Radiocarbon dates dispel old myths about peninsula forest burns

by Ed Berg

Old myths die hard. One of my favorite hard-dying myths is that Captain Cook saw very little forest on the Kenai Peninsula when he sailed up the Inlet in 1778. Every time there is a public meeting on forest issues on the Kenai, someone trots out this story, and it has become part of our oral tradition.

With the assistance of Alan Boraas at the Kenai Peninsula College, I read through the accounts of Cook and his officers describing their 12-day exploration of Cook Inlet. Cook himself said very little about the vegetation, being mostly concerned about the strong tides and finding water deep enough to avoid being grounded.

He certainly said nothing about the Kenai being barren of forest. Cook's assistant surgeon William Ellis, however, wrote in his journal that, "The low land on the eastern side had a fertile appearance, and was well covered with trees," as viewed from his ship anchored for the night of May 29, north of Ninilchik at 60°8' North Latitude.

How the myth of the treeless Kenai got started I haven't a clue, but it can't be blamed on Captain Cook or his crew.

Another myth that I hear at these same public meetings is that a big forest fire once burned over the entire peninsula. This myth possibly started with forester William Langille's 1904 report on the forests of the Kenai Peninsula, prepared for Teddy Roosevelt's head forester Gifford Pinchot. Langille was not at all impressed with the "impoverished state" forests on the western side of the Kenai. He reported many recently burned areas and saw "old logs and decayed stumps of a large size", and speculated that there had once been "a prehistoric forest of greater proportions" that had been destroyed by fire prior to the Russian occupancy.

I don't question Langille's assessment that the Kenai forests were "impoverished" in 1904, but I think that their degraded condition had nothing to do with fire. Rather, Langille arrived on the Kenai some 25-30 years after an extensive spruce bark beetle outbreak on the central and southern Peninsula in the 1870-80s. He described the standing dead forests between Homer and Anchor point, which had a thriving live understory of limby, short-bodied trees with a rapid taper.

This is exactly what you would expect to see 25-30 years after a bark beetle outbreak, where the surviving pole-sized trees had "released" and grown rapidly under the opened up canopy. The hole-ridden bark had probably fallen off the old beetle-killed trees by the time Langille arrived, and it would have not been obvious that the trees had been killed by beetles, unless a person knew what to look for, such as scars of beetle egg galleries.

We now have more direct evidence to bear on the proposition that the Kenai once had a big fire. In the Refuge Notebook of October 25, 2002 I described our recent study of charcoal fragments collected from soil under blown-over trees (throw mounds). We have obtained radiocarbon (C-14) dates on 63 charcoal samples, distributed over the logged areas from Clam Gulch (Falls Creek Road) to Happy Valley (Cottonfield Road). The median time-since-fire on these stands was about 600 years; the most recent fire was more than 300 years ago.

Furthermore, the median time between fires was also about 600 years. The oldest charcoal sample was about 3,600 years old. It thus appears that the 1.5 to 2 feet of soil that is typically turned up in a throw mound represents about 3,000 years. Much of this soil is volcanic ash, probably from Redoubt and Augustine. Soil scientists working on the Kenai typically dig a 3-foot hole in soil surveys, and they on occasion find deeper (and older) charcoal which we would have missed using throw mounds.

We know from the pollen record that spruce came into the central Kenai about 8,000 years ago, so there could be a lot of charcoal older than 3,000 years that we missed.

A skeptic could ask if whether we might have also missed a lot of younger charcoal. This is unlikely. To collect our samples we drove along the main logging roads and stopped every half-mile to examine all throw mounds within a few hundred yards of the truck. Sometimes there would be only a few, or occasionally none, but sometimes there would be 40-50 mounds.

Usually we found charcoal in at least one mound and sometimes in many mounds. There was, however, a stretch of 7 miles along Cottonfield Road where we didn't find any charcoal at all, even though we checked a number of mounds. We collected charcoal fragments as small as a quarter of an inch. Young charcoal would probably be in larger pieces and should be easier to spot than old charcoal, so chances of missing young charcoal are not great.

A word needs to be said about the shortcomings of radiocarbon dating, especially of charcoal derived from burned trees. Trees take up carbon from carbon dioxide in the air. Most of this atmospheric carbon dioxide has stable Carbon-12, but a small fraction has radioactive Carbon-14. The Carbon-14 steadily decays to Nitrogen-14, with a half-life of 5,730 years, meaning that every 5,730 years half of the remaining C-14 disappears. A sample that has a full proportion of C-14 might be a few hundred years old, but a sample that has only a tiny amount of C-14 might be 30,000 years old.

