Supporting Information. Anoszko, E.R., L.E. Frelich, R.L. Rich, and P.B. Reich. 2021. Wind and fire: rapid shifts in tree community composition following multiple disturbances in the southern boreal forest. Ecosphere.

Appendix S1: **Supplementary methods for determination of agents of tree mortality**

Wind was determined to be the mortality agent if a tree was dead and there was no evidence of fire and the tree had fallen or the bole had broken and had a decay class of at least two according to U.S. Forest Service common stand exam (CSE) protocol (Figure S1). Trees with a mortality class of 1 that had fallen or broken were recorded as having a mortality agent of "other" so as to exclude them from mortality estimates for the 1999 blowdown (Figure S1). In areas where we saw evidence of wind followed by fire, mortality was recorded as wind if a tree's bole was broken and the standing broken end was charred or the fallen bole was charred on the bottom side, or if a tip up mound existed that showed charring on roots that would have been below ground prior to wind throw but were subsequently exposed to fire. In these areas we recorded a tree as having fire mortality if it was standing dead with intact branches and an unbroken bole and had visible charring on the lower portion of the bole or around the root crown and was of decay class 1or 2 (indicating it was less than 10 years since mortality, Figure S1).

Trees that were standing dead with a broken bole could be recorded as either wind or fire depending on the species, decay class and the presence or absence of charring on the break. For example, the boles of some trees including aspen and birch tend to break quite easily following fire mortality, whereas pines tend to remain standing for a long time following fire events. In the cases of aspen and birch, a bole break on a standing dead tree was not determined to be evidence of wind mortality unless the portion above the break was charred (indicating it fell prior to occurrence of fire), or very decayed (indicating that more than 10 years had passed since it died). Standing dead pines with bole breaks were recorded as having wind caused mortality if the bark had burned more completely than other standing dead unbroken individuals of the same size, indicating that they were not living at the time of the fire. Mortality was recorded as other if a tree was standing dead and severely decayed, but without any charring, or if it showed clear signs of animal or insect damage (Figure S1). Trees marked as having a mortality agent of "other" were uncommon and made up <3% of the total trees in the study and were excluded from estimates of disturbance related basal area loss.

When the mortality of an individual tree was in doubt, it was assigned a mortality cause based on the relative disturbance severities of the coarse scale plot and a priori knowledge of tree species susceptibility to wind throw and fire mortality. In the cases of fallen trees, we also looked for charring of the entire bole as opposed to charring only on the lower portion of the fallen bole which would indicate a tree bole fell as a result of fire mortality rather than wind mortality. For example, a fallen, severely-charred cedar would be unlikely to have been killed by wind as cedars are amongst the most wind-firm species in the study area (Rich et al. 2007). Similarly, a 5cm diameter balsam fir that had fallen over with burned roots would not be recorded as having wind mortality because small balsam fir are unlikely to be damaged by wind, but do uproot easily after fire. In some cases, determining the species of a tree that had been badly burned or decayed was difficult, but we were normally able to find some remnants of bark or a distinctive branching structure or wood structure that would aid identification. In a few rare cases, a tree was so badly decayed or burned that positive identification was impossible and it was recorded as being an unknown species and excluded from further analysis.

