CEDAR BOG LAKE IS A SMALL BOG LAKE in central Minnesota. It is characterized by turbid waters, very high organic matter content, and interminable mosquito populations. It is also the site of a research program that has been more or less active since the mid-1930s. Some of the early research suggested that the bog lake was filling in or growing toward the center at a rather rapid rate. A discussion of recent studies of Cedar Bog Lake provides an opportunity to see how peat systems function, and to address the question of the fate of Cedar Bog Lake.

Geologically, peatlands resulted from Minnesota’s momentous glacial history. Glaciers leveled the land, and inhibited rapid water flow. By doing so, they created an environment optimal for peatland formation and organic matter accumulation. Glacial activity had other consequences important to this discussion: the glaciers scoured small basins all over the North country. During glacial retreat, these pockets remained filled with ice. As the ice block melted, there remained “ice-block lakes,” which are widespread in today’s landscape. Ice block lakes that have retained their original character are part of Minnesota’s glory. Many others have become water islands in a morass of peat. They also are glorious in their own way.

While traveling through the state’s peatlands, you may have noticed their second most striking feature—the flora. Their first resounding feature is the fearsome insect population. However, with fortitude and repellant, one is afforded the opportunity to find brilliant green mosses, fascinating...

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carnivorous plants, stark black spruce, and many other interesting, water-loving species. The characteristic vegetational complex that comprises Minnesota's peatlands has been extensively studied. As a result, vegetative cover often can be used to characterize peatlands as “bog” or “fen.” The differences, as we shall discuss, are important in the issue of potential lake fill-in processes.

Typically, a “fen” (minerotrophic peatland) receives significant amounts of groundwater inputs. These inputs are comparatively rich in nutrients, and have a relatively high pH. Fen water pH's typically range from 6 to 7.5. A “bog” (ombrotrophic peatland) is primarily fed by precipitation, which is iron-poor, or very dilute. Sphagnum moss and other acid-loving plants are characteristic of bog sites. These plants aid in maintaining bog water pH's at 3 to 4 through cation-exchange and production of organic acids. Peat from bogs is mined for fuel and horticultural purposes. Fen peat does not have the qualities desired for commercial uses.

These two categories, fen and bog, are broad, and encompass a range of characteristics pertinent to peatland description. In spite of their breadth, plant cover characteristics can usually be used to classify a site. For example, Northern white cedar, sedges, or tall shrubs are indicators of fen areas. Bogs provide a less optimum environment for tree growth and support low shrubs, short scrubby black spruce, and large open areas with only Sphagnum moss. Both bog and fen support black spruce and tamarack. The differences are more apparent in growth, height, and vigor than in species.

An interesting feature peculiar to both fens and bogs is the amassing of organic material. In most terrestrial and aquatic systems, plant material decomposes about as rapidly as it is
The habitat on the Cedar Creek Natural History Area is about a third forest, a third wetland, and a third open field and Prairie. Forests range from white cedar stands in low, wet sites, shown in the foreground, to stands of pines and oaks, or sugar maple and basswood on the uplands. Wetlands vary from open cattail marsh, to floating bogs characterized by sedges and swamp loosestrife. Croplands, abandoned fields and undisturbed savannah and tall grass prairie, shown in the upper right, are widely distributed over the area.

The valley of Cedar Creek showing islands of forest surrounded by marsh. Photo by David F. Gogal

produced. The decomposition process provides energy and nutrients for many insects and other animals and drives a system known as soil genesis or soil formation. Thus, soils consist of mineral matter overlain by decomposing plant material. The amount of plant material stays fairly constant year after year.

However, the slow rate of water movement through fens, and the high water storage capacity of bogs, inhibit decomposition of dead plant material. Unlike the mineral soils of upland forests, peatland soils are highly organic and contain large quantities of plant material which are in various stages of decomposition. In most peatland sites, there is an accumulation of new organic matter year after year, i.e., the soils are growing comparatively rapidly.

