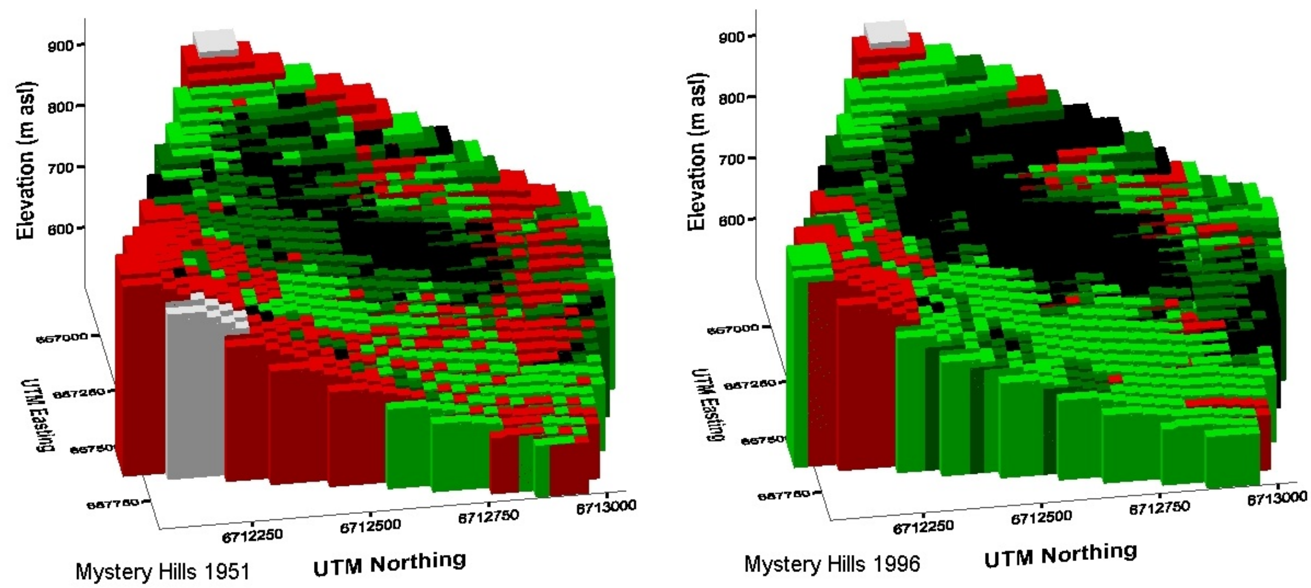
Kenai Mountain Treeline Advances Like Spreading Bread Mold, Not Like Rising Bathtub Water

by Roman Dial and Ed Berg



Vegetation and topography in the Mystery Hills. Closed canopy forest in the valley expanded substantially in the 1951-1996 period, as did shrubs on the valley slopes. Red = tundra; light green = shrub; olive green = open woodland; black = closed canopy. Square (pixel) sizes are 30 meters (100 feet). Longitude and latitude are in UTM meters; elevation is in meters above sea level.

Driving the Seward and Sterling Highways in the spring is a good time to see that tree-line is slowly but surely creeping up the Kenai mountainsides. The melting snow offers a contrast to the small, dark mountain hemlock and white spruce that poke through this year's shallow snow. Most of these little guys are trees that are invading the alpine shrub and tundra lands; they aren't stunted old-growth trees, but are new recruits to the alpine zone and they are spreading upward.

Because trees grow relatively slowly at tree-line, it's difficult to rely on memory to document how much trees have grown over the years. As with your children, it's easier to compare photos to observe the growth. For their thesis projects, two graduate students at Alaska Pacific University, Katriina Timm and Alissa McMahon, compared aerial black-and-white photos taken in the early 1950s to photos taken in the same area in 1996 to see how much tree-line has risen in the western Kenai Mountains.

The aerial photos Katriina and Alissa used were "orthorectified" and "georeferenced", meaning that landmarks (e.g., trees) on the photos could be precisely located by latitude and longitude. The aerial photos were digitally scanned, and displayed on a computer screen using a geographic information system (GIS). This way, the grad students were able to compare one photo to another as overlays and relate any vegetation changes to elevation and aspect.

To compare the two years in an unbiased fashion, Katriina spread a thousand random points across the GIS landscape. Because she was interested in tree-line changes, the points were located at an elevation of 1500 or more feet above sea level (the average level of tree-line as shown on local topographic maps). She then classified each point as unvegetated, tundra, shrub, open-woodland, or closed-canopy forest. Because the points were located in the exact same location on both the 1951 and 1996 photos, Katriina could trace the history of each point from 1951 to 1996.

What Katriina found was quite striking. First, the number of closed-canopy forest points above 1500 feet doubled from 1951 to 1996, from 8% to 16% of the total area sampled. Most of the new closed-canopy points had been open woodland points in 1951. While the number of open-woodland points remained essentially constant, only about a quarter of them remained in the same place. By 1996 the other three quarters of the woodland points were located at mostly higher elevations. Formerly shrub and even tundra points had become wooded over the 45-year period. Perhaps the most dramatic change was in tundra, the dominant alpine vegetation type, where 20% had disappeared from 1951 to 1996, having converted to shrub or open-woodland.

Tree-line on the Kenai is not a level line, like a bathtub ring, but rather a ragged boundary of patchy woods and forest run through by avalanche paths. Katriina's analysis showed that most of the new woods and forests had advanced on northern exposures, with far fewer changes than expected on the drier south and west facing aspects. This is consistent with interior Alaska tree-line studies done by Dr. Glen Juday of the University of Alaska Fairbanks, where white spruce is actually growing slower as summers warm, because of drought stress.

One can visualize tree-line on the Kenai as spreading like mold across a slice of bread, with infilling between established patches of trees as well as new, small patches. Overall, the highest 25% of the 1996 wooded points on Katriina's GIS are 160 feet higher than the highest 25% in 1951. If we interpret tree line as the ragged edge made up by the highest 25% of the trees observed, then tree line has increased by nearly a yard each year since 1951. Yule Kilcher, the late patriarch of the Kilcher clan in Homer, once remarked that tree line had advanced "a few hundred feet" in the Kachemak Bay area since he first arrived there in the 1940s.

To be sure that the changes they saw using aerial photography were real, Katriina and Alissa also visited the mountain slopes. Hiking into the alpine zone, they found groups of young trees spreading both uphill and downhill from patches that first established themselves in the 1950s. Sacrificing a hundred or so trees to science and dating the trees by counting tree rings, they found that the largest cohort of their sample germinated during the warm but not-too-dry decade of 1985-1995. The still warmer and drier last decade, from the mid-1990s to 2005, when they conducted their field work, was the decade of least new tree recruits to the alpine zone, consistent with the patterns of drought-stressed growth seen in the Interior.

Together with warming sea water temperatures in Cook Inlet, Kachemak Bay, and Prince William Sound; drying lakes and wetlands across the Kenai Lowlands; spruce bark beetle and other forest tree pest outbreaks throughout the Peninsula's uplands; as well as the retreating glaciers and thinning icefields of the highest mountain ranges, rising tree-line points to a fundamental change in the Kenai's climate. Even if the climate were to reverse itself today, the changes we have already seen during the last 50 to 100 years would likely take more than that length of time to reverse themselves.

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