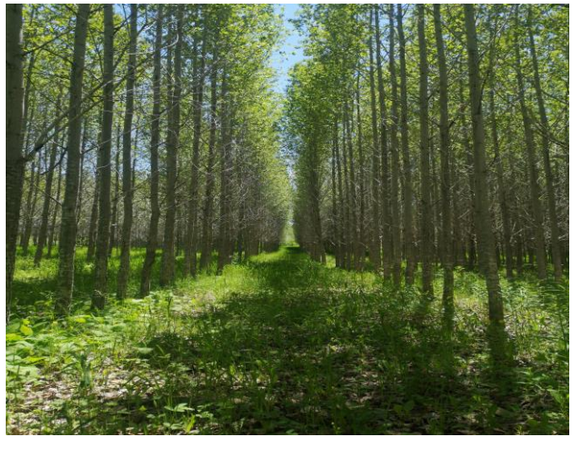
Plant diversity in mixed and monoculture hybrid poplar plantations



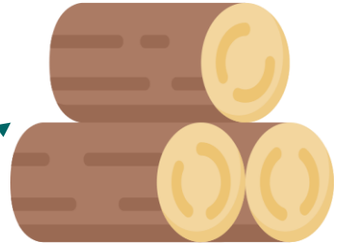
Presented by : Mialintsoa Aroniaina RANDRIAMANANJARA

Supervisor: Annie DesRochers

Co-supervisor : Nicole Fenton

CONTEXT

FOREST PLANTATIONS



33% of the world's wood

50% of global production by 2050

(Kanninen, 2010 ; Jürgensen et al., 2014; FAO,2015)

CONTEXT

Plantation and biodiversity

- Desert of biodiversity

(Simberloff & Von Holle, 1999; Bremer & Farley, 2010; Barrette et al., 2014)

CONTEXT

Plantation and biodiversity

- Desert of biodiverity

(Simberloff & Von Holle, 1999; Bremer & Farley, 2010; Barrette et al., 2014)

Planting on agricultural farmland

- **Increase the biodiversity of the understorey vegetation (vascular and non-vascular plants)**

(Carnus et al., 2006; Newmaster et al., 2007; Aubin et al., 2008; Brockerhoff et al., 2008; Royer-Tardif et al., 2017)

CONTEXT

Planting on agricultural farmland

Quebec: Establishment of exotic species such as hybrid poplar (*Populus* spp.) on abandoned farmlands

- **Increase the biodiversity of the understorey vegetation (vascular and non-vascular plants)**

(Carnus et al., 2006; Newmaster et al., 2007; Aubin et al., 2008; Brockerhoff et al., 2008; Royer-Tardif et al., 2017)

CONTEXT

1 What types of plantations promote plant diversity ?

Are mixed plantations promising compared to monocultures?

2 No consensus on the impact of compositional complexity of exotic species plantations on functional and plant diversity in the understory

OBJECTIVE

Determine the effect of mixed plantations (hybrid poplar + spruce) on the biodiversity of understory vegetation compared to monocultures (pure hybrid poplars or pure spruce).

Monoculture on agricultural farmland

VS

Mixed plantation on agricultural farmland

HYPOTHESIS

Difference in species composition between mixed plantations and monocultures

Mixed plantations would promote diversity compared to monocultures : provides more complex structure and light heterogeneity

