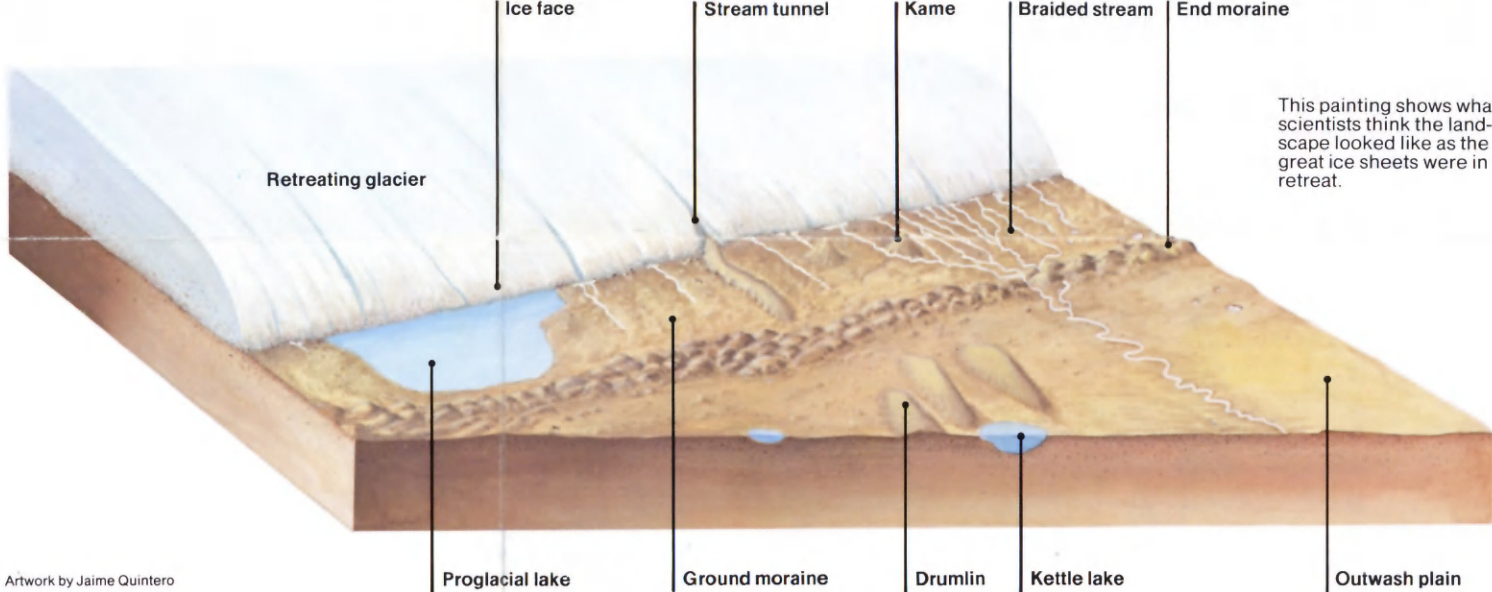
The Ice Age Shapes the Landscape

The two continental ice sheets that exist today—the Antarctic and the Greenland—suggest how awesome the Ice Age was. Two-thirds of all freshwater lies locked in the Antarctic sheet, which is, at its thickest, more than 4 kilometers (2.5 miles) deep.

Here in Wisconsin, the Earth's crust has rebounded 50 meters (160 feet) since the Ice Age glaciers receded. Rebound is subtle—1.3 centimeters (0.5 inch) per year—but the land features that glaciers leave behind are easy to spot. Moving slowly, glaciers nevertheless attacked the land with violence and power, grinding bedrock into fine powder. Then, once released, the staggering torrents of meltwater tore across the landscape, carving the gorge known as the Dalles of the St. Croix River. The waters' sustained force is evident in potholes abraded into bedrock. But most apparent on the Wisconsin landscape are features resulting from stagnant ice conditions and from deposition.

