Shrub invasion shows recent drying of ancient Kenai peatlands

by Ed Berg

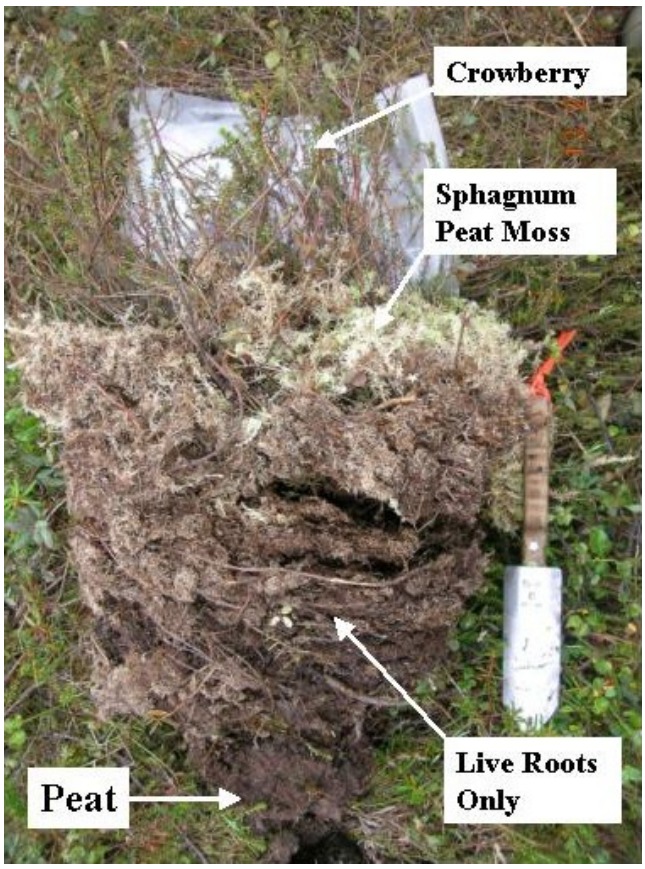

Photo of plug of sod. USFWS/Ed Berg.

A major shrub invasion is underway on the wetlands of the Kenai Peninsula, presumably due to warmer summers. Wetlands that used to require rubber boots can now be navigated in sandals and sneakers, but the scratchy shrubs may require long pants.

The shrub invasion is not as noticeable as retreating glaciers or drying ponds—both of which we have in spades—because there is no visible reference for comparison, like a glacier front or exposed shoreline. The shrubs have been steadily invading for at least the last several decades, but unless you have been hiking local wetlands for these decades, you may not have noticed the change. The change, however, is easily demonstrated with the aid of a "geoprobe," otherwise known as a stout shovel.

To see the shrub invasion, you must venture out into a local muskeg covered with dwarf birch, Labrador tea, crowberry, blueberry, sweet gale, and other woody shrubs. Apply the geoprobe and cut out a plug of sod about a foot deep. Here is what you will typically find: live sphagnum peat moss (with tiny cabbage-like tops) will form a green layer several inches thick at the top. Below the live moss will be a brown layer of partially decomposed peat moss. This layer will grade downward into fine-textured pure sphagnum peat, which if you keep digging, may extend downward more than 20 feet, representing thousands of years of wet peat bog growth.

Now here is the clincher: the woody shrub roots are all at the top of your sod plug. The roots run all through the layers of live moss and partially decomposed moss, but you won't find them down in the deeper peat proper. Furthermore, most of the roots are alive and attached to the shrubs growing up above the surface. There is no zone of old dead roots. This means that the shrubs are new on this landscape; this is a "first-time" mini-forest of shrubs.

Well now, you say, perhaps shrubs have always lived in these muskegs but they have simply died and rotted away, like shrubs on normal upland soils. You don't find old shrub roots when you spade up the backyard for a garden, so why expect to find old roots in muskegs?

Muskegs are basically peatlands, and peat is usually very wet. Nothing rots in a wet peatland. Human bodies are occasionally found in the famous peat bogs of Ireland, completely mummified and thousands of years old. (The early Irish did have normal cemeteries, so these peat bog mummies probably represent untimely endings and clandestine burials.)

Sphagnum peat has been used for thousands of years for wound dressings, diapers and menstrual pads because it is both very absorbent (a dry ounce of sphagnum can hold a pint of blood) and because it is antiseptic, i.e., human bacteria don't like its acidity. It is the waterlogged condition of peatlands, however, and not the acidity, that preserves dead wood in a peatland, if wood ever grew there. In Ireland for exam-

ple old corduroy roads of logs are occasionally found, buried in many feet of peat. Indeed, whole farmsteads have been unearthed, which were overrun by blanket bogs during wet periods several thousand of years ago.

So, when I don't find old wood of any kind in Kenai peatlands (be it logs, stumps, or shrub roots), I conclude that trees and shrubs never grew in these peatlands in the past. The shrubs (and trees) now moving into our muskegs are newcomers, pioneers on a drying landscape. The fact that their roots are alive means that these woody plants are first generation immigrants. The fact that the woody plants are thriving in muskegs for the first time in 8-14,000 years means that the muskegs are changing quite radically.

