

# Supplementary Information

## Supplementary Tables

**Table S1.** List of species included in analysis and their traits.

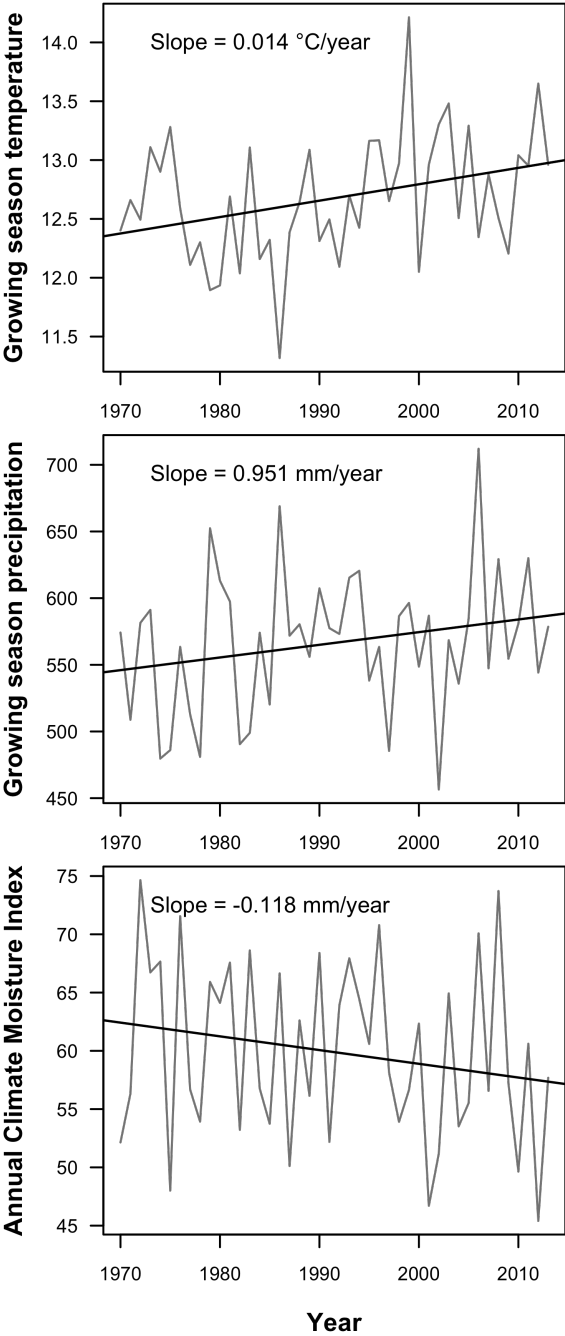
Species name	Vernacular name	Group	Shade tolerance	Temperature index
<i>Acer pensylvanicum</i>	Striped maple	Temperate	3.5	5.22
<i>Acer rubrum</i>	Red maple (soft)	Temperate	3.4	9.28
<i>Acer saccharinum</i>	Silver maple (soft)	Temperate	3.6	9.97
<i>Acer saccharum</i>	Sugar maple (hard)	Temperate	4.8	6.93
<i>Acer spicatum</i>	Mountain maple	Temperate	3.3	4.52
<i>Alnus rugosa</i>	Speckled alder	Boreal	1	1.22
<i>Amelanchier</i> sp.	Serviceberry	Temperate	3.4	9.40
<i>Betula alleghaniensis</i>	Yellow birch	Temperate	3.2	4.49
<i>Betula papyrifera</i>	White birch	Pioneer	1.5	3.69
<i>Betula populifolia</i>	Grey birch	Pioneer	1.5	5.58
<i>Carpinus caroliniana</i>	Blue beech	Temperate	4.6	15.90
<i>Carya cordiformis</i>	Bitternut hickory	Temperate	2.1	11.06
<i>Fagus grandifolia</i>	American beech	Temperate	4.8	8.46
<i>Fraxinus americana</i>	White ash	Temperate	2.5	9.54
<i>Fraxinus nigra</i>	Black ash	Temperate	3	4.92
<i>Fraxinus pennsylvanica</i>	Red ash (green)	Temperate	3.1	11.86
<i>Juglans cinerea</i>	Butternut	Temperate	1.9	8.10
<i>Larix laricina</i>	Tamarack	Boreal	1	3.92
<i>Malus</i> sp.	Crab apple	Temperate	2.2	7.96
<i>Ostrya virginiana</i>	Ironwood	Temperate	4.6	8.91
<i>Picea glauca</i>	White spruce	Boreal	4.2	3.08
<i>Picea mariana</i>	Black spruce	Boreal	4.1	1.68
<i>Picea rubens</i>	Red spruce	Boreal	4.4	4.26