When the forward movement of glaciers reached equilibrium with meltback, stagnant ice resulted. Conical hills, called **kames** grew as debris washed through holes in the ice. Visualize kames as reverse funnels. As stream tunnels beneath glaciers filled up with debris, **eskers** formed. Eskers look like inverted streams winding across today's landscape. Depressions in the ground, known as **kettles**, formed as stranded ice blocks melted and the debris covering them subsided. This melting process could take thousands of years. Some kettles are simple bowl-shaped depressions, but others are now bogs, marshes, or lakes.

Features deposited by the ice itself—not by meltwater—include **ground** and **end moraines**, **drumlins**, and **erratics**. The materials that compose them had not been sorted by the action of moving water. Ground moraines were deposited under moving ice, or were just let down like a carpet as stagnant ice melted. End moraines



Artwork by Jaime Quintero

This painting shows what scientists think the landscape looked like as the great ice sheets were in retreat.

represent glacial dumps at the edge of moving ice and trend perpendicular to the glacier's direction of flow. There are three types of end moraine. Terminal moraines are the outermost end moraines of a glacier's advance, marking where it terminated. Recessional moraines are those left by retreating ice. Interlobate moraines are built between lobes of ice. Erratics are rocks carried from a distance in or on the ice. If you can keep all that straight, you're on your way to becoming a geologist!

Drumlins look like the upside-down bowls of teaspoons, or halves of teardrops. Their formation is not well understood. They were built up in layers beneath moving glaciers and usually occur in groups—sometimes in hundreds—behind the end moraines. A drumlin's long axis parallels the glacier's direction of flow.



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Continental Glaciation
To understand the changes continental glacial ice sheets (left) brought, you must grasp their magnitude. Over thousands of years the cold of arctic climates crept southward. Falling snow did not melt but accumulated year after year. Under pressure of its own weight, snow was changed to ice. In time an ice sheet more than 1,600 meters (1 mile) thick resulted. Its mass produced pressures causing it to spread.

Year by year and meter by meter it moved across the land, engulfing soil and rock and incorporating them into its mass. Trillions of tons of materials, lifted, ground, and mixed together in glacial ice, were carried southward. Over the Ice Age's millions of years the land was leveled and the Earth's surface depressed by the ice sheets' weight. A small change in our present annual temperature—a 5°C (9°F) drop—could renew such snow buildup.

The photos (right) show features whose formation or origin is depicted in the imaginary glacial landscape illustrated above.

The Driftless Area. For unknown reasons, southwestern Wisconsin escaped the ravages of

glaciation (see map at left). This Driftless Area, a low plateau deeply cut by stream valleys, is an old landscape whose rougher surface contrasts with ice-formed topography. The Mill Bluff unit adjoins the Driftless Area. Its castellated buttes, spires, and pinnacles were sculpted by waves of Glacial Lake Wisconsin breaking on sandstone outliers of the Driftless Area. That lake formed when the Green Bay lobe blocked the Wisconsin River. Railroad and highway routes traversed the old lake bed to avoid this difficult terrain.



End moraines formed as glacial dumps at the edge of moving ice. They trend perpendicular to the glacier's direction of flow.



Kames are conical hills formed by debris deposited by meltwater flowing into funnel-shaped holes in the ice.



Kettles are surface depressions formed as sand and gravel settled over a melting ice block. Green-bush Kettle, in the Kettle



Erratics are rocks transported from a distance, usually in or on the ice. They differ from the bedrock or soils on which



Moraine unit, is an out-standing example.



Eskers, serpentine ridges of gravel and sand, probably mark stream channels under stagnant ice sheets. The well known



Potholes were worn into solid rock at falls and strong rapids where sand, gravel, and stones were spun around by the cur-

Ice Age

General Information

The Ice Age Reserve consists of nine units across Wisconsin (map at right). Detail maps of five units are below. All nine units are described at right. By car you can visit more than one unit in a day: Horicon Marsh, Kettle Moraine, and Campbellsport Drumlins; or Devil's Lake and Mill Bluff, for example. Hikers note: Sections of the Ice Age National Scenic Trail are now open and being marked.

Fees. Entrance and use fees are charged at some units. Federal Golden Eagle, Golden Age and Golden Access Passports and Wisconsin Department of Natural Resources admission stickers are honored.

