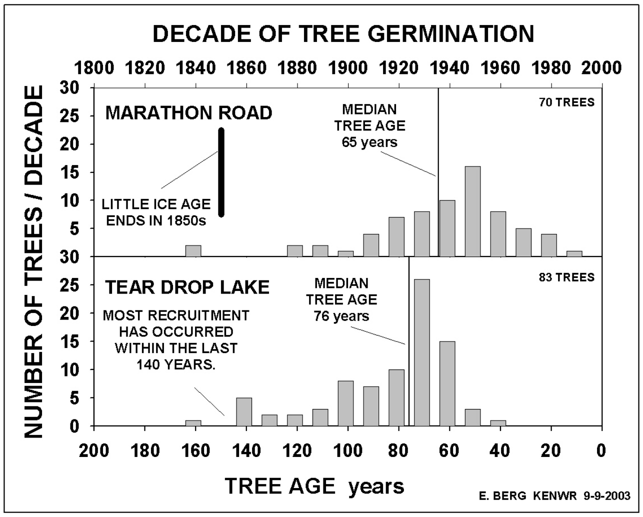
Black spruce forests spreading onto muskeg peatlands

by Ed Berg



Marathon Road and Tear Drop Lake's tree recruitment began in earnest in the mid-1800s

I have long puzzled about the diffuse halos of small black spruce trees that surround many lakes and muskeg areas on the Kenai Peninsula. You can see these halos when you fly over the lakes and muskeg of the northern Peninsula, as well as in the big muskegs along the Sterling Highway between Soldotna and Anchor Point. The typical pattern is a normal mature forest on an upland that grades into smaller and more scattered black spruce trees as you move out onto a flat-lying muskeg. As the muskeg gets wetter and wetter, the trees get smaller and are found mainly on slightly elevated hummocks.

I see two possibilities to explain this pattern: first, that these halos are stable transition zones (ecotones) that have been sitting there for hundreds or thousands of years. In this case the small trees should be old stunted dwarfs, growing slowly with extremely tight tree-rings, and living right on the edge of their tolerance to water-logging. The other possibility is that these small trees represent new forest invading a drying wetland. In this case the trees should be young, with normal ring-widths. On this interpretation, the trees are small because they are young, not because they are stunted; it's kids versus dwarfs.

This question is interesting because it could be a test of long-term climate change on the Peninsula. Muskeg areas are basically peatlands where peat has been accumulating for thousands of years. This peat is derived from *Sphagnum* moss and sedges, and not from woody material such as we find in the soils of a forest. Peatlands are very acidic and decomposition is very slow, as shown by the mummified human remains found in peatbog burials in Europe.

If a peatland has been forested for thousands of years, there should be well-preserved dead wood in the peat. If you only find trees and dead wood on the top of the peat, then something has changed: forest is now growing where before there was only moist *Sphagnum* moss and other wetland plants. What was an open wetland has now dried out enough to start becoming a forest.

To evaluate these two possibilities, we have been doing some detailed studies of tree ages in wetland situations. Basically, we are finding that the small trees are indeed young and that the wetland forests are new forests; we have kids, not dwarfs.

Here is a striking example: the area north and east of the Kenai airport is dotted with black spruce "islands," that cover about 10% of a large flat peatland of about 6500 acres. The older, taller trees in the center of the islands give the islands a distinctive peaked appearance. On the aerial photos the forest islands look like spreading colonies of fuzzy mold, especially when you look at a sequence of photos from 1950 to the present.

You can see these black spruce islands driving north on Marathon Road from Kenai, along the east side of the airport and further north. We spoke with employees at Marathon's Beaver Creek gasfield at the end of the road. Some of them have been driving the road for more than 20 years, and they commented on the dramatic growth of the forest during the time they have been making this daily drive.

To get some specific numbers on the timing of the forestation process, we ran a transect through one of the spruce islands, where we counted the tree-rings on every tree in a one-meter wide belt that was 50 meters (164 feet) long. To do this we took core samples with an increment borer from stems larger than two inches diameter. For smaller trees we dug or pulled up the entire tree by hand and cut out sections several inches to a foot long near what appeared to be the original base of the tree.

Back in the lab we polished the samples with a belt sander and counted the rings under a microscope. Some of the trees grew very slowly, and a stem one inch in diameter could be 90 years old. Because it was difficult to tell the exact location of the tree base (which would show the maximum number of rings and give the true age), we counted two or three disks cut from each stem section, and used the maximum number of rings as our best estimate of the stem age.