After about 40,000 years virtually all of the C-14 is gone, and samples older than 40,000 years simply can't be dated with C-14. On the Kenai when we find such "dead" carbon, it is from the Tertiary coal beds that are dated to 5-20 million years, using radioactive Potassium-40 that decays to Argon-40 with a half-life of 1.3 billion years.

There can be quite a bit of laboratory error in measuring the amount of C-14 in a sample; a given date can be off by several hundred years. The height of the bars on the graph shows the measurement error of two "standard deviations" above and below the measured date. That is, the bars show that if you repeated the measurement of a sample many times, you would expect 95% of those measurements to fall within the bar.

As you can see, some of the bars cover more than 400 years. That is a lot of slop in the estimated age of a single sample, and that is why it is nice to have many samples.

There is a second source of error that can be even worse than the measurement error. Let's say that you burn a 300-year old tree; there is a 300-year difference in the age of the wood at the center and at outside of the tree. Thus, charcoal from the center should date 300 years older than charcoal formed on the outside of the tree, where the wood was laid down a year or two before the date of burning.

This time-of-growth error is called the "inbuilt age" of the sample, and it systematically biases fire dates based on radiocarbon-dated charcoal to be too old.

The problem is extreme when dead wood is burned: let's say that our 300-year old tree had been dead for 100 years before it burned. The carbon at the center of that tree would date 400 years older than the actual date of the fire.

Fortunately, on the Kenai we have some factors that should reduce the magnitude of the inbuilt age error. First, many fires move quickly through the forest and just burn the outside of the trees and the branches, so that most of the charcoal should be formed from young tissue.

Second, because of periodic bark beetle attacks, spruce trees on the Kenai generally don't live more than 300 years, if that.

Third, the fact that dead wood rots rapidly in our damp climate means that there isn't a lot of old wood available to contribute old charcoal.

I would thus expect that on the Kenai a radiocarbon date could erroneously date a fire as 200-300 years too old, but probably not a lot more than that. This contrasts strongly with a recent study on Vancouver Island in a coastal rainforest where western red cedar can live to 1,000 years or more, and there are large rotting trunks on the ground that don't burn readily.

Dan Gavin compared radiocarbon dates with fire dates determined from tree-rings and found inbuilt age errors as much as 670 years.

In the graph, the black triangles represent my best guess as to the dates of fires. When samples grouped within a few hundred years, I picked the youngest date for the fire, reasoning that the older dates represented older wood from inside the trees or dead wood. This could lead to underestimating the intervals between fires.

For example, on Falls Creek Road at Mile 1 we picked up two charcoal samples that dated to 1220 and 1410. With radiocarbon dating there is no way to tell if this was two burns separated by 190 years, or one burn where some of the wood was 190 years older than the younger wood, or simply measurement error in the C-14 dating process.

Looking at the graph, some basic patterns are apparent. First, as I noted, none of the six areas appears to have burned since the late 1600s, and there are intervals of many centuries between the burns.

Second, there is no single “big burn” that hit all of the sites simultaneously, contrary to popular mythology.

Third, these burns were fairly small, probably on the order of a few square miles. Each of the six roads shows a different pattern of burn dates, and the roads are separated by at least several miles.

Our samples were taken along logging roads that generally stick to the upland areas, but occasional they cross wet drainages like Clam Creek (on East Road) that probably served as natural firebreaks. Deep Creek is the largest drainage, which lies between the Caribou Hills Road on the north, and East Road and Cottonfield Road on the south.

Many areas of the Kenai have burned much more recently than the area of this study. For example, we have preliminary evidence of an early 1900s burn in the Clam Gulch area, two 1926 burns in the Kasilof area, and of course the 310,000-acre 1947 burn in the Sterling area and the 79,000-acre 1969 Swanson River burn, and numerous smaller 19^{th} and 20^{th} century burns north of the Kenai River.

Most of these were human-caused burns, and one can legitimately ask if some of the old burns documented in this study could have been caused by the Native inhabitants. This is not an area rich in archeological sites, like the Kenai or Kasilof Rivers, or Kachemak Bay.

The Dena’ina Athabaskan Indians arrived on the peninsula at least 1,000 years ago, but they are not known to have used fire as landscape management tool. They could have, of course, had their escaped campfires, but they didn’t burn forest for “mosquito control” like some of the early European settlers of the peninsula.

In short, I would expect that the great majority of the old burns were generated by lightning and not by escaped campfires.

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Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. He will be giving a seminar for the University of Alaska Anchorage Biology Department on “Fire History Studies on Kenai Peninsula” March 7 at 3:30 p.m. in Room 110 of the Engineering Building on the UAA campus in Anchorage. 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.