Canadian Forest Service research in Yukon tracks climate influences on forest recovery from forest spruce beetle outbreaks

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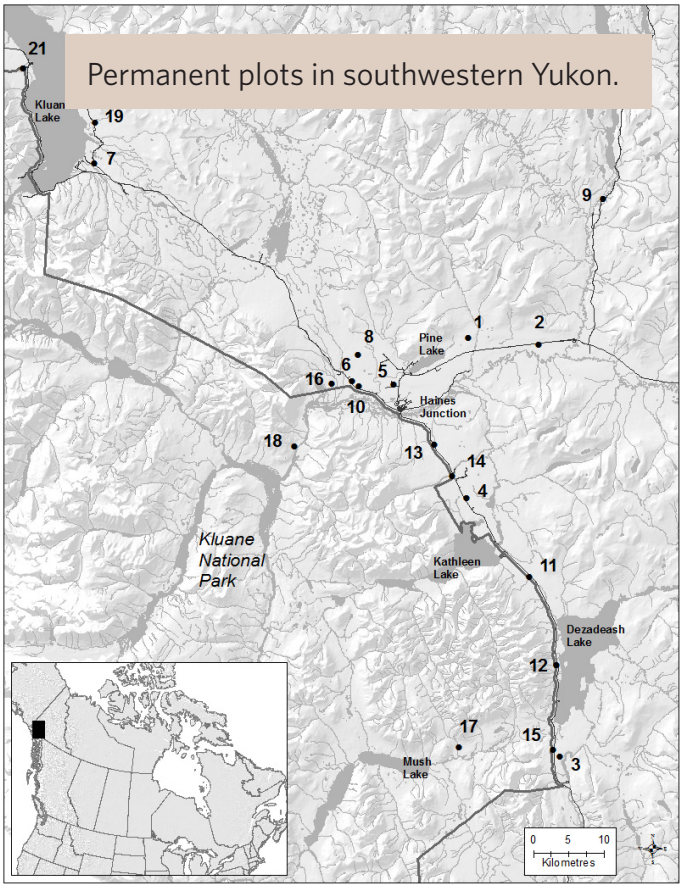
Yukon is home to extensive boreal forest that covers an area of approximately 28.1 million hectares (ha) and plays an integral role in the regulation of climate locally, regionally and internationally.

Yukon's forests contribute to the territory's economy by providing wood and other forest products, local employment, regional development, tourism and recreational opportunities in addition to being valued as a vital cultural, social, historical and educational resource.



Boreal forests around the world are projected to be warming at rates substantially above the global average. In Canada, western boreal forests have exhibited significant recent increases in temperature and more frequent temperature extremes.

Boreal ecosystems are especially vulnerable to climate change. Melting permafrost, increased severity of insect outbreaks and drought are driving major forest changes that may be accompanied by increased fire risk, and are influenced by land-use activities. Potential exists for rapid ecosystem transitions, with parts of the boreal forest nearing ecological "tipping points" by the end of the century. Scientists are already beginning to see evidence of climate associated declines of spruce, pine and aspen in some parts of the boreal forest.

In collaboration with Universities of Victoria and University of British Columbia, scientists from Parks Canada, the Yukon Territory and Canadian Forest Service researchers have been collecting data from permanent plots in the boreal forests of southwestern Yukon since the early 2000s when an unprecedented spruce beetle outbreak was underway. The outbreak subsided by 2010 after affecting approximately 730,000 hectares of forest in southern Yukon. Periodic measurements of forest characteristics in the plots allow us to assess the capacity of these forests to recover from this outbreak and determine the impacts of climate change, as well as risks of future disturbances

such as forest fires. Data collected will guide forest management in order to maintain values of interest to both federal and territorial governments as well as First Nations.

The impacts of spruce beetle outbreaks in stands vary depending on the size of local beetle populations, forest composition, host stress (which is typically caused by drought) and regional climate variations from year to year. In most cases, enough spruce seedlings and smaller trees survive the beetle outbreak to recover pre-outbreak forest conditions. The spruce beetle kills mature trees in the forest, allowing for a re-distribution of resources such as light, nutrients and water to the remaining trees that may have previously been growing poorly due to competition. The result is increased growth that may be evident in the rings produced by trees every year.

Tree ring sample illustrating an increase in tree growth, as evident by wider rings in the years following a spruce beetle outbreak.