One virtue of digging and pulling all the small trees out of the peat moss is that we could see that there was no dead wood under the moss. This was a new, first-time forest. There were no old buried stumps or downed logs beneath the damp, lush *Sphagnum* and feather mosses.

We used a soil auger and found that the peat was only about one meter thick under the forest. We found abundant volcanic ash in the peat, but no charcoal. This area lies west of the 1969 Kenai burn, so the youth of these stands cannot be attributed to regrowth after a fire.

As shown in the graph for Marathon Road, most of the older trees began recruiting in the 1870s, and most of the trees have recruited since the early 1900s. In the soil auger samples in the forest we saw only peat mosses and sedges, and no woody material. We are getting a radiocarbon date on the bottommost (basal) peat, and I would expect that the peat began forming 6-8000 years ago, based on other Kenai Peninsula peat dates.

This means that for 6-8000 years this area was wet peat bog with few shrubs and probably only occasional black spruce trees on growing on hummocks. Then, for some reason about 130 years ago the forest began to move invade. Generally this is the end of "The Little Ice Age," a climatically cool period in the northern hemisphere that lasted from about 1300 to the mid-1800s.

Grewingk Glacier in Kachemak Bay, for example began retreating in 1858 and it (and other western Kenai glaciers) have been pulling back ever since. Treeline on the Kenai has been rising since that time as well, and the widespread spruce bark beetle outbreak on the southern Peninsula in the 1870s was likely associated with this warming.

On the Kenai a warmer climate, and especially warmer summers, can mean a drier climate through increased evapotranspiration of water from the soil and vegetation. At the Kenai airport we only get 19 inches of total precipitation per year, about the same as Fargo, North Dakota. The cooler climate of the Little Ice Age probably left more water in the muskegs prior to the 1850s, which made them too wet for trees and shrubs, but perfect for peat moss.

In 1999 we made a similar transect south of Brown's Lake in Funny River. This transect ran from a mature black spruce forest on a hill down across a muskeg to the edge of pond that we called Teardrop Lake (for its shape). Again, this proved to be a young, first-time forest, on top of two - three meters of *Sphagnum* peat with no woody material in it. As the graph shows, tree recruitment began in earnest here in the 1850s, a bit earlier than at Marathon Road.

When we returned to Tear Drop Lake this summer, I was amazed to see how the *Sphagnum* moss had grown over many of the small saplings that we had cut and cast aside in 1999. We measured two to three inches of *Sphagnum* growth in four years.

The *Sphagnum* moss at Tear Drop Lake was mostly the dry, compact, brown type (*Sphagnum* fuscum) that grows fairly slowly, and is a further indication that this wetland is drying out. At a nearby wet pond edge site we found that as much as 10 inches of a moist, loose type of *Sphagnum* had grown up since 1999, completely covering some of the logs that we had cut. I had no idea that *Sphagnum* moss could grow so fast.

At Marathon Road most of the present black spruce reproduction is vegetative cloning from buried branches, called "layering." When moss grows vigorously, it can cover up the lower branches of trees. The branches sprout roots, and in time a new stem grows up from the buried branch. This process often produces a cluster of smaller children around the skirts of the parental tree. Genetically, these stems are identical, even if the original connection to the parent has rotted away. Since we were interested in recruitment through seed germination, rather than vegetative propagation, we excluded stems from our study that were obviously attached to another tree.

We expect to do more of these transects in some of the large muskegs, because they show quite clearly the profound change that our wetlands have been undergoing for the last 150 years. This kind of data also put the global warming issue in a longer-term time perspective.

Basically, the Kenai climate has been ameliorating through some combination of warming and drying over the last 150 years, since the end of the Little Ice Age. The amelioration process has dramatically accelerated in our area, especially with warmer winters since 1978 and warmer summers since 1987. My expectation for the future is that the black spruce forest will continue to expand into the muskegs until they eventually become continuous forests. Snow machiners will not appreciate forest closure of the muskegs, but by that time they will probably have airborne snowmachines and thick forest won't be a problem anymore.

Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. For more information about the Refuge, visit the headquarters in Soldotna, call (907) 262-7021. Previous Refuge Notebook columns can be viewed on the Web at http://kenai.fws.gov.