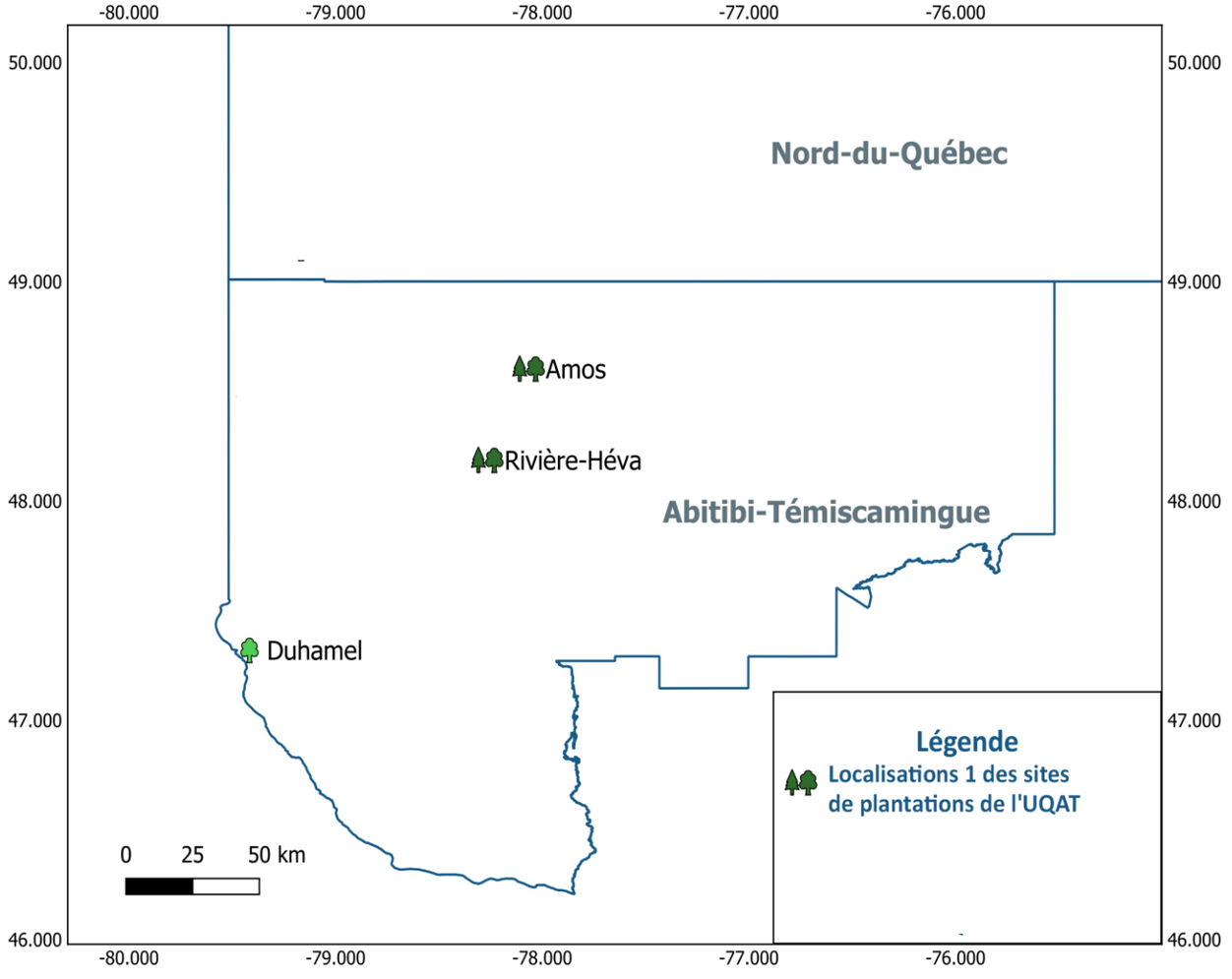
Bryophyte and lichen diversity :

Mixed plantations **>** Coniferous monocultures **>** Deciduous monocultures

Vascular plant diversity :

Deciduous monocultures **>** Coniferous monocultures

Localisation of the plantations



20 year old plantations
Monoculture and mixed species (hybrid poplar, Norway spruce (Picea abies) (**PA**); white spruce (Picea glauca (Moench)) (**PG**)

METHODS

3 sites
8 blocks/site

- *Populus maximowiczii* x *P. balsamifera* (PMB)
- *P. balsamifera x P. trichocarpa* (PBT)
- Norway spruce (*Picea abies*) (PA)
- White spruce (*Picea glauca* (Moench)) (PG)
- Mixed plantations : PAPMB ; PAPBT ; PGPBT; PGPMB