Protecting the Reserve. Units of the Reserve are managed for various purposes: Wildlife management, recreation, or scientific study. Please obey the regulations at each unit. Do not disturb wildlife or plants. Build fires only in grills, fireplaces, or fire rings provided. Dispose of litter properly. Pets must be on a leash and under physical control at all times. Some lands in the Reserve are not in public ownership; please respect private property.

For Your Safety. Many units have rugged terrain and large bodies of water. Be careful and supervise children. When hiking, stay on designated trails. Swim only in authorized areas when life-guards are on duty. Above all, drive safely.

This National Park System area is administered by the Department of Natural Resources, State of Wisconsin. The address is **Ice Age National Scientific Reserve, DNR Box 7921, Madison, WI 53707.**



National Scientific Reserve Wisconsin

Department of Natural Resources State of Wisconsin National Park Service U.S. Department of the Interior

The Nine Units

Two Creeks Buried Forest

Highway Access: Wis. 42, 19 kilometers (12 miles) north of Two Rivers. **Glacial Features:** Buried Forest and Lake Michigan. **Recreation/Services/Facilities:** This unit is not yet in operation. **For Information:** Two Creeks Ice Age Unit, c/o DNR, Point Beach State Forest, Rt. 3, Box 183, Two Rivers, WI 54241. (414) 794-7480.

Kettle Moraine

Highway Access: U.S. 45/Wisc. 67, 32 kilometers (20 miles) west of Sheboygan. **Glacial Features:** Kames, eskers, kettles, interlobate moraine. **Recreation:** Swimming, boating, hiking, camping, picnicking, cross-country skiing. **Services:** Interpretive center, free information brochure, exhibits, naturalist programs, nature trails, and campground and trailside shelter reservations. **Facilities:** Trailer dumping station. **For Information:** Kettle Moraine Ice Age Unit, DNR, Box 426, Campbellsport, WI 53010. (414) 626-2116.

Campbellsport Drumlins

Highway Access: Fond du Lac County Hwy. Y or V, 5 kilometers (3 miles) west of Campbellsport. **Glacial Features:** Drumlins. **Recreation/Services/Facilities:** Scenic drive. (This unit is not yet in operation.) **For information:** Campbellsport Drumlin Ice Age Unit, c/o DNR, North Unit, Kettle Moraine State Forest, Box 426, Campbellsport, WI 53010. (414) 626-2116.