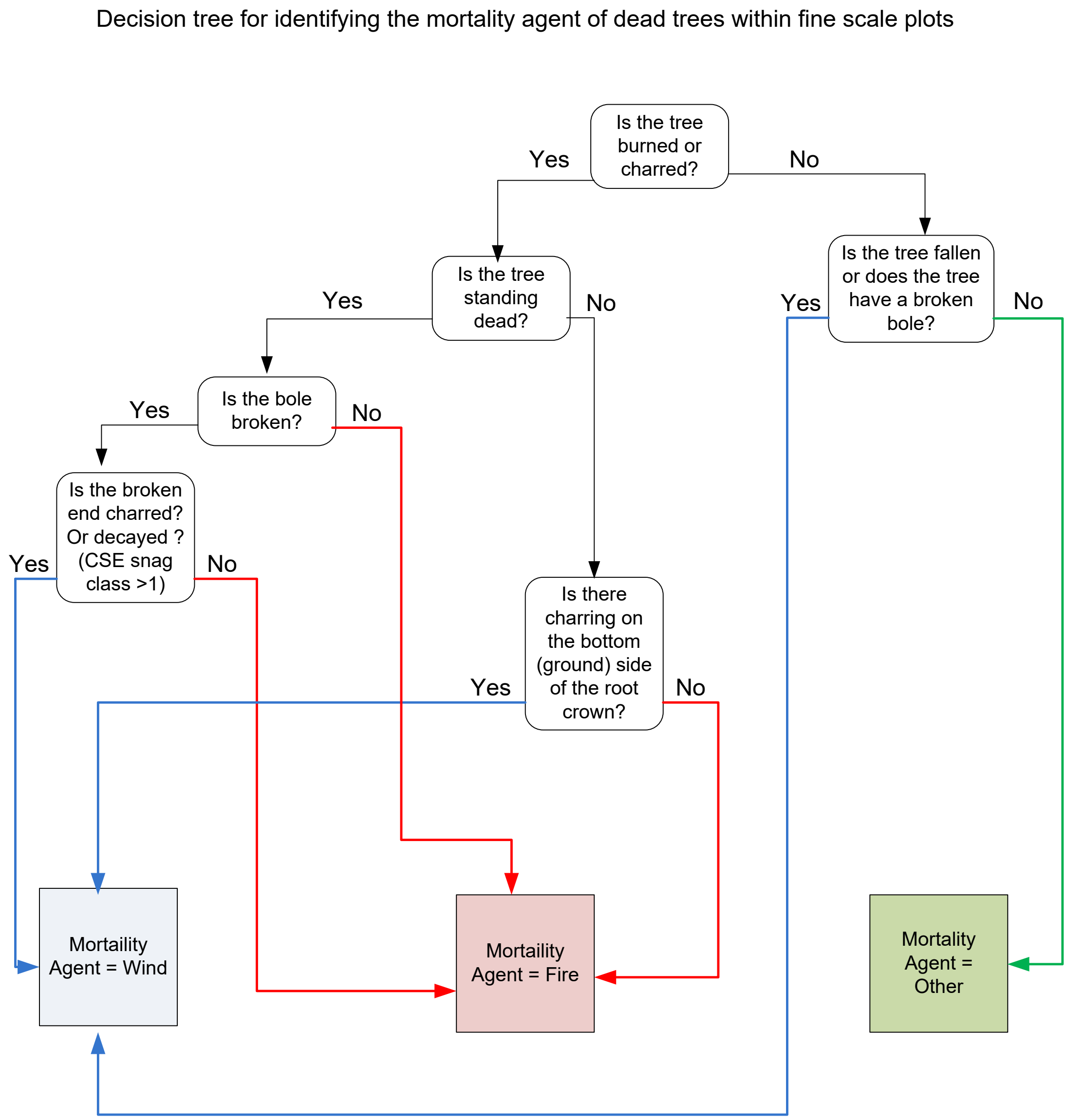
We used logistic regression of the form $\text{logit}(p) = \beta 0 + \beta 1 * (W) + \beta 2 * (DBH) + \beta 3 * (DownDead)$ to determine mortality agents for dead trees in our coarse scale plots. In this model p is the probability of a tree being killed by fire where p = 1 means that a tree has a 100% likelihood of having fire for a mortality cause and p = 0 means that a tree has a 0% chance of having fire as a mortality cause (and therefore is assumed to have been killed by wind). W is the categorical wind severity of the coarse plot on a 0-5 scale, DBH is the diameter at breast height in cm and DownDead is a binary variable set = 0 if the tree is fallen and dead, or 1 if the tree is dead and standing. We used mortality data from fine scale plots where we recorded mortality causes for all individual trees encountered to parameterize our models. Because tree species show differential susceptibility to wind we parameterized the model 7 times using data for individual species or species that show similar susceptibility to wind (Table S1).

All models showed good fit with p values for chi square tests <0.0001. We then used our models to predict the likelihood of fire mortality by tree species, diameter, wind severity, and standing dead vs down and dead for all dead trees in coarse scale plots. We then used these probabilities to determine the proportion of basal area that had been killed by wind vs fire in coarse scale. For example, for a 19.4 cm birch that is down and dead and is found in a plot with wind severity of 2, the log odds are 1.999 and the probability of being killed by fire = 0.69. In this case, for plot level basal area calculations we assumed that 0.69* 1178 cm2 (the basal area of the tree) = 812.82 cm2 was killed by fire and the remainder was killed by wind.

Table S1. Logistic regression models to predict tree mortality agents for coarse scale trees in plots where pre-disturbance measurements of live basal area were unavailable. These models were parameterized using data from the fine scale plots and were used to predict the probability that a dead tree in coarse scale was killed by either wind or fire.

	Intercept	Categorical wind Severity	DBH in cm	DownDead (0= fallen dead, 1= standing dead)
	$\beta 0$	β_1	β_2	β_3
Tree Species				
Balsam Fir	8.0867	-0.9361	-0.1694	1.2765
Birch	5.3255	-0.8796	-0.1183	2.365
Jack Pine	3.6655	-0.9661	-0.0599	0.9912
Black spruce, white spruce and tamarack	5.8219	-0.7995	-0.1634	0.2454
Red Pine and White Pine	3.8535	-2.0758	-0.0589	2.5841
Aspen (bigtooth, quaking, and balsam poplar)	3.8304	-1.2205	-0.0569	1.0483
Cedar, red maple and black ash	7.0317	-1.5628	-0.0868	20.9929

Figure S1. Decision tree for determining mortality agent for trees in plots where the extent of previous wind disturbance was unknown.



Appendix S1: Literature cited

Rich, R. L., L. E. Frelich, and P. B. Reich. 2007. Wind-throw mortality in the southern boreal forest: effects of species, diameter and stand age. Journal of Ecology 95:1261-1273.