

Larivière D., Djupström L., Nilsson O. (2025). Impact of varying retention proportions on Scots pine (*Pinus sylvestris*) establishment across planting, direct seeding, and natural regeneration. *Silva Fennica* vol. 59 no. 3 article id 25007. <https://doi.org/10.14214/sf.25007>

Supplementary file S4

Mean Height vs. Canopy Area (CA)

Equation 1 in R

Transformed(H5) ~ Canopy Area + Markb + (1 | StandID/Block)

```
mod_CA_P_H <- lmer(log(mean_H5)~ sum_Area_SQUAREMETERS + Markb + (1 | BelD/Block), weights = sum_ANTAL5, data= TRY)
mod_seeded_H <- lmer(log(mean_H5+1)~ sum_Area_SQUAREMETERS + Markb +(1|BelD/Block), weights = sum_ANTAL5, data= TRY_SEEDED)
mod_CA_NR_H <- lmer(mean_H5~ sum_Area_SQUAREMETERS + Markb + (1 | BelD/Block), weights = sum_ANTAL5, data= TRY_NR)
```

Supplementary S4 Table 1. Effects of canopy area and site preparation on mean seedling height across regeneration types. Shown are the direction of the effect (based on fixed-effect estimates), F-values with numerator (NumDF) and denominator (DenDF) degrees of freedom from Type II Wald F-tests (Satterthwaite approximation), and associated p-values. Response variables were log-transformed mean height for Planted and Direct-Seeded seedlings (weighted by total number of seedlings per plot) and mean height for Naturally Regenerated seedlings.

Type	Factor	Effect direction	F (NumDF, DenDF)	p-value
Planted seedlings	Canopy Area	Negative (Estimate = -0.0010)	F = 11.52 (1, 58.25)	0.001 **
	Site preparation	Positive (Estimate = +0.327)	F = 60.14 (1, 36.46)	<0.001 ***
Direct seeded	Canopy Area	Negative (Estimate = -0.0010)	F = 11.23 (1, 58.79)	0.001 **
	Site preparation	Positive (Estimate = +0.437)	F = 39.44 (1, 37.04)	<0.001 ***
Naturally regenerated	Canopy Area	~0 (Estimate = -0.005, ns)	F = 0.14 (1, 39.66)	0.714
	Site preparation	Negative (Estimate = -10.38)	F = 16.63 (1, 35.02)	<0.001 ***

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001

F-values are from Type II Wald F-tests with Satterthwaite df.

Response variable for Planted and Seeded = log(mean_H5) (weights = sum_ANTAL5); for NR = mean_H5. "Effect direction" indicates the sign of the fixed-effect estimate.

"Canopy Area" = canopy area (mean of the total pixel area within a 20 m radius of each plot, m²).

"Site preparation" = mechanical site-preparation treatment (0 = without, 1 = with).

Recruitment or Proportion of Survival / Germination vs. Canopy Area (CA)

Equation 1 in R

Transformed(S5) ~ Canopy Area + Markb + (1 | StandID/Block)

```
mod_surv <- lmer(log(prop.surv+1)~ sum_Area_SQUAREMETERS + Markb+(1 | BeID/Block), weights = sum_ANTAL5, data= TRY)
mod_CA_SEEDED_PROP <- lmer(log(prop.surv)~ sum_Area_SQUAREMETERS +Markb + (1 | BeID/Block), weights = sum_ANTAL5, data= TRY_SEEDED)
mod <- glmer(sum_ANTAL5 ~sum_Area_SQUAREMETERS_scaled + Markb + (1 | BeID/Block), data= TRY_NR, family = poisson(link = "log")
```

Supplementary S4 Table 2. Effects of canopy area and site preparation on proportion of survival/germination and recruitment across regeneration types. Shown are the direction of the effect (based on fixed-effect estimates), F-values with numerator (NumDF) and denominator (DenDF) degrees of freedom from Type II Wald F-tests (Satterthwaite approximation), and associated p-values. For Naturally Regenerated recruitment, each cell reports the χ^2 -statistic from a Type III Wald chi-square test based on a Poisson GLMM, along with the p-value

