AGGP-Agroforestry

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WHITE SPRUCE GROWTH AND CARBON STOCKS IN SHELTERBELTS IN SASKATCHEWAN

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Tree growth (3PG model) and C dynamics (CBM-CFS3 model) modelling approaches were used to determine the total ecosystem C (TEC) stocks and C stocks additions in white spruce shelterbelts in Saskatchewan. Our growth curves and biomass prediction values (Figure 1) were limited to age 60 years. All older-than-60 years shelterbelts were assigned a conservative, 60-year biomass estimate. Differences in climatic and soil conditions caused the wide ranges of white spruce growth in shelterbelts – mean aboveground biomass (stems, branches, bark), at age 60 years, was 152-253 Mg Km^{-1}, diameter at breast height (DBH) was 29-34 cm, and height was 14-17 m (Figure 1). The growth curves were used as input in the CBM-CFS3 model to produce an inventory of the carbon stocks (Table 1) in all white spruce shelterbelts planted from 1925 to 2009.

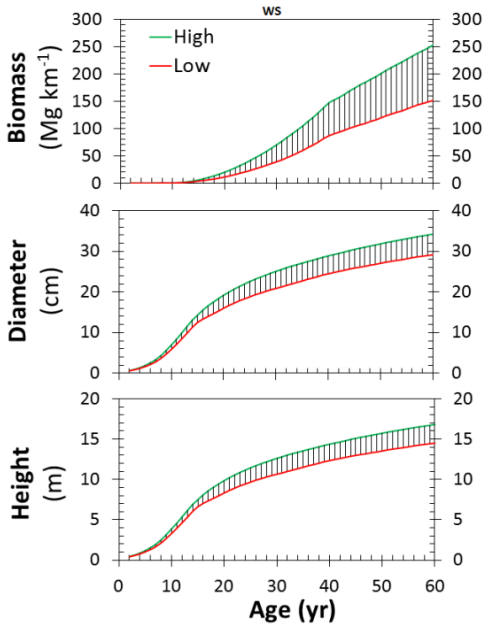

Figure 1. White spruce growth in shelterbelts – range of biomass, DBH diameter, and height.

CARBON STOCKS INVENTORY

- TEC stocks and C stocks additions in white spruce shelterbelts were 0.13 and 0.05 Tg (1 Tg = 1 million Mg), respectively. Nearly 90% of these C stocks additions (0.045 Tg) occurred since 1990, regardless of tree planting period, and have an estimated value of $2.50 million, at $15 per Mg CO_2-eq (Table 1).
- About 35% (347 Km) of all white spruce shelterbelts (991 Km) were planted in the last 25 years.
- For six common shelterbelt species in Saskatchewan, the total length of white spruce shelterbelts is 2.0%, and the TEC stocks stored in them is 1.2%, of the cumulative length and TEC stocks, respectively.
- With the highest number in the Dark Brown soil zone (Table 1), white spruce shelterbelts are relatively more common, compared to other common shelterbelt species, in the Dark Gray and Gray soil zones, where they represent up to 38% of the cumulative TEC stocks in some clusters (Figure 2).

Table 1. Total ecosystem C and C additions stocks in white spruce shelterbelts in Saskatchewan.

WS: 2015 C stocks and estimated length

Soil zone	*White spruce shelterbelts planted 1925-2009* Total Ecosystem C Since 1925 (Mg C)	Total Ecosystem C **Since 1990** (Mg C)	C Additions Since 1925 (Mg C)	C Additions **Since 1990** (Mg C)	Length Km
Gray	3,121	2,158	1,286	1,232	15
Dark Gray	28,867	19,360	11,796	10,330	78
Black	20,267	11,935	7,980	7,023	33
Dark Brown	67,785	38,260	23,353	21,629	826
Brown	11,710	6,646	6,026	5,134	39
Totals (Mg C):	131,750	78,359	50,440	45,348	991
(Tg C =)	0.132	**0.078**	0.050	**0.045**	
North ←					South

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Relative occurrence and C sequestration rate

- White spruce growth and its C sequestration potential make it a valuable species for shelterbelt establishment (Figure 2)
- The average C sequestration rate was 2.43–2.75 Mg C Km^{-1} yr^{-1}, the highest being in the Gray soil zone.
- White spruce relative spatial occurrence and estimated rate of C sequestration (Figure 2) could be used as a guideline for identifying best locations for future planting.

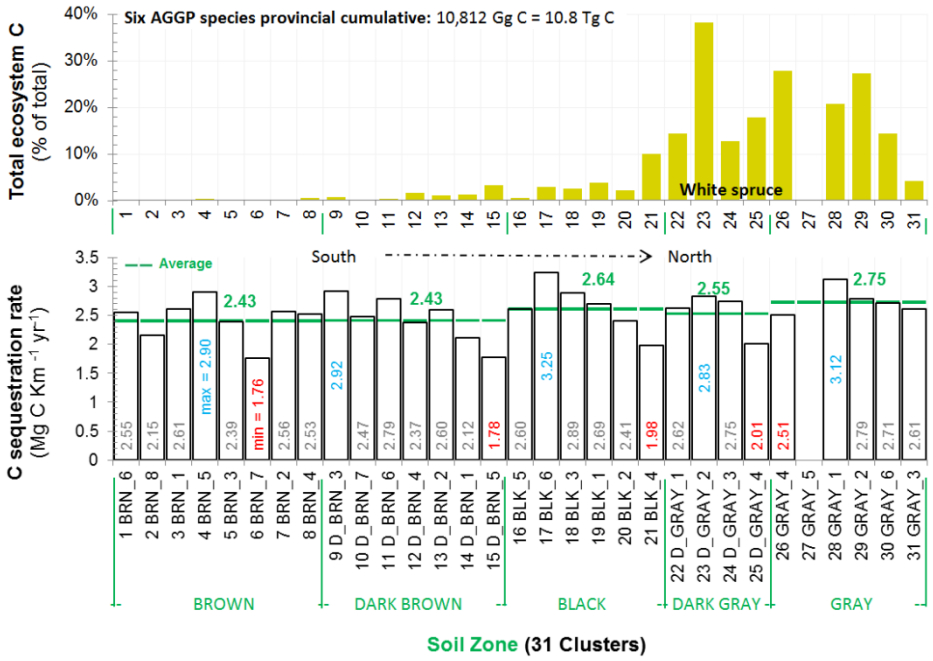

Figure 2. Relative spatial occurrence (top) and C sequestration rate of white spruce shelterbelts across 31 clusters and 5 soil zones in Saskatchewan.

- Best predicted areas for future planting are the Black, Dark Gray, and Gray soil zones, where on the majority of the clusters, the C sequestration rate is estimated >2.6 Mg C Km^{-1} yr^{-1}, ranging 1.98–3.25 Mg C Km^{-1} yr^{-1}.
- Planting white spruce shelterbelt trees on agricultural landscapes is an important strategy for mitigating greenhouse gasses.

Further reading

Amichev, B.Y., et al. 2016. **Carbon sequestration by planted shelterbelts in Saskatchewan: 3PG and CBM-CFS3 model simulations.** *Ecological Modelling* 325:35-46

AGGP Fact Sheet(s): **SASK-1, SASK-2, SASK-4, SASK-10**

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