Bark beetles hammer forests throughout the West, headed eastward

by Ed Berg

The spruce bark beetle outbreak of the last decade is slowly shifting to the back burner of environmental issues on the Kenai as deep grass covers the stump fields and homeowners enjoy their "emerging views," as the realtors like to say. There is always a background level of bark beetle activity, and people are still cutting an occasional beetle-killed tree on their property, especially around Soldotna where many younger trees survived the outbreak of the mid-1990s. In Kachemak Bay, however, there is not much left to eat; Homer experienced another record warm summer in 2005 but there was hardly a beetle to be seen.

In the western U.S., British Columbia and the Yukon, however, the bark beetle outbreak is going full bore, in response to warmer climate, as on the Kenai in the 1990s. The western culprit is the mountain pine beetle (MPB) *Dendroctonus ponderosae*, a close cousin of our spruce bark beetle *Dendroctonus rufipennis*. The MPB specializes on lodgepole pine (which is optimistically being widely replanted on the southern Kenai), and has killed millions of acres of pine forest in the West. It is now moving northward and is about two-thirds of the way up British Columbia.

Last week I attended a Forest Service conference in Utah, where bark beetle researchers from around the U.S. and Canada shared their research and experiences. There is no "cure" in sight for bark beetles, but we have a much better understanding of the ecological role of bark beetles in the forests and can make better forecasts of their future activity. Bark beetles, like fire and wood-rotting fungi, are a natural part of the forest cycle, even though they can certainly derail human ambitions and economies.

I spent several years of weekends in the mid-1990s cutting down my beautiful old Sitka spruce trees in Kachemak Bay. These giants had survived the bark beetle outbreak of the 1870s-1880s as pole-sized juveniles but they were prime beetle fodder at ages of more than 270 years in the 1990s. My audience at the Utah conference listened with a mixture of empathy and scientific interest as I described the 250-year record of bark beetle activity that we have developed for the Kenai Peninsula and the Yukon using growth pulses in tree-rings (dendrochronology). Many of these researchers had seen some of their favorite forests hammered by the beetles and had cut down their share of beetle-killed trees.

It was a special treat at this conference to hear a talk from fellow dendrochronologist Tom Veblen from the University of Colorado, who has used tree-rings to document extensive bark beetle outbreaks in the 1850s and 1940s in the Colorado Rockies. When I started studying bark beetle history on the Kenai in 1993, I applied Veblen's method looking for growth pulses in tree-rings as an indication of canopy thinning, due to bark beetle outbreaks.

Tom Veblen and his graduate students have published several papers examining the relationship between fire and bark beetle outbreaks in subalpine forests in Colorado. Essentially, they found no relationship at all; beetle-killed subalpine forests were no more likely to burn than non-beetle killed forests. I have found similar results on the Kenai, where on the southern Kenai white spruce forests have not burned for an average of more than 600 years, whereas the beetles have thinned the forests on an average of every 50 years or so. In both Colorado and the Kenai it is dry weather, rather than fuel build-up, that drives forest fires. Under dry conditions everything burns well, dead or a live.

One of the most poignant talks at the conference was given by Diana Tomback of the University of Colorado on the tenuous future of Whitebark Pine, a high-elevation species similar to our Mountain Hemlock. Whitebark pine lives in a narrow belt at timberline above other conifer species which require warmer conditions. In the past whitebark pine was safe from mountain pine beetles because the cold winters would often hit the −40°F necessary to kill the beetles. As the climate has warmed in the 1990s, however, the beetles have moved higher and higher.

As if the mountain pine beetles were not enough, whitebark pine is also susceptible to white pine blister rust, a fungus introduced from Asia in 1910 that has

been a major forest pathogen throughout the West. A small percentage of whitebark seedlings are resistant to the blister rust, so foresters had hoped that future generations of whitebark pine would free of rust. With climate warming and mountain pine beetles added to the equation, however, there may not be many future generations of whitebark pine. The large seeds (called pine nuts) of whitebark pine are important food sources for grizzly bears, squirrels, and the Clark's Nutcracker bird, so the loss of whitebark pine could have a cascading effect in the ecosystem that would affect many other species, directly or indirectly.

The climate warming in the West is also driving the northward expansion of mountain pine beetle through the lodgepole pine forests of British Columbia, as noted above. Lodgepole pine lives on the west side of the Rocky Mountains; it is mainly a subalpine species, not a boreal forest species. The Rockies meet the boreal forest in central British Columbia, in the area of the Peace River. (If you have driven the Alaska Highway, you crossed the Peace River near Fort St. John in east-central B.C., not far from the Alberta border.) The pine species of the boreal forest is Jack Pine, which extends all across the southern boreal forest from Alberta to Nova Scotia, and dips down into Minnesota, Wisconsin, and Michigan.