Cedar Bog Lake, part of a fen site, is a small ice block lake in a peatland. It is located within Cedar Creek Natural History Area about thirty miles north of the Twin Cities. The vigorous vegetation that surrounds the lake, and the animals that live in the fields swamp and lake invite study. They have been studied for over fifty years. In the 1930s, Raymond Lindeman studied the flora and fauna of Cedar Bog Lake, as well as surrounding emergent and terrestrial vegetation. Emergent plants obtain nutrients from the water, but their leaves remain high above the water surface in the fall. Lindeman synthesized, in words and mathematical equations, how plants and animals interacted, and how their interaction via production and consumption of food calories might shape the lake’s future structure and function.

In the thirties, when Lindeman waded through collections of aquatic plant material and benthic fauna, the entire lake bottom was densely covered by plant growth. Various pondweeds such as coontail (Ceratophyllum demersum) and Bushy pondweed (Najas flexilis) were abundant. Cattails surrounded the lake during drier periods, but later, during wetter years, swamp loosestrife (Decodon verticillatus) took hold.

Clearly marked concentric rings of vegetation surrounded the lake in 1930, and do today. The composition and width of the zones has changed dramatically, however. Murray Buell, who worked with Lindeman in the ’30s, noted that the rings consisted of in-lake plants, followed by tamarack, northern white cedar, and then, deciduous species such as basswood and maple. Today, the same species are present, yet not with the same frequency or density. Little submerged aquatic vegetation is found in the lake, except at the margin. Concentric zones of tamarack and cedar grow closer to the lake’s edge. Swamp loosestrife borders over half of the lake perimeter.

More interesting, perhaps, is the story told by the soils formed under the living plants, and the sediment accumulating at the lake bottom. Lindeman measured cores of soils and lake sediments along a transect from the outer edge of the forest, across the swamp across the lake, and out to the opposite edge of the forest. Examination of his core samples revealed that at one time, the lake was much larger.

Lindeman learned that Cedar Bog Lake had been gradually
filling in since the glacial retreat. During dry periods, such as during Lindeman’s time, the cattail and swamp loosestrife, were advancing toward lake center. This encouraged Lindeman to predict that the lake would fill in within 250 years: a rate of 0.2 metres per year. However, Murray Buell, a Lindeman co-worker in the early thirties, measured the distance, from a benchmark through the floating mat vegetation, to the lake’s edge. In 1968, he remeasured the transect length and found little or no decrease in the size of the lake during the 35+ -year period; i.e., little or no movement of the vegetative mat toward lake center.

We have developed a third assessment of the rate at which the land moves toward lake center, or the rate at which the lake is filling in. Measurement of five aerial photographs taken between 1938 and 1983 revealed that lake size had decreased from 14,000 square metres to 12,600 square metres. That is a rate of advancing toward lake center of 0.03 metres per year. At that rate, the lake will fill in within 2,000 years.

Death and sedimentation of algae and submerged plants within the lake augment the lake fill-in process, and may even exceed the rate of encroachment of the edge mat. We do not have accurate measurements of these rates, but we expect the rates to be high. A major variable, which is less predictable, is change in groundwater inputs, and resulting fluctuations in lake water level. These changes will also influence the rate at which Cedar Bog Lake fills in. In fact, if the lake became isolated from the groundwater, the whole lake could rise as organic matter accumulates at the bottom. Such a process results in peatlands described as raised bogs. Lakes, as part of raised bog systems, also rise with respect to the accumulating sediment at lake bottom. Thus, in this case, the lake has risen and the sediment cores reflect differences over time. Lake fill-in was not the vehicle of change, but the measurements in sediment cores may be similar and the differences difficult to detect without measurements of the groundwater.

Thus, the question remains: Is Cedar Bog Lake filling in, or is the whole lake rising? Undoubtedly, evidence from Lindeman’s core samples support the idea of lake fill-in. Under the present swamp loosestrife mat, partially decomposed vegetation from the mat edge lies over lake sediment. That may imply that the mat is encroaching on the lake. The aerial photos also indicate that lake area has decreased over a fifty-year period. Yet, with regard to an overall rise of the fen area, and potential changes in groundwater inputs, measurements are still required. It does appear that Cedar Bog Lake is becoming smaller, and that is probably typical of many Minnesota bog lakes. The cause may vary with each lake, and remains to be determined for Cedar Bog Lake.

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