An alternative of soil scarification for forest reforestation; effects of soil replacement

Aoyama, K., Yoshida, T., and Kamitani, T.
Journal of Forest Research 14:58-62. 2009.

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Summary

I introduce “soil replacement”, which is the treatment following soil scarification

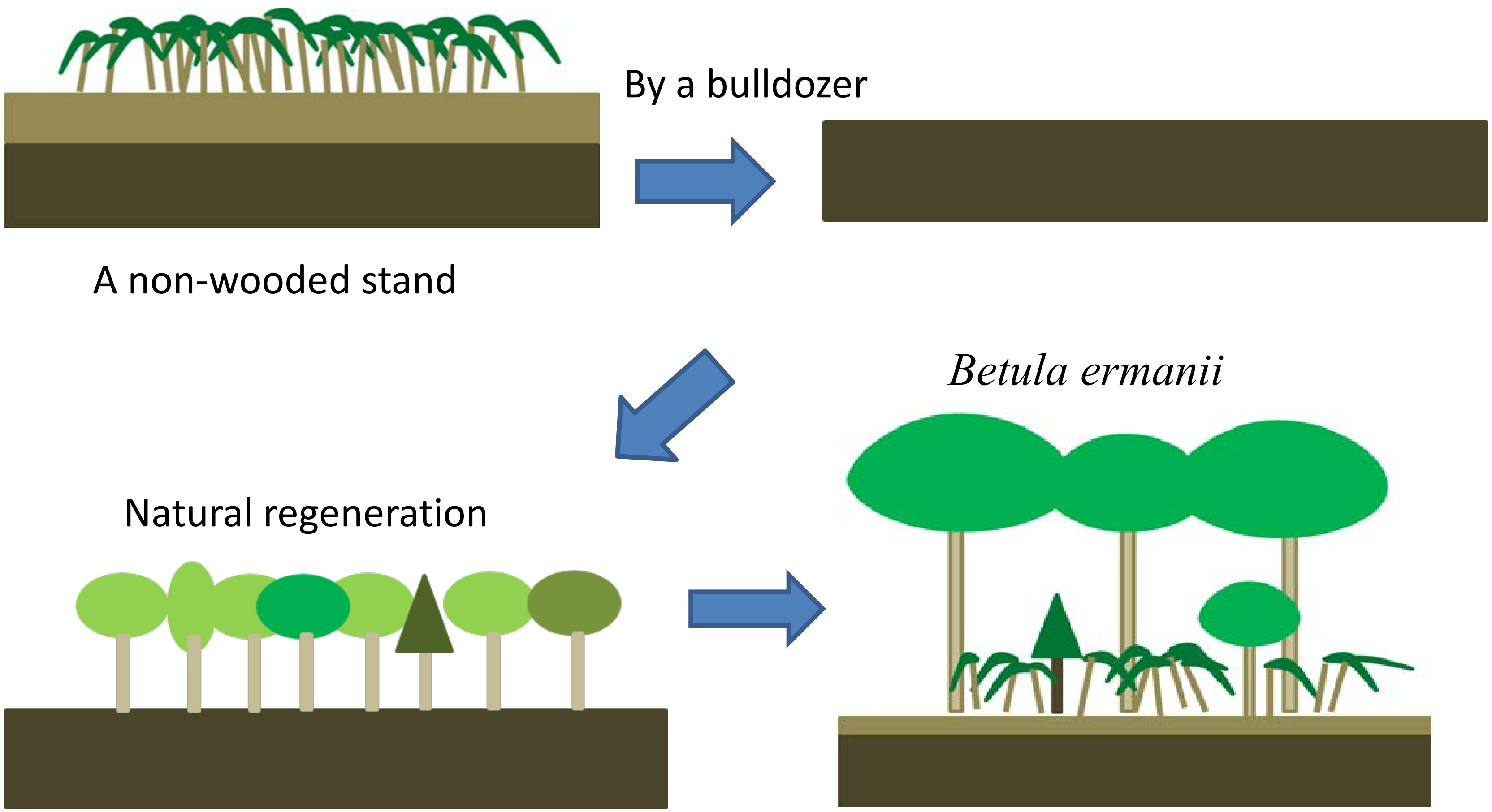
The contents in this slide

- What's soil scarification?
- The problems of soil scarification
- What's soil replacement?
- The comparison of the soil scarification followed by soil replacement with normal soil scarification

What's soil scarification ?