These conclusions come from my studies of the history of Kenai peatlands over the last several years. In 2003 Edward Mitchell (a wetlands specialist then at University of Alaska, Anchorage) and I cored five peatlands in the central peninsula area. We took peat cores by repeatedly driving a two inch tube deeper and deeper into the peat, taking about a meter of core per drive, until we hit mineral soil. One of our cores, from Merganser Creek on Swan Lake Road, was almost seven meters (22 feet) long. In each core it appeared that the woody roots were confined to the top six to 12 inches of the core. I submitted samples of peat from the bottom of the cores to a laboratory for radiocarbon dating, and obtained basal dates ranging from 7690 to 18,480 years old.

I then sent three cores (from Merganser Creek, Headquarters Lake, and Marathon Road near the Kenai airport) to Paul Glaser, a peat specialist at the University of Minnesota. Paul made a layer-by-layer analysis of the peat composition and texture, its magnetic properties, and described the layers of sand and volcanic ash in the peat. His colleague Jan Janssens identified many of the moss species, using well-preserved moss leaves extracted from the peat. In all of the 23 feet of peat examined, woody roots were only found at the top of the cores, confirming our original visual impressions when we first extruded the peat samples out of the coring tube in the field.

The next step was to figure out how long the shrub invasion has been underway in our peatlands; is this a matter of five years, 20 years, 50 or hundreds of years? This first generation of shrubs is still alive, but how long do shrubs typically live? The biggest shrub—dwarf birch—can have stems an inch thick; it has annual growth rings and is probably the easiest shrub to date with tree-rings. Dwarf birch has been dated with 147 rings (years) in Greenland, so it probably has the longevity necessary for dating the shrub invasion process on the Kenai. The annual rings are tiny and must be stained purple with phloroglucinol and hydrochloric acid, and counted under a compound microscope at 40- to 100-power.

One difficulty in dating dwarf birch is its sprawling, indeterminate clonal growth form. When you start digging up dwarf birch shrubs, you often find that several bushes are connected by underground roots. If you trace the roots backwards, they sometimes all narrow down to nothing, and you feel confident that you have dug up the entire plant with all its above-ground bushes. Sometimes, however, you reach a point where the root has rotted to the point where it is brittle and hard to recover. In this latter case you don't know if you have gotten the original (oldest) bush, or perhaps the original bush has long since died and rotted away. This means that the ring ages counted on the shrubs are "apparent" ages of the entire plant, but these ages might be too young, if the original part of the plant has disappeared.

My assistant Matt Bowser dug up and counted the growth rings of 157 dwarf birch at the three sites where we had analyzed peat cores. The average apparent age was 14 years, with the oldest bushes being 32 years. Matt found very few dead shrub roots in his excavations, so it appears likely that in most cases he found the original plant and that his apparent ages are close to the true age of the whole plants. If there had been abundant ancestral plants that generated the current crop of shrubs, either clonally or by seeds, they should have left some trace of themselves behind in the form of dead stems and roots, and we simply do not see such traces in any significant amounts.

Even given some uncertainty about the true ages of the shrubs, we are confident that the dwarf birch shrub invasion has occurred within the last several decades, and not the last several centuries. This invasion represents a profound change: extensive areas that were stable wet sphagnum peat bogs for 8-14,000 years have dried out in the last several decades and are becoming shrublands. You can also see young black spruce trees advancing into these muskegs, and in another 50-100 years many of these wetlands will be continuous black spruce forest with a shrub and moss understory.

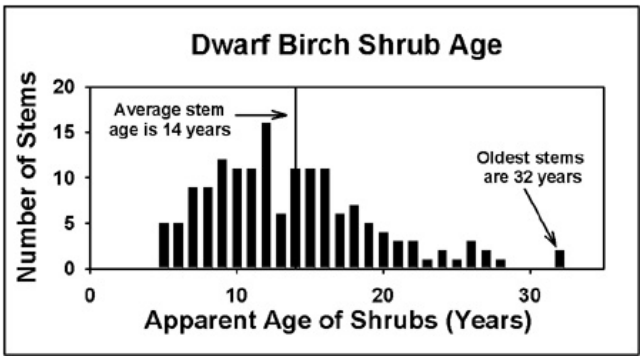

Chart of Dwarf Birch Shrub Age. USFWS/Matt Bowser..

The climate story behind the shrub and tree invasion appears to be the increased evapotranspiration accompanying our dramatically warming summers. The annual water balance (precipitation minus potential evapotranspiration) declined almost 50% after the drought of 1968-69 and has never fully recovered, due to warmer summers. It is likely that drying of the Peninsula began at that time, and it appears to have accelerated in the 1990s, as shown by recently dried up ponds and fallen water levels of closed-basin lakes.

Aerial photography studies of the Copper River basin and western Alaska have shown extensive loss of shallow lakes and shrinkage of larger lakes, so the drying landscape is not limited to the Kenai Peninsula and it appears to be an expression of the general warming climate in the northern latitudes.

My peatland studies are revealing some other interesting stories, which I'll save for future Notebooks. I didn't expect such dramatic testimony about very recent climate change from mucking around in peatlands, but we live in interesting times, as the Chinese say.

Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. Ed will be teaching his 1-credit "Cycles of Nature" course at the Soldotna and Kachemak Bay campuses of the Kenai Peninsula College, starting October 4 and 6, respectively. Call 260-2812 for a course description. Registration is now open. Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.