P. balsamifera x P. trichocarpa (PBT)

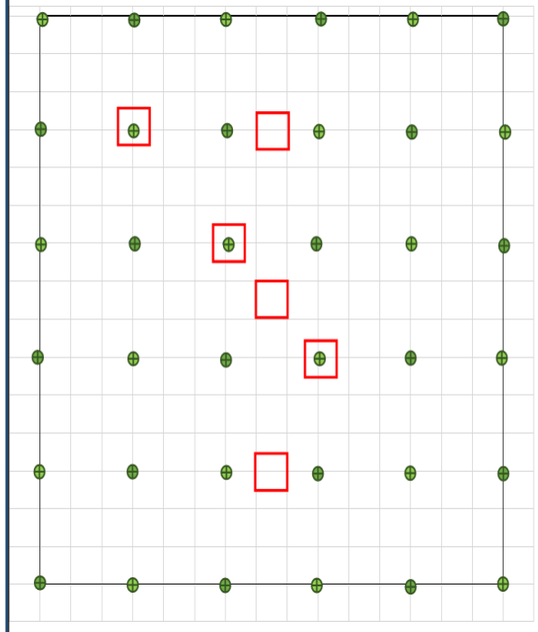
Populus maximowiczii x P. balsamifera (PMB)

Picea abies (PA)

Picea glauca (Moench)) (PG)

METHODS

Monoculture

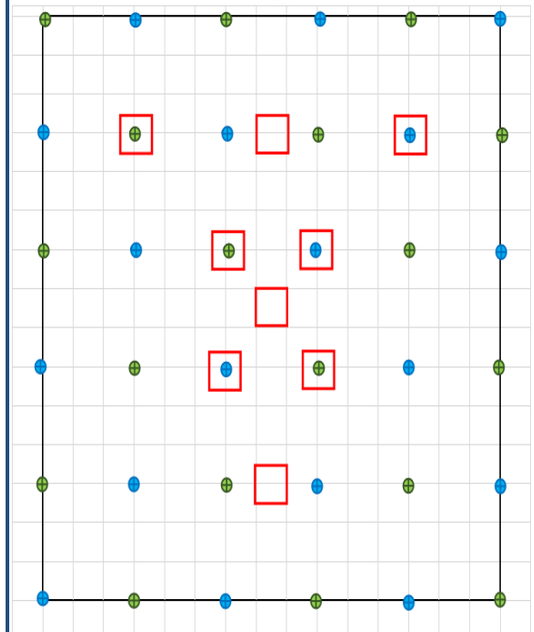


Quadrat 1m x 1m

Hybrid poplar or white spruce

Plot boundary

Mixed plantation



Quadrat 1m x 1m

White spruce

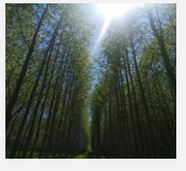
Hybrid poplar

Plot boundary

Each plantation:
225m²
36 trees

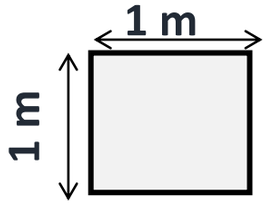
Quadrats under and between trees
Monoculture: 6 quadrats
Mixed: 9 quadrats

Measurement of light at 50 cm above the ground

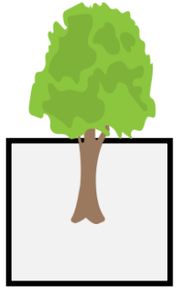


METHODS

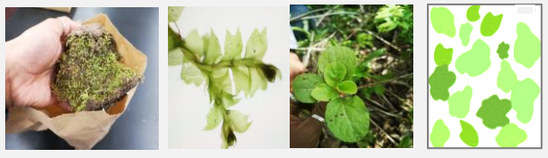
Each quadrat

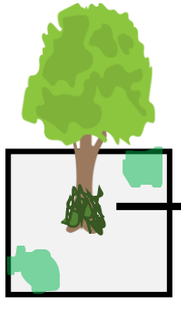


Quadrat



Taxonomic and functional approaches, plant cover





Collection and identification of bryophytes on the ground; base and trunk of trees