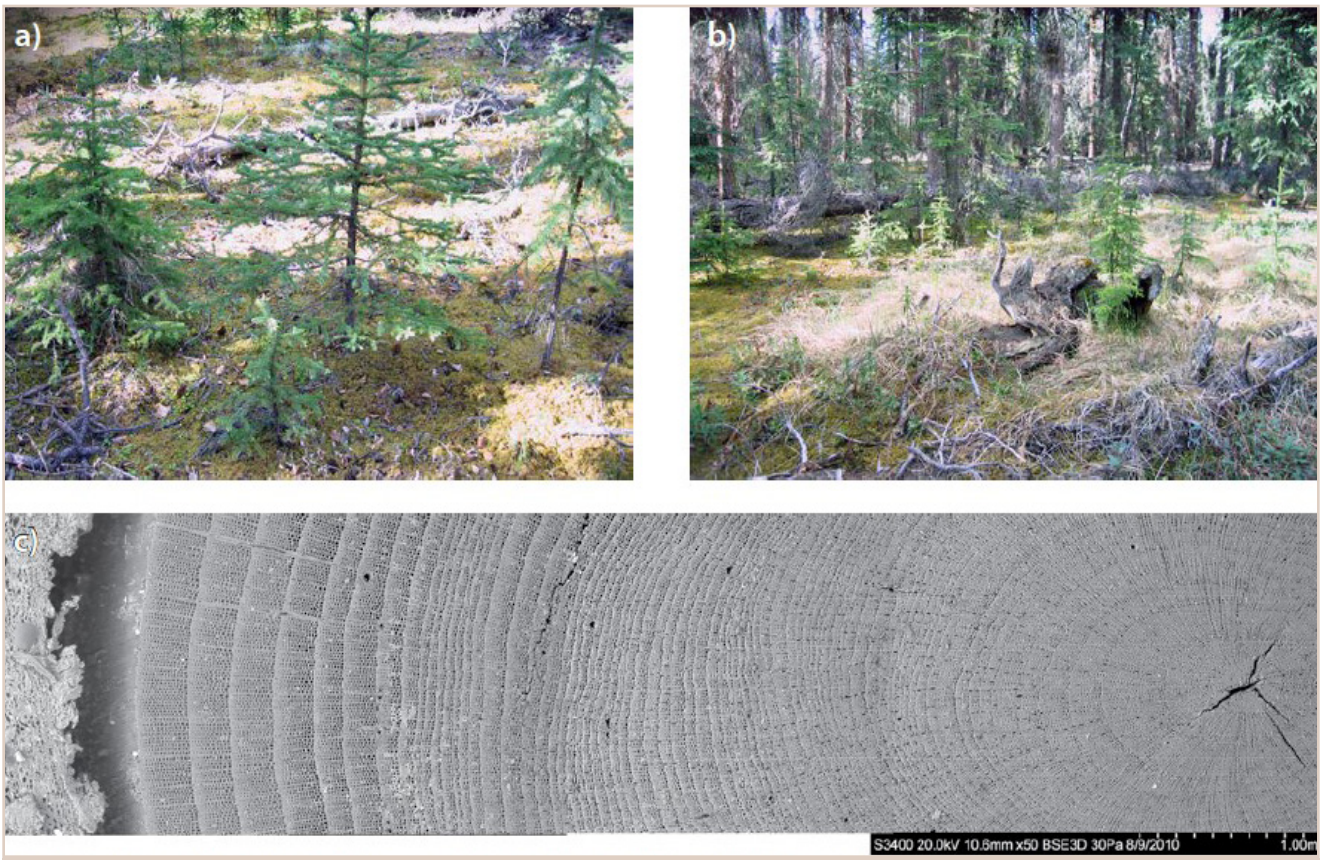
During our most recent visit to the plots in the summer of 2016, researchers collected tree-ring samples to determine the impact of the beetle outbreak on the growth of surviving trees. Trees of every size were sampled, from canopy trees down to tiny seedlings, to get an idea of how old they are and how well they were growing before and after the outbreak.

Surviving trees in some of the forests demonstrate remarkable examples of increased growth in the years following the outbreak. Growth increased by at least 50% in nearly half of all remaining canopy and sub-canopy trees, 10 years after the outbreak. However, despite abundant regeneration and increases in growth among some trees, forests returned to pre-outbreak conditions in only four of the 21 stands 10 years after the outbreak. More time is needed for these forests to recover.

Scanning electron micrograph showing annual growth rings in a cross-section of a white spruce seedling from southwestern Yukon.

These data form a picture of how the boreal forest in the southern Yukon could develop in the years following the outbreak.

However, the impacts of continued warming on the capacity of these forest to recover remains uncertain; our models of climate suitability for spruce and spruce-dominated ecosystems, suggest warmer temperatures could help stands to recover faster than in the past, up to a point. Our models suggest that after 2055, the climatic habitat in this region may become increasingly unsuitable for spruce and boreal forests.



a) and b) Examples of white spruce advanced regeneration (>10 cm < 1.3 m height class) that basal cross-sections were collected for to determine year of establishment and c) scanned electron microscope image of a spruce advanced regeneration cross-section.

Links

Spruce beetle and the forests of the southwest Yukon. 2007. Garbutt, R.W.; Hawkes, B.C.; Allen, E.A. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC.
https://cfs.nrcan.gc.ca/publications?id=26731