Ice Age Trail
Hiking
Bicycle
Proposed

National Scientific Reserve
Areas in operation
Areas not yet in operation

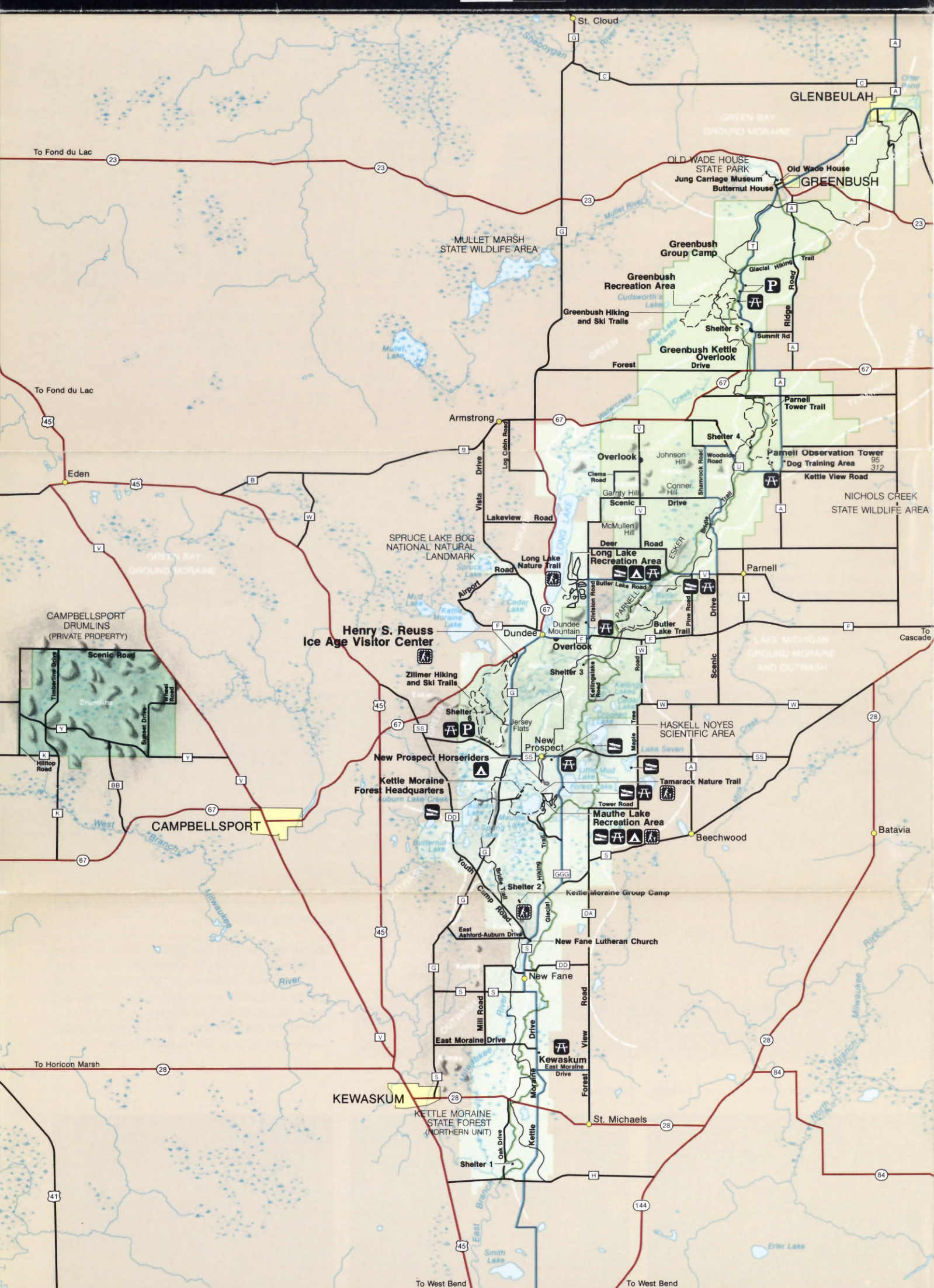
Unpaved road
Hiking trail
Bridle and snowmobile trail