PRELIMINARY RESULTS

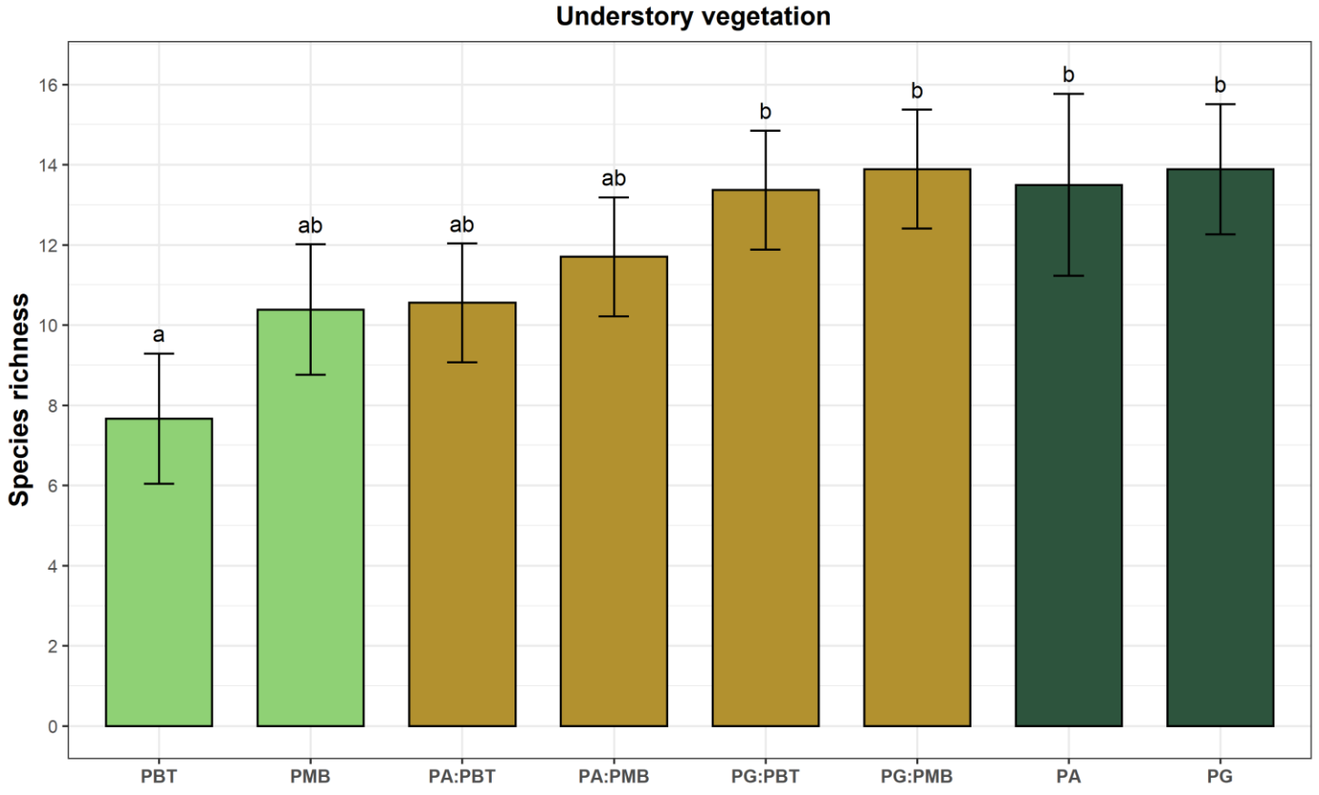


Fig 1: Mean richness of understory vegetation per plantation types (PBT, P. *balsamifera* x P. *trichocarpa*; PMB, Populus *maximowiczii* x P. *balsamifera*; PG, white spruce; PA, Norway spruce; PG:PBT, white spruce + clone PBT; PG:PMB, white spruce + clone PMB ; PA:PBT, Norway spruce + clone PBT;PA:PMB, Norway spruce + clone PMB. (A) all understory plant species (vascular + bryophyte + lichens), totaling 116 species

- The total **species richness of hybrid poplar** plantations with **low species richness improves** when **mixed with coniferous, especially white spruce**