Species name	Vernacular name	Group	Shade tolerance	Temperature index
<i>Pinus banksiana</i>	Jack pine	Boreal	1.4	2.99
<i>Pinus resinosa</i>	Red pine	Pioneer	1.9	5.54
<i>Pinus strobus</i>	Eastern white pine	Pioneer	3.2	6.85
<i>Populus balsamifera</i>	Balsam poplar	Pioneer	1.3	4.25
<i>Populus deltoides</i>	Cottonwood	Pioneer	1.8	8.12
<i>Populus grandidentata</i>	Large tooth aspen	Pioneer	1.2	6.14
<i>Populus tremuloides</i>	Trembling aspen	Pioneer	1.2	4.22
<i>Prunus pensylvanica</i>	Pin cherry	Pioneer	1	4.01
<i>Prunus serotina</i>	Black cherry	Temperate	2.5	4.69
<i>Prunus virginiana</i>	Chokecherry	Temperate	2.6	7.79
<i>Quercus alba</i>	White oak	Temperate	2.9	12.95
<i>Quercus bicolor</i>	Swamp white oak	Temperate	3	9.51
<i>Quercus macrocarpa</i>	Bur oak	Temperate	2.7	6.72
<i>Quercus rubra</i>	Red oak	Temperate	2.8	9.67
<i>Salix</i> sp.	Willow	Pioneer	1.5	13.32
<i>Sorbus americana</i>	American mountain-ash	Pioneer	2.6	2.31
<i>Sorbus decora</i>	Northern mountain-ash	Boreal	NA	2.60
<i>Thuja occidentalis</i>	White cedar	Boreal	3.5	4.30
<i>Tilia americana</i>	Basswood	Temperate	4	5.34
<i>Tsuga canadensis</i>	Eastern hemlock	Temperate	4.8	6.87
<i>Ulmus americana</i>	American elm	Temperate	3.1	10.67
<i>Ulmus rubra</i>	Red elm (slippery)	Temperate	3.3	12.37
<i>Ulmus thomasii</i>	Rock elm	Temperate	3.2	7.80

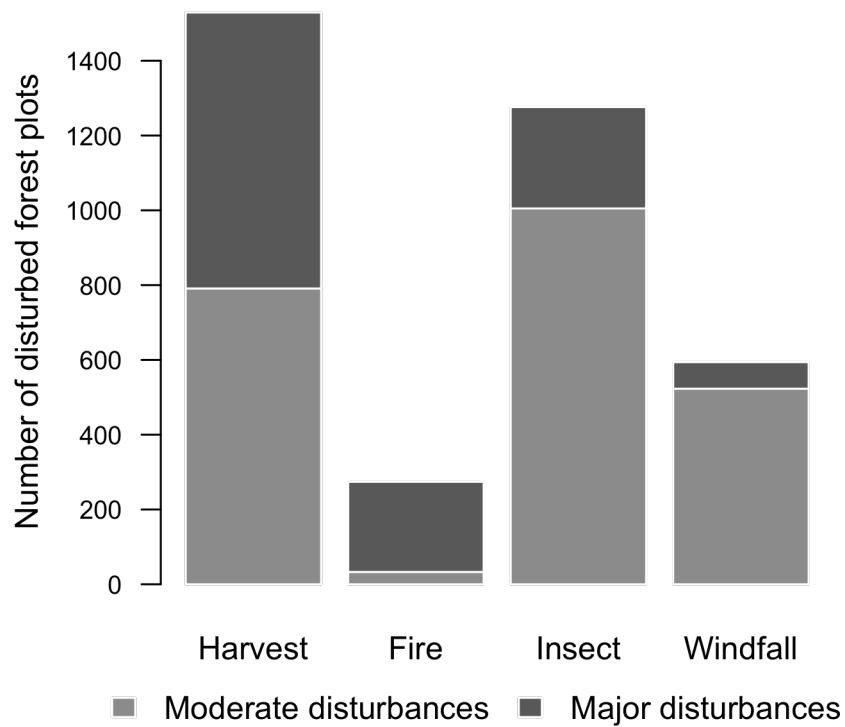
5 **Table S2.** List of R packages used.