Campground
Picnic area
Self-guiding trail

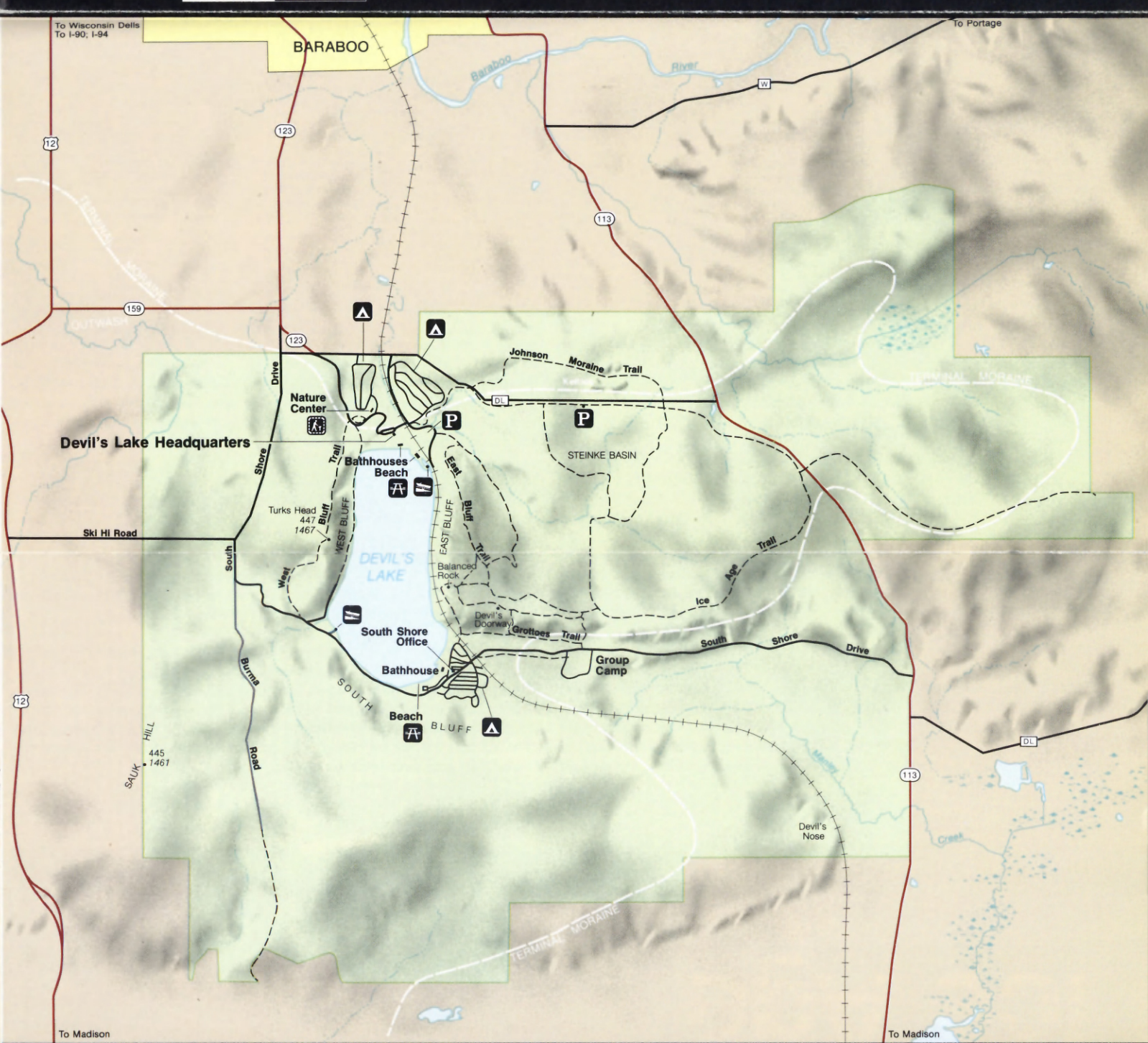
Boat Launch
Parking

Glacial features are shown in white.
Elevations are given in meters, with feet in italics.