Type	Factor	Effect direction	F / χ^2 (NumDF, DenDF)	p-value
Proportion survival (%)	Canopy Area	Negative (Estimate = -0.00041)	F = 3.61 (1, 62.96)	0.062 .
	Site preparation	Positive (Estimate = +0.070)	F = 5.14 (1, 50.76)	0.028 *
Proportion germination (%)	Canopy Area	~0 (Estimate = -0.00020, ns)	F = 0.18 (1, 46.12)	0.673
	Site preparation	Positive (Estimate = +1.305)	F = 95.78 (1, 50.41)	<0.001 ***
Recruitment	Area (Canopy Area_scaled)	~0 (Estimate = +0.064, ns)	χ^2 = 1.36 (1)	0.244
	Site preparation	Positive (Estimate = +0.962)	χ^2 = 241.61 (1)	<0.001 ***

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001.

F-values are from Type II Wald F-tests with Satterthwaite df.

Response variable for Planted and Seeded = log(prop_surv + 1) (weights = sum_ANTAL5); for NR = sum_ANTAL5.

"Effect direction" indicates the sign of the fixed-effect estimate.

"Canopy Area" = canopy area in m² (20 m radius).

"Site preparation" = mechanical site-preparation treatment (0 = without, 1 = with).

Growth vs. Canopy Area (CA)

Equation 1 in R

Transformed(G5) ~ Canopy Area + Markb + (1 | StandID/Block)

```
mod_G <- lmer(log(Mean_H_diff+1)~ sum_Area_SQUAREMETERS + Markb +(1 | BelD/Block)+(1|mean_H1), weights = sum_ANTAL5, data= TRY)
```

```
mod_G <- lmer(log(Mean_H_diff+1)~ sum_Area_SQUAREMETERS +Markb + (1|mean_H1),weights = weights, data= TRY_SEEDED)
```

```
mod <- lmer(Mean_H_diff~ sum_Area_SQUAREMETERS +Markb + (1 | BelD/Block) + (1|mean_H1),weights = weights, data= TRY_NR)
```

Supplementary S4 Table 3. Effects of canopy area and site preparation on mean seedling height across regeneration types. Shown are the direction of the effect (based on fixed-effect estimates), F-values with numerator (NumDF) and denominator (DenDF) degrees of freedom from Type II Wald F-tests (Satterthwaite approximation), and associated p-values.

Type	Factor	Effect direction	F (NumDF, DenDF)	p-value
Planted seedlings	Canopy Area	Negative (Estimate = -0.00111)	F = 7.16 (1, 59.38)	0.010 **
	Site preparation	Positive (Estimate = +0.472)	F = 55.48 (1, 37.52)	<0.001 ***
Direct seeded	Canopy Area	Negative (Estimate = -0.00111)	F = 12.27 (1, 63.77)	<0.001 ***
	Site preparation	Positive (Estimate = +0.468)	F = 23.50 (1, 59.01)	<0.001 ***
Naturally regenerated	Canopy Area	~0 (Estimate = +0.016, ns)	F = 1.14 (1, 33.78)	0.293
	Site preparation	Negative (Estimate = -10.50)	F = 13.53 (1, 38.33)	<0.001 ***

Notes: p < 0.05, ** p < 0.01, *** p < 0.001.

F-values are from Type II Wald F-tests with Satterthwaite df.

Response variable = Mean_H_diff (log-transformed for planted and seeded, raw for NR); weights = sum_ANTAL5 for planted, weights for seeded and NR.

"Effect direction" indicates the sign of the fixed-effect estimate.

"Canopy Area" = canopy area (mean of the total pixel area within a 20 m radius of each plot, m²).

"Site preparation" = mechanical site-preparation treatment (0 = without, 1 = with).

"Growth (Mean Height Difference)" is the difference in mean height between Inventory 1 and Inventory 5.