Packages	Main functions	Uses
adespatial	forward.sel	Forward selection
FD	functcomp	Functional composition
raster		Manipulation of spatial data
sf		Manipulation of spatial data
stats	lm	Linear regressions
vegan	varpart	Variation partitioning
zoo	rollmean	Rolling average
TBI	tbi	Temporal beta diversity. Function available online: <a href="http://adn.biol.umontreal.ca/~numericalecology/FonctionsR/">http://adn.biol.umontreal.ca/~numericalecology/FonctionsR/</a>

# Supplementary Figures

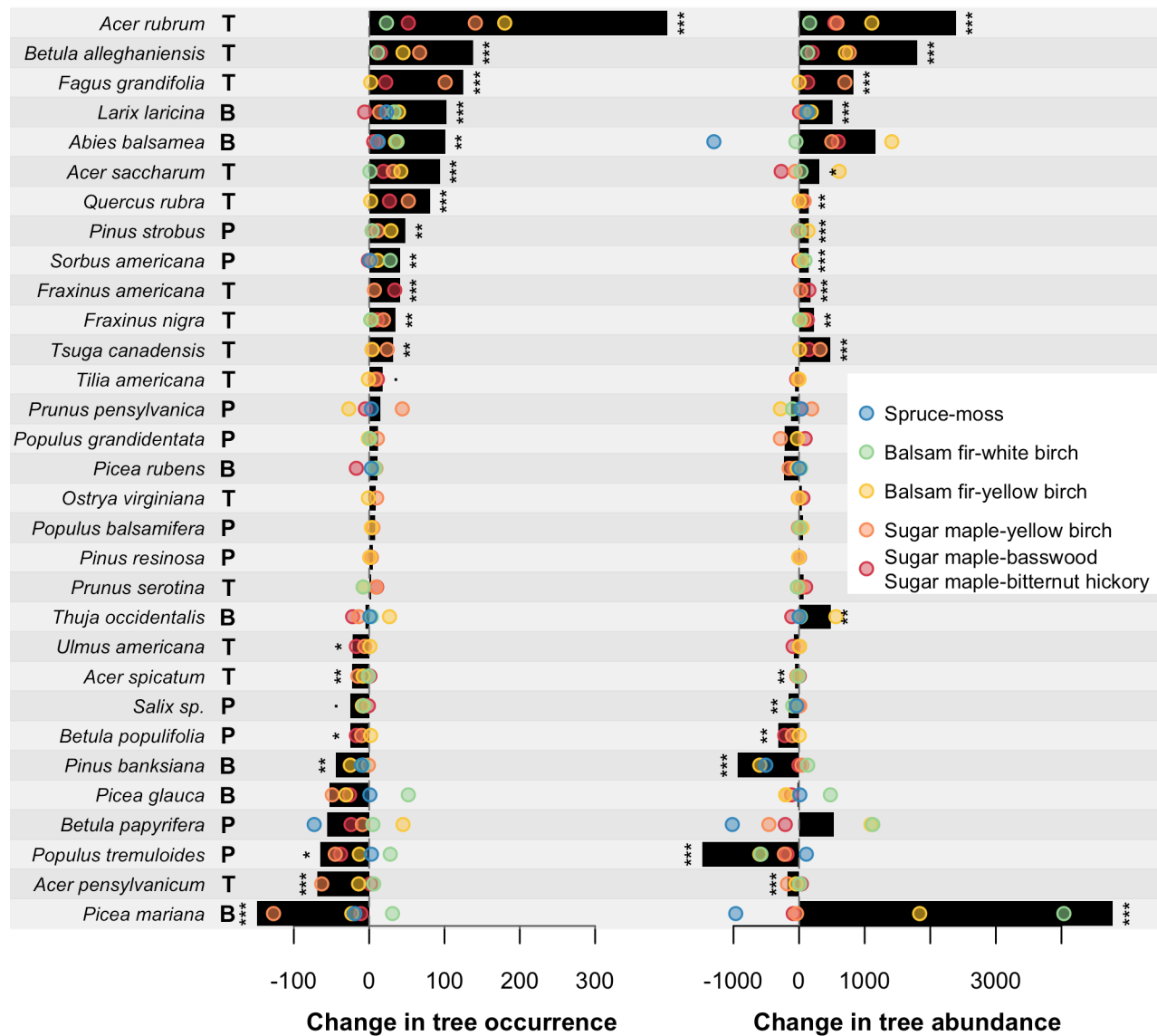


**Figure S1.** Temporal trends in growing season temperatures (top), total growing season precipitation (middle) and annual climate moisture index (bottom). Grey lines represent averaged climate values across all 6281 studied forest plots. Straight black lines show slope of least-squared linear regressions.