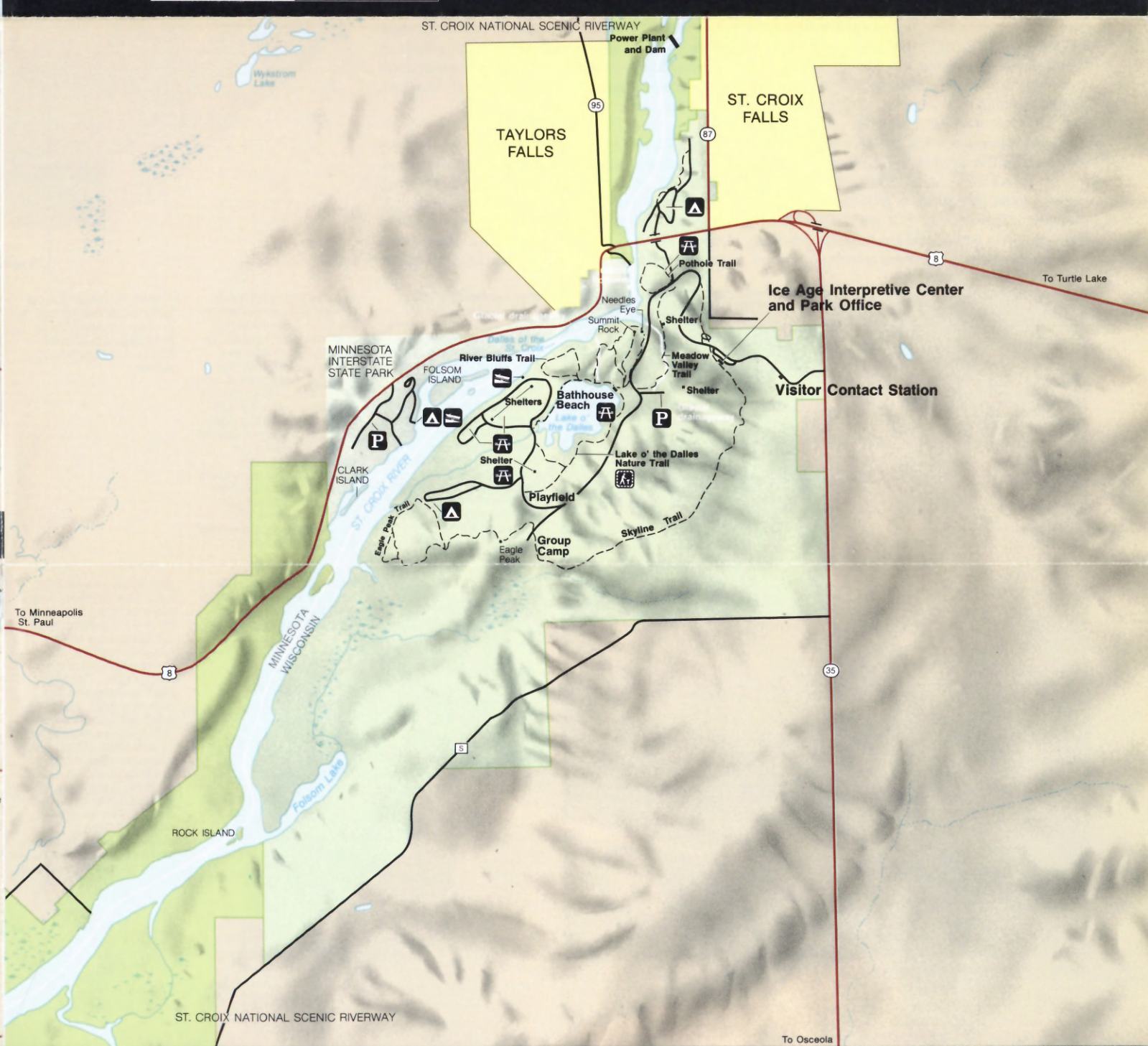
Kettle Moraine and Campbellsport Drumlins



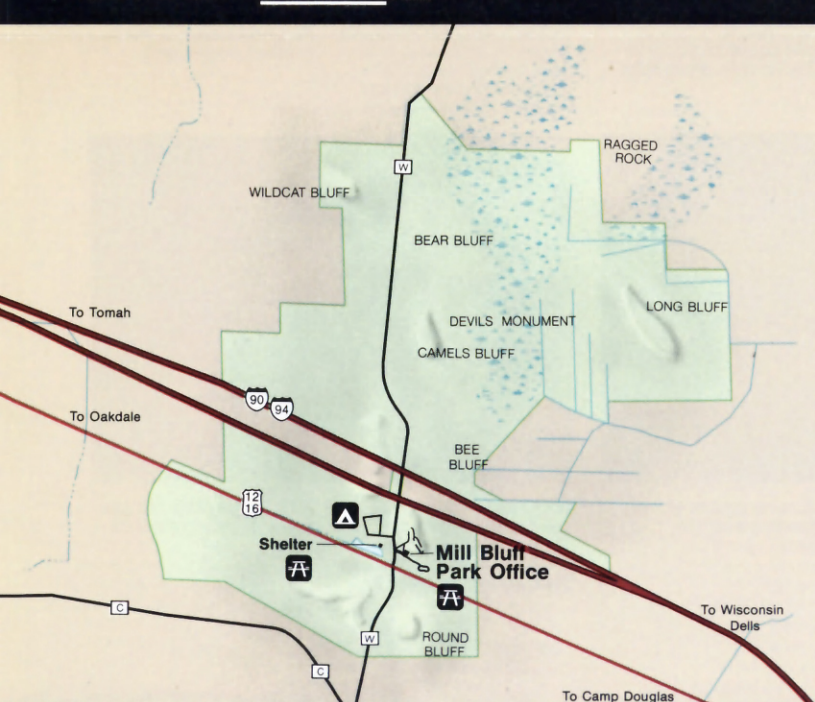
Devil's Lake



Interstate



Mill Bluff



Horicon Marsh

