Drivers of land cover change after large fire disturbance in boreal forests

NJ Day^{1*}, KA Reid^{1,2}, XJ Walker³, AL White¹, SG Cumming⁴, KE Dunfield⁵, JF Johnstone⁶, MC Mack³, MR Turetsky⁵, JL Baltzer¹



*nday@wlu.ca; nicolajday.weebly.com; @N_J_Day

¹Wilfrid Laurier University; ²Memorial University; ³Northern Arizona University; ⁴Université Laval; ⁵University of Guelph; ⁶University of Saskatchewan

Fire adaptive regeneration strategies



Fire adaptive regeneration strategies

Rhizome





Disperser





Seed Bank



Megafires expected to become more frequent





Alaska: Johnstone et al. (2010) Can. J. For. Res. 40: 1302

What is the impact of megafires on forests?

Soil combustion, understory plants, tree seedlings, soil fungi





What is the impact of extreme fire years on forests?

Soil combustion, understory plants, tree seedlings, soil fungi









What is the impact of extreme fire years on forests?

Soil combustion, understory plants, tree seedlings, soil fungi









Permanent plot network



From Walker et al. (2018) Int. J. Wildland Fire 27: 125

2014 Combustion estimates



Total emissions: 94.3 ± 7.9 Tg C from 2.85 Mha

Drier sites lost greatest proportion of organic layer

Burn depth:

- NWT 2014: 9.4 cm
- AK 2004: 15.4 cm

From Walker et al. (in press) Global Change Biol.

Most understory recovery via resprouting but seed beds are important for seeders







Understory determined by:

- organic depth
- pre-fire stand type
- stand age



White (2018)

Successional shift in tree seedlings towards jack pine

Pre-Fire mixed stand Pre-Fire black spruce dominated stand -Black spruce Black spruce *** *** t = -19.489 t = -20.518 P < 0.001 P < 0.001 Jack pine Jack pine *** *** t = 16.32 t = 16.489 P < 0.001 P < 0.001 -1.0 -0.5 0.0 0.5 1.0 0.5 1.0 -1.0 -0.5 0.0 **Proportional Change Proportional Change** DECREASE **INCREASE INCREASE** DECREASE

Reid (2017)

Fewer mycorrhizas in deeper burns and this correlates with plant regeneration



From Day et al. (in review) Global Change Biol.

Soil fungi determined burn depth soil pH soil moisture pre-fire stand type

stand age





Conclusions

- NWT forests appear to be resilient
 - soil moisture play a critical role in this: burn depth \rightarrow rhizomes, seed beds, fungi
- Drier sites are more susceptible to organic combustion and vegetation change
- Shift towards jack pine dominance?





Acknowledgements



- Co-authors: Kirsten Reid, Alison White, Xanthe Walker, Steve Cumming, Jill Johnstone, Michelle Mack, Merritt Turetsky, Jennifer Baltzer
- Bruce Hannah and the WLU-GNWT partnership
- Ka'a'gee Tu First Nations, Tłįcho Government
- Genome Quebec
- Many, many field and lab assistants



Northwest Territories Cumulative Impact Monitoring Program