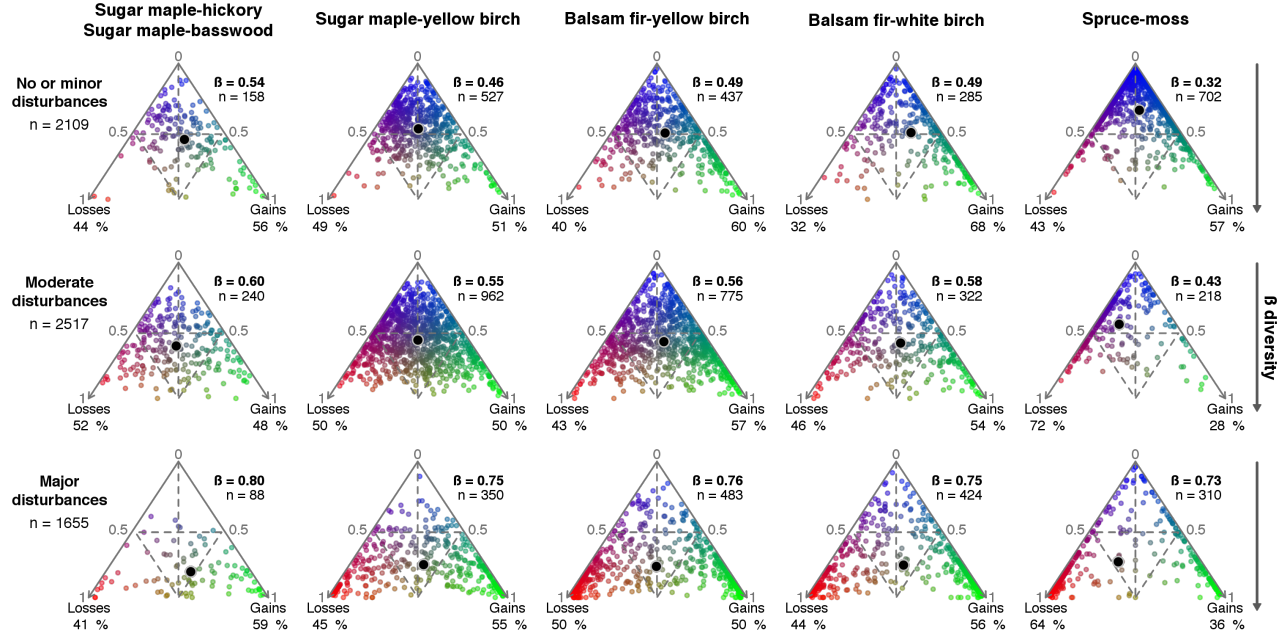
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12 **Figure S2.** Frequency of forest plots by disturbance type and level of intensity.

