Spatial scale of stand-replacing forest disturbance influences the amplitude of snowshoe hare population fluctuations in boreal forests of northwest Canada.

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The "natural disturbance model" is still a compelling paradigm for managing boreal timber harvesting because of the strong influence of temporal and spatial scales on ecosystem processes, and the stand-replacing character of both wildfire and timber harvesting. In western boreal forests of North America, many wildfires burn only a few hectares before dying out, but the most ecologically influential fires are those that extend from 1,000 to over 10,000 ha, creating large patches of regenerating forest of fairly uniform age. However, in regions managed for timber harvest, such large burns are rare because of active fire suppression. Also, in many regions, managers have chosen to clearcut relatively small patches of only 10-200 ha, a range of patch sizes rarely created by fires. Consequently, the spatial patterns of young stands that wildfires would have created have actually been created only rarely for many decades: the natural disturbance model has not been applied.

We thought this might be a problem for snowshoe hares, a species that does best in mid-successional forests (15-40 years old), and we predicted that different spatial scales of stand-replacing forest disturbance (wildfire and timber harvesting) would result in different amplitudes of change in abundance of snowshoe hare through a population cycle. We monitored hares (fecal pellet counts) in sub-boreal British Columbia (2001-2006) and in the Liard Basin of Yukon (2013-2021), where forest harvesting had mainly created small patch cuts in contrast to a few large patches created by fire or harvesting. Landscapes with large (>2,000 ha) mid-seral patches supported significantly more hares, with wider amplitude in cyclic fluctuation, than landscapes with small patches (20-200 ha) and than mature forest landscapes (>80 y old). Densities of hares high enough to support Canada lynx reproduction only occurred in landscapes disturbed at the scale of a moderate to large-sized wildfire. Landscapes unaffected by stand replacing disturbance for at least 80 years supported very few hares and without cyclic fluctuations. Based on these findings, we recommend that historical patterns of cutting dominated by small patches (20-200 ha) be shifted in future to include many larger patches (2,000-5,000 ha), enhancing the likelihood of continuing hare-lynx cycles in these regions.

Our findings pertain to sub-xeric, mesic, and sub-hygric site conditions supporting closed coniferous canopies in lower elevation boreal forests that are extensively managed for timber production, which involves suppression of wildfires that are the dominant natural disturbance and that kill the great majority of coniferous canopy trees.

In the Sub-boreal Spruce of central British Columbia, the mountain pine beetle outbreak has made our findings inapplicable in the short-term because extensive salvage logging in the last two decades has created many extensive and fairly even-aged patches. However, our recommendations should pertain to future rotations a few decades in the future. In Yukon, large-scale commercial timber harvesting is on hold until the economics of transporting product to markets improve; our recommendations need to be brought forward in future planning.

Although we recommend substantially increased patch sizes, we note that these can span a very wide range of sizes and will require retaining unharvested stands within the bigger patch, as also created

by wildfires. Managers would best tailor our recommendation to include controlling run-off from patch cuts so it does not compromise water quality, by retaining mature forest along riparian zones and as patches on steeper slopes.

Our findings deal with **spatial mismatch** between fire-driven and harvest-driven spatial patterns of stand-replacing disturbance, but also need to be interpreted in British Columbia in the light of **temporal patterns** (i.e. rates of cut). The rate of timber harvest (annual allowable cut) significantly exceeded “natural” rates of creation of young stands by wildfires even before the mountain pine beetle outbreak, which has made the situation more extreme. Old growth forest has been decimated. Our findings should not result in any cutting of old growth stands in central British Columbia: these are too ecologically rare and valuable to cut at all.