In the Peace River area, lodgepole pine and jack pine overlap in a hybrid zone, similar to our Lutz spruce hybrid zone on the southern Kenai where white spruce hybridizes with Sitka spruce. In 2002 mountain pine beetles appeared just west of the lodgepole-jack pine hybrid zone, apparently having been transported by wind in a single long-distance dispersal event. The beetles had in effect breached the Rocky Mountain barrier, which hitherto confined them to the west side of the Rockies.

Now, here is the question: will the mountain pine beetles move through and beyond the hybrid zone and go all the way across Canada to the East Coast? With a warmer climate they appear to have a green light… The beetles might have to make some evolutionary adjustments to thrive on jack pine, but they can be eased along by first adjusting to the lodgepole-jack pine hybrids as sort of a halfway house. In laboratory tests, however, the beetles survive and reproduce quite well in freshly cut bolts of jack pine, so maybe they are already pretty well equipped to live in jack pine.

In the past, cold weather in the boreal forest was too much for mountain pine beetles and set a very definite limit on their northern expansion. Several weeks of −40°F winter weather or early fall or late spring cold snaps of +13°F are sufficient to kill beetle larvae and shut down an outbreak. Recent warmer winters have decreased winter larval mortality from 80% to less than 10%, according to some estimates, so there are a lot more mountain pine beetles available now to fuel the expansion to the north and east.

The story gets worse. In the past the Rocky Mountains and the Great Plains were the barriers that kept mountain pine beetles from spreading to the Midwest and eastern U.S. Having now breached the Rocky Mountains, if the beetles are able to skirt around the Great Plains to the north through the Canadian boreal forest, the pine forests of the eastern U.S. and Midwest will be easy picking. These mountain pine beetles are much more versatile than our spruce bark beetles. According to Canadian Forest Service entomologist Allan Carroll, if the climate is right, the mountain pine beetles can eat just about any kind of pine (Jeffrey Pine is one exception, albeit a minor one). If this scenario plays out—and with predicted climate warming there is no reason why it will not—the mountain pine beetle will nearly encircle the Great Plains, running from the intermontane west from Arizona up through British Columbia, across the boreal forest to eastern Canada, and down through the Midwest and East Coast, across the South and into Texas.

If the mountain pine beetles move into the eastern U.S., they will meet another cousin—the southern pine beetle (*Dendroctonus frontalis*), which presently ranges Pennsylvania to Texas and from New Mexico and Arizona to Honduras. The southern pine beetles are moving northward into Ohio, Pennsylvania, and New Jersey. The southern pine beetle already does a lot of damage to commercial pine forests in the Southeast, and if the mountain pine beetle is added to these forests, the price of a wood-built home may go out of sight.

One might hope that spruce will still be available for lumber, even if pine is eliminated, but our own spruce bark beetle continues to make a name for itself down through British Columbia and into southern Utah in record-breaking levels of attack. In the Southwest the Pinyon Ips beetle (*Ips confuses*) is hammering Pinyon pine-juniper woodlands, and other bark beetle species are attacking Ponderosa pine forests.

A common denominator of all these insect outbreaks is that they are way outside their known ranges of natural variability. We see this in southern Alaska and the Yukon, for example, where the current out-

break continues to expand into new areas in the Yukon and across Cook Inlet, greatly exceeding the area and duration of all previous outbreaks that we have been able to document in the last 250 years. Similarly, the outbreaks in the West are all well beyond their known ranges, and have the potential to go much further yet. All of these outbreaks appear to be driven by a warming climate—both warmer summers which allow more effective infestation of drought-stressed trees and warmer winters which allow greater survival of the beetle larvae.

The climatic control of the outbreaks has been well-studied in the mountain pine beetle, and less so in other bark beetle species. Jesse Logan and Barbara Bentz with the Forest Service in Logan, Utah and Jim Powell at Utah State University have studied the life cycle of the mountain pine beetles in great detail, first growing the beetles under different temperature conditions in the lab, and then modeling how beetle populations will cycle over a period of years, given various weather scenarios. When their beetle population model was coupled with warmer climates predicted by whole-earth climate simulation models, their model quite clearly predicted the now-observed northward spread of mountain pine beetles in British Columbia and the shift higher in elevation to the whitebark pine zone.

The long and the short of all this is that now is a bad time in history to be a conifer tree of any kind. The warming climate will shift forests in North America towards more hardwoods, and the lumber industry will probably lose the cheap supplies of pine, spruce and fir that we have historically enjoyed. On the Kenai Peninsula we already see a shift to more alder in areas of recent beetle-killed spruce, and a shift to more birch and cottonwood in some of the beetle-kill areas of the 1970s; the supply of spruce available for saw timber has shrunken to a truly marginal level. This appears to be yet another example of how Alaska is the "canary in the coal mine" that is warning of things to come throughout North America in the era of global warming.

Ed Berg has been the ecologist at the Kenai National Wildlife Refuge since 1993. Previous Refuge Notebook columns can be viewed on the Web at http://www.fws.gov/refuge/kenai/.