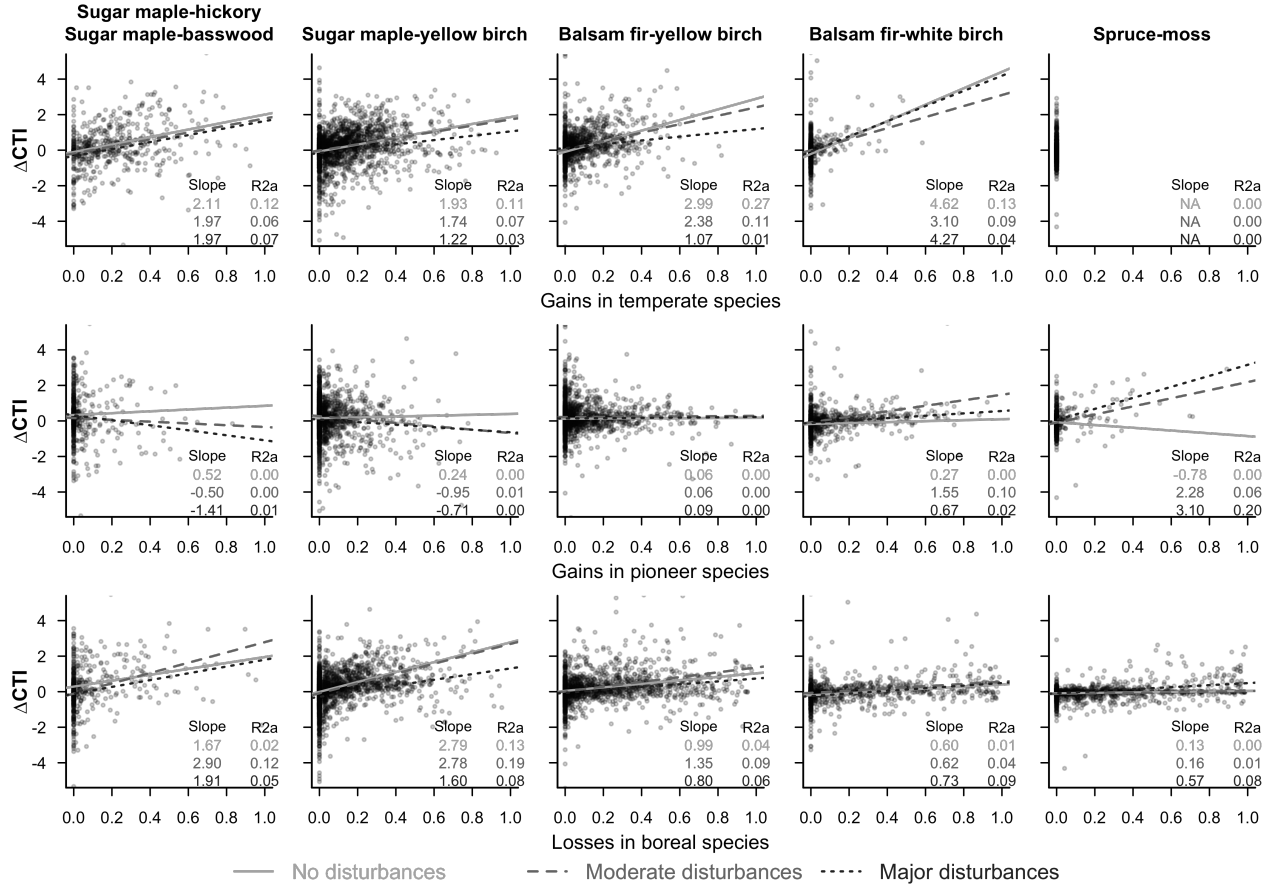


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14 **Figure S3.** Species temporal changes for Québec forests and for each bioclimatic domain. Change in species  
 15 occurrence (left) and species abundance (right). Only species occupying more than 20 plots are shown. The  
 16 bars represent the mean change across the study area, while the colored points represent the mean change  
 17 by domain. The stars represent the level of the significance of the p-value (\* p < 0.05; \*\* p < 0.01; \*\*\* p  
 18 < 0.001) associated with Wilcoxon signed-rank tests used to determine whether individual species change in  
 19 occurrence and abundance were significant. An increase in occurrence indicates that the species has spread  
 20 regionally, while an increase in abundance indicates that the species has spread locally and/or regionally.  
 21 Letters next to species names correspond to (T)emperate; (P)ioneer and (B)oreal species.



**Figure S4.** Triangle diagram of gains and losses in tree abundance by bioclimatic domains and disturbance levels. Each point represents a forest plot and the large black point represents the centroid. At the upper tip of the triangle, similarity is high ( $\beta = 0$ ; blue colors). At the base of the triangle, dissimilarity is high ( $\beta = 1$ ). On the left, forests in red are dominated by losses (red colors), while on the right, forests in green are dominated by gains (green colors). The similar distributions of gain and loss values in the ternary diagrams suggests that there is no major difference in temporal  $\beta$  diversity patterns among domains.



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30 **Figure S5.** Relation between change in Community Temperature Index ( $\Delta\text{CTI}$ ) and gains in temperate  
 31 (top), gains in pioneer (middle) and losses in boreal species (bottom). On each figures, slope et adjusted  $R^2$   
 32 are given for the three levels of disturbances.