The impact of climate, soil and disturbance type on forest succession at Quebec's boreal-temperate ecotone

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Background

- Climate change will shift geographic ranges northwards
- Trees can not keep up with their climatic niche due to their
- long generation times and short dispersal distances¹



- How do climate, soil and disturbance impact the succession probabilities at the ecotone?
- Are there differences in post-fire succession probabilities between the temperate, mixed and boreal forest?





- **Significant uncertainty** on these lags still exists due to different climate scenarios and future fire regimes
- Additional factors also complicate the migration of trees:
 - Interspecific competition²
 - Soil heterogeneity³

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- Natural and anthropogenic disturbances⁴
- It is important to improve our knowledge of forest succession under future climate conditions
- The **boreal-temperate ecotone** is an ideal study area since the impacts of global change are visible earlier at transition zones⁵

STA

Study area



Methods														
SIFORT data ⁶	Species grouping	Markov chain model ⁷	Transition probabilities											
 Raster covering Quebec 	1 Paper birch	State State State												
 15" x 15" Closeified with photo 	2 Shade intolerants	Time	To State 1 State 2 State 3											
 Classified with photo- interpretation 	3 Yellow birch	q_{11}	State 1 0.75 0.2 0.05											
 5 inventories between 	щ 4 Maples	State												

1970 and 2019

Selected 39 097
 polygons that were
 inventoried at least twice



Some preliminary results

Α	Pap. Birch	Other intol.	Y. Birch	Maple	Other Dec.	Bals. Fir	B/R Spruce	Jack Pine	Other Con.	в	Pap. Birch	Other intol.	Y. Birch	Maple	Other Dec.	Bals. Fir	B/R Spruce	Jack Pine	Other Con.	С	Pap. Birch	Other intol.	Y. Birch	Maple	Other Dec.	Bals. Fir	B/R Spruce	Jack Pine	Other Con.	D	Pap. Birch	Other intol.	Y. Birch	Maple	Other Dec.	Bals. Fir	B/R Spruce	Jack Pine	Other Con.
Pap. Birc	h 0.46	0.08	0.11	0.08	0.05	0.07	0.07	0	0.07	Pap. Birch	0	-0.03	0.01	0.01	0	0	0	0	0	Pap. Birc	h -0.05	0	0.05	0.03	0.01	-0.04	0	0	0	Pap. Birc	h 0.06	0.02	0.02	0.01	0	-0.09	-0.01	0	-0.02
Other into	0.25	0.41	0.08	0.08	0.03	0.04	0.07	0.01	0.05	Other intol.	0.09	-0.14	0.01	0.01	0	0.01	0	0	0.01	Other into	0.02	0	0.02	0.02	0	-0.02	0	0	0	Other into	I0.01	0.06	0.01	0.01	0	-0.04	0	0	-0.01
Y. Birc	h 0.09	0.02	0.57	0.17	0.05	0.03	0.02	0	0.04	Y. Birch	0	0	0	0	0	0	0	0	0	Y. Birc	h -0.12	-0.01	0.14	0.06	0	-0.04	-0.01	0	-0.01	Y. Birc	h -0.01	1 0	0.04	0.02	0	-0.04	0	0	-0.01
Mapl	e 0.06	0.03	0.18	0.67	0.02	0.01	0.01	0	0.02	Maple	0	-0.01	0	0	0	0	0	0	0	Maple	e -0.05	-0.01	-0.01	0.1	0	-0.01	0	0	0	Мар	e -0.01	1 0	-0.01	0.03	0	-0.01	0	0	0
Other Dec	0.09	0.03	0.14	0.06	0.39	0.15	0.06	0	0.07	Other Dec.	0	-0.01	0	0	0	0	0	0	0	Other Dec	-0.04	-0.01	0.04	0.02	0.15	-0.14	-0.02	0	0	Other De	c. 0	0	0.02	0.01	0.11	<mark>-0.15</mark>	-0.01	0	0
Bals. Fi	r 0.16	0.04	0.15	0.05	0.06	0.34	0.13	0	0.06	Bals. Fir	0	-0.01	0	0	0	0	0	0	0	Bals. Fi	r -0.02	0	0.06	0.02	0.01	-0.07	0	0	0	Bals. F	ir 0.04	0.01	0.04	0.01	0.01	-0.12	0.01	0	0
B/R Spruc	e 0.13	0.04	0.06	0.03	0.05	0.06	0.53	0.01	0.09	B/R Spruce	0	-0.01	0	0	0	0	-0.01	0	0	B/R Spruc	e -0.02	0	0.01	0.01	0.01	-0.04	0.04	0	-0.01	B/R Spruc	e 0.01	0.01	0	0	0	-0.07	0.07	0	-0.03
Jack Pin	e 0.05	0.03	0.02	0.01	0.01	0.02	0.11	0.71	0.05	Jack Pine	0	0	0	0	0	0	0	0	0	Jack Pin	e ()	0	0	0	0	-0.01	0	0	0	Jack Pin	e O	0	0	0	0	-0.02	0.01	0	0
Other Cor	0.15	0.04	0.16	0.06	0.07	0.15	0.17	0	0.2	Other Con.	0	-0.01	0.01	0	0	0	-0.01	0	0	Other Con	0.03	0	0.05	0.02	0.02	-0.09	0	0	0.03	Other Co	n. 0.02	0.01	0.04	0.01	0.01	-0.15	0.02	0	0.04

Fig. 1: A: Transition probabilities after 10 years without perturbation. B: Change in probability compared to panel A for fire. C: Change in probability compared to panel A for harvest. D: Change in probability compared to panel A for pest outbreak.

Pap. birch to B/R spruce

Y. birch to Maple

Maple to Pap. birch

Future work



Fig. 2: Transition probabilities as function of time without perturbation, after fire, harvest and pest outbreak.

- Model all covariates simultaneously
- Increase study area to include all of the boreal-temperate ecotone and afterwards the province
- Compare post-fire succession between forest types
- Integrate results with Quebec Landscape Dynamics Model⁸



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