- Removing the surface soil with understory vegetation(mostly *Sasa* sp.) by a bulldozer and changing a non-wooded stand to a forest.

What’s soil scarification?



Low cost afforestation!

The problems of soil scarification

- An outflow of nitrogen for 2～3 years after the soil scarification
- A reduction of a carbon stock
- The domination

  by *Betula* sp.

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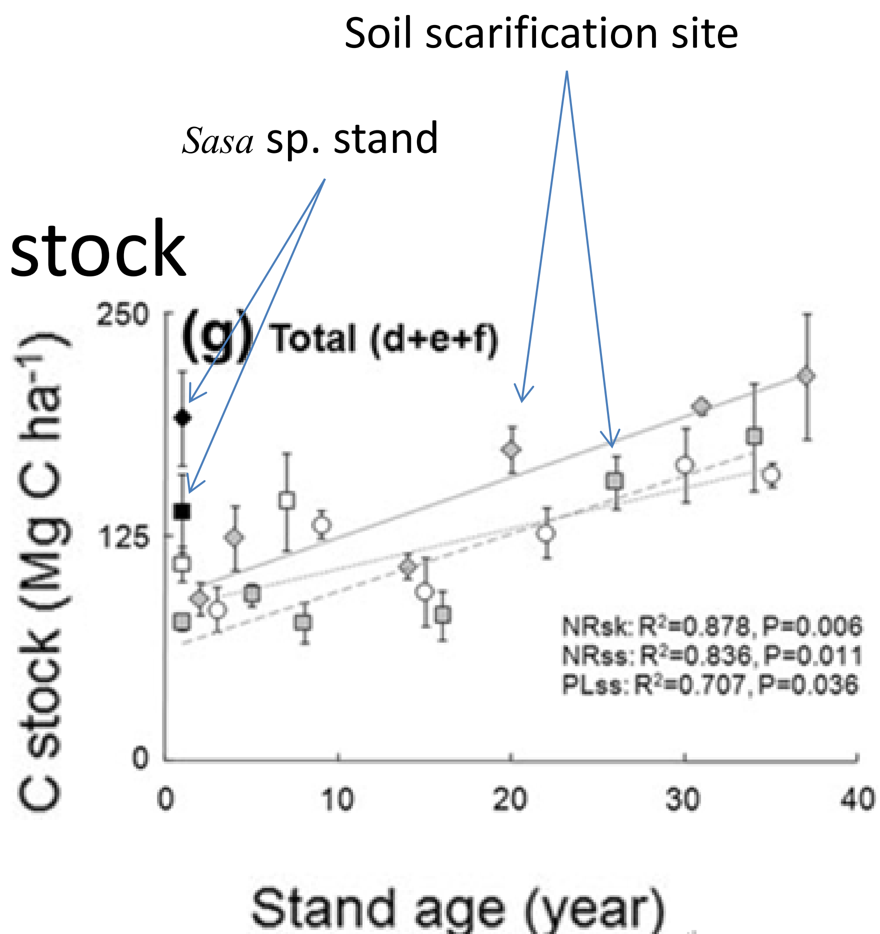
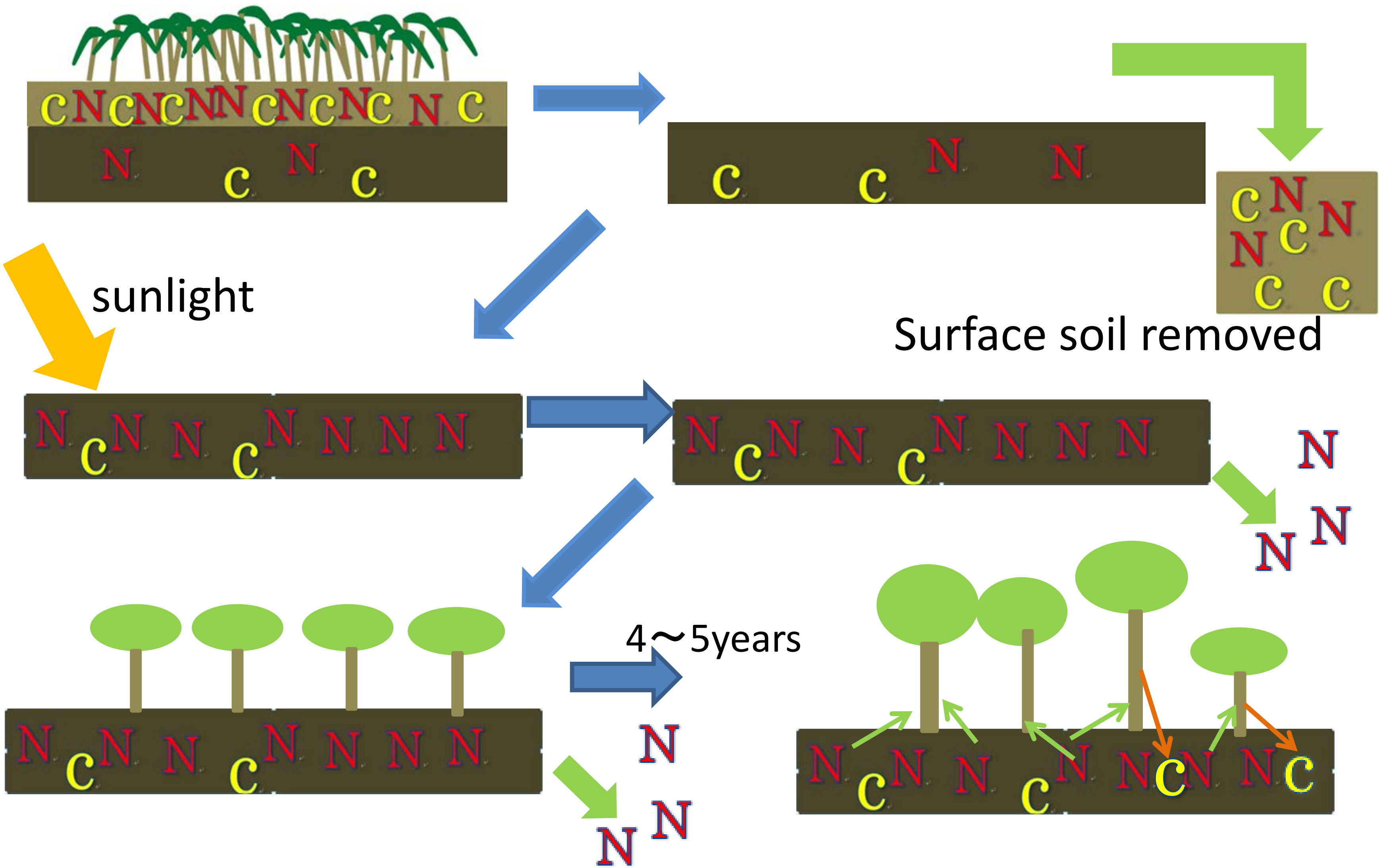
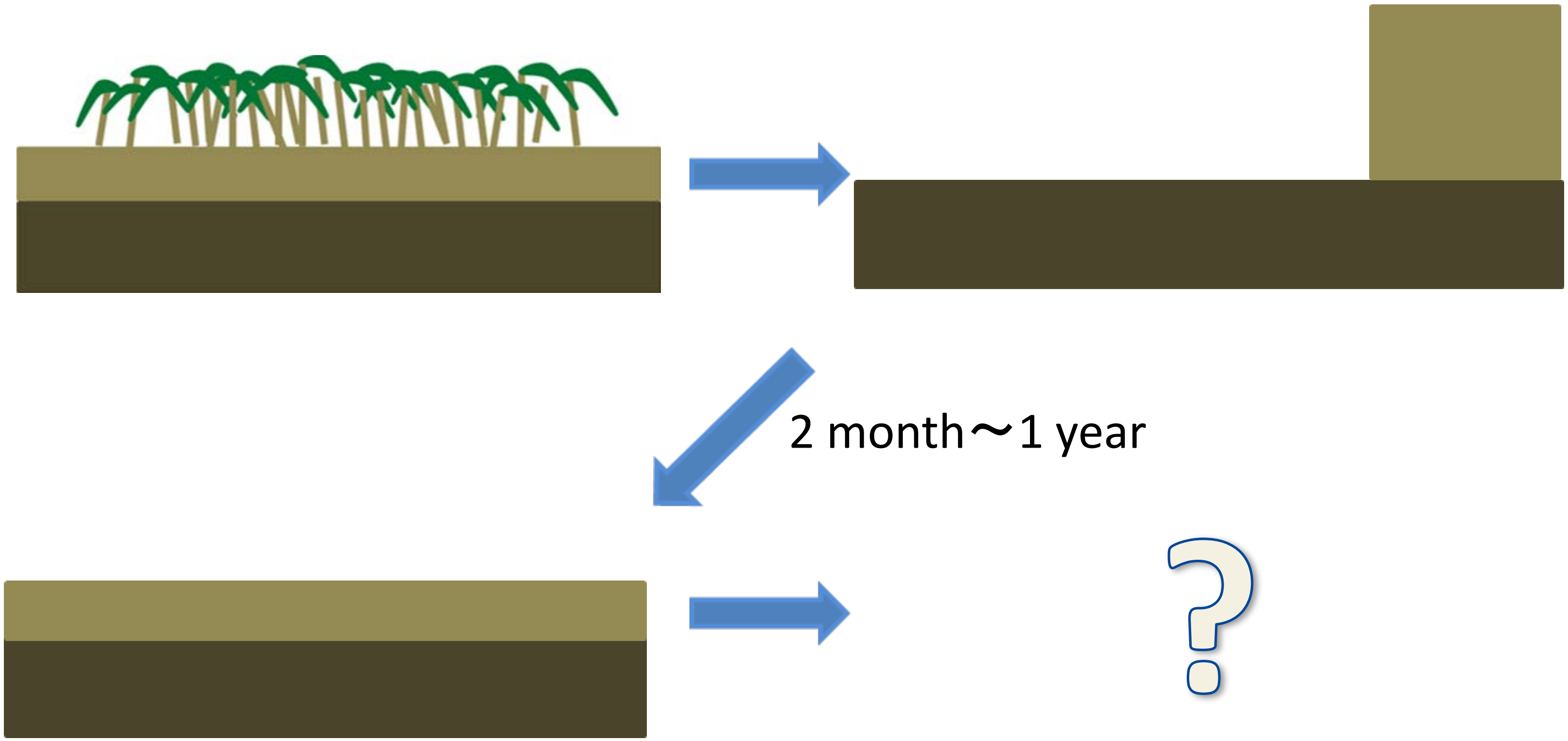