PRELIMINARY RESULTS

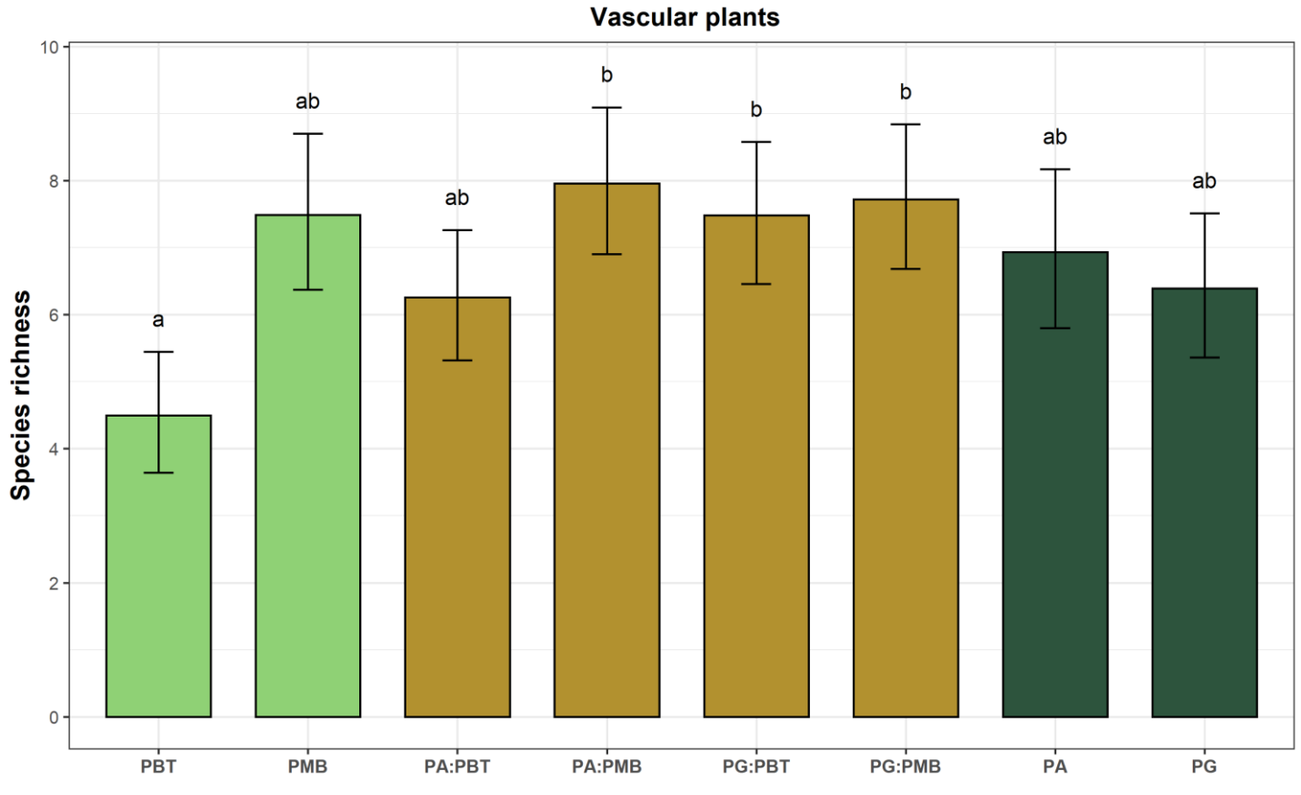


Fig 2: Mean richness of vascular plants per plantation types (PBT, P. *balsamifera* x P. *trichocarpa*; PMB, Populus *maximowiczii* x P. *balsamifera*; PG, white spruce; PA, Norway spruce; PG:PBT, white spruce + clone PBT; PG:PMB, white spruce + clone PMB ; PA:PBT, Norway spruce + clone PBT;PA:PMB, Norway spruce + clone PMB.

- **Species richness increases** when moving from a poplar monoculture **(PBT)** to a mixed plantation **(PG:PBT)**

