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Ecological feedbacks under changing environments: Implications for sustainable forestry

Climate change has and will continue to produce significant changes in northern forests. Warming has increased fire and (as is well known) led to unprecedented insect outbreaks, including in areas without little or no outbreak history. Evidence from Oregon indicates that trees in areas without a history of spruce budworm infestations have not evolved foliar defenses against the budworm. If true in Canada areas newly invaded by budworm will be especially susceptible, and questions are raised about a similar situation with mountain pine beetle and jack pine.

Large range shifts can be expected. Models indicate that the climatic envelopes of 25% of biomes at latitudes above 50 degrees will shift northward at an average rate of 1000 m/yr, roughly 10 X faster than spruce migrated following the withdrawal of glaciers. The only plants likely to keep up with that rate of change are weeds. The ability of forests to cope with an increasingly altered climate will depend on their buffering capacity, which could be considerable. Common garden studies of lodgepole pine populations spanning 13 degrees latitude find more genetic variability within than between stands in response to moisture stress and temperature.

Longer growing seasons, increased decomposition and nitrogen release, and (in droughty areas) higher atmospheric CO2 may increase NPP, but that depends on other limiting factors and is likely to vary widely among environmental settings. Areas subject to drought may extend northward. Increased carbon sequestration will not necessarily appear as wood. In one black spruce stand an increased carbon sink with warmer temperatures was traced to inhibition of decomposition by high water tables, a situation that will ultimately reduce NPP. Disturbances are likely to play the major role in future forest productivity. One study estimated that increased disturbances could cost wood producers in North America 1 to 2 billion dollars per year during the 21st century.

Given the outlook for the 21st century, it would seem prudent for forest managers to shift focus from productivity to stability, thereby protecting productivity in the long-term. I will review evidence showing that the best way to do that is to utilize the mechanisms by which forests stabilize themselves, in which biological diversity at several scales plays a central role.