PRELIMINARY RESULTS

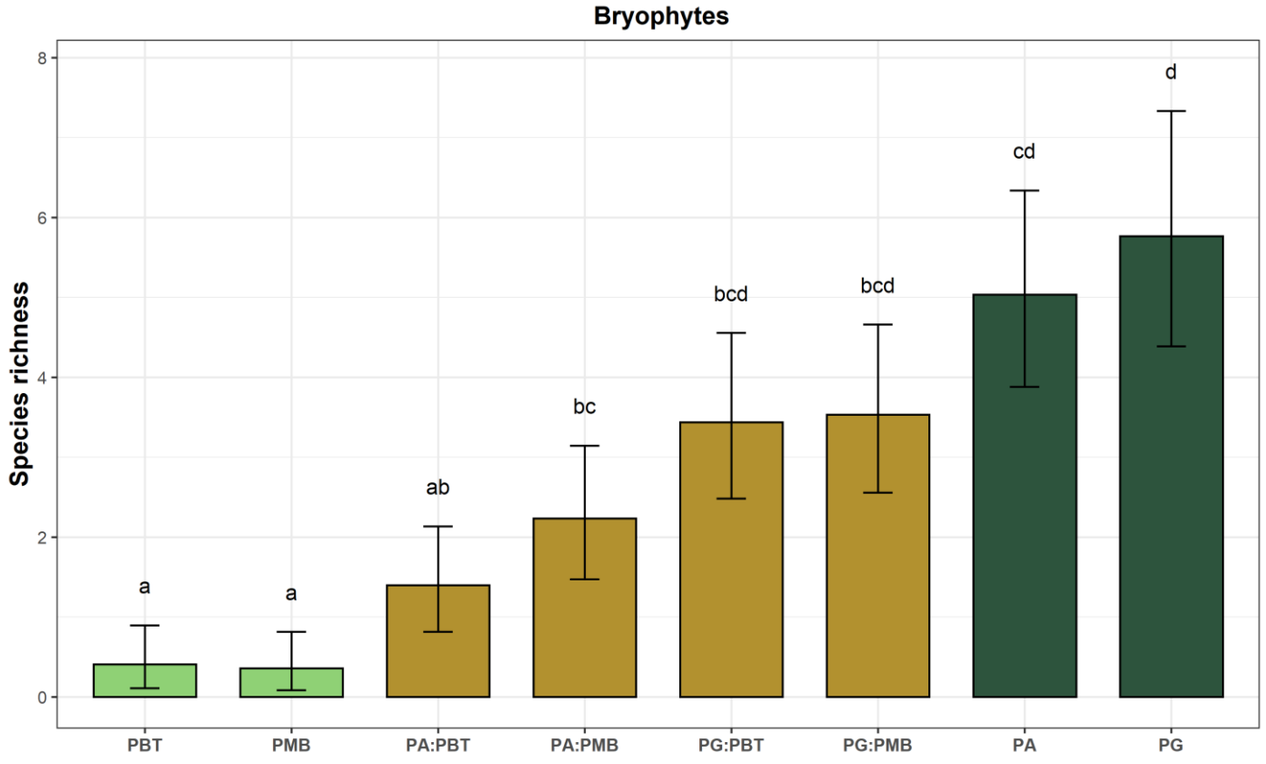


Fig 3: Mean richness of bryophytes per plantation types (PBT, P. *balsamifera* x P. *trichocarpa*; PMB, Populus *maximowiczii* x P. *balsamifera*; PG, white spruce; PA, Norway spruce; PG:PBT, white spruce + clone PBT; PG:PMB, white spruce + clone PMB ; PA:PBT, Norway spruce + clone PBT;PA:PMB, Norway spruce + clone PMB. **46 species identified**

- **Coniferous monocultures and mixed plantations promote bryophyte establishment** compared **to other plantation types**

Discussion

Increasing resource diversity : mixed stands hosted a more heterogeneous and species-rich flora than pure hybrid poplar

Heterogeneous light environment (greater light penetration through the canopy) : increase in vascular plants (Hart & Chen, 2006)

Absence of deciduous litter == bryophyte establishment (Jean et al., 2017), Coniferous monocultures promote bryophyte establishment (Saetre et al. 1997).

DISCUSSION AND CONCLUSION

Conclusion

Biodiversity of understory vegetation in poplar plantations (PBT) increases when mixed with coniferous

Presence of coniferous in the mixed plantations favors bryophyte species richness

Importance of the **identity of the species planted and mixed**

Next steps : species composition of vascular plants and bryophytes in each plantation type; species cover; understory vegetation traits and functional groups

THANK YOU ☺

Committee members :

Annie DesRochers

Nicole Fenton

Xavier Cavard

Mélanie Jean

Bryology Laboratory-UQAT

Nicole Fenton

Julie Arseneault

My sincere thanks to :

Jean-Rémi Gauthier

Marie-Claude Mayotte

Mathilde Joncas

Béatrice Dupuis

Hugo Morin-Brassard

Victor Beaudet

Patrice Blaney

Guillaume Tougas