The problems of soil scarification



The trial to improve soil scarification

What’s soil replacement ?



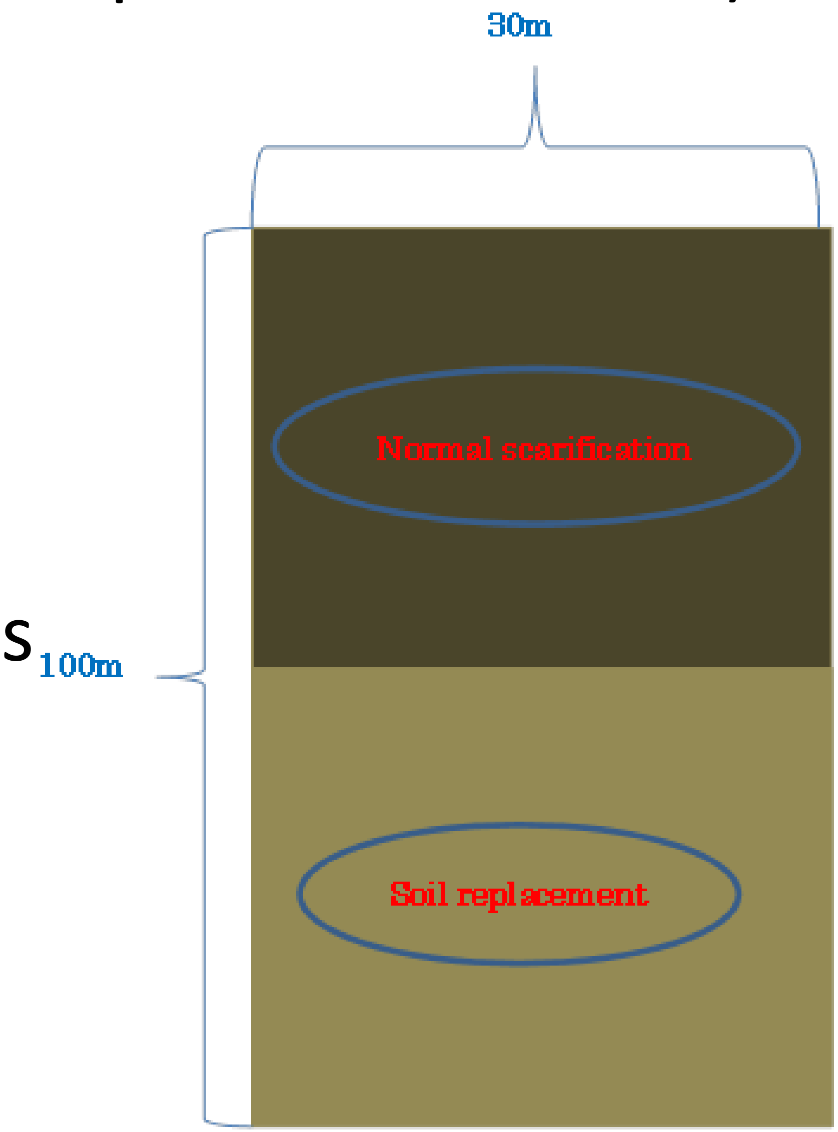
Hypothesis

- Rapid vegetation recovery due to the improvement of soil properties
- The increase of the carbon stock
- The diversification in tree species because of natural regeneration originating from buried seeds

Study site(in the Uryu Experimental Forest)

- In 1998, the surface soil was removed by a bulldozer.

- In 1999, the debris was replaced to the half of scarified area.



Methods(in 2004)

Soil properties

- The thickness of the organic layer
- Soil moisture content
- Soil hardness
- The inorganic nitrogen content

Overstory trees(with height equal to or larger than 130cm)

- DBH
- Stem analysis(the tallest tree in each plot)

Saplings(with height smaller than 130cm)

- Height

Results(soil properties)

Table 1 Mean soil properties in the 5-year-old soil-replaced site in comparison with the 6-year-old normally treated scarification site

	Unit	Soil-replaced site		Normal scarification site	
Soil moisture	%	38.6 ± 4.7	>	33.3 ± 2.8	*
Depth of organic layer	cm	16.8 ± 4.7	>	2.1 ± 1.3	*
N_{10} (0–5 cm depth)	–	11.1 ± 5.1	<	15.5 ± 3.8	*
N_{10} (5–10 cm depth)	–	10.4 ± 3.7		10.8 ± 1.6	ns
N_{10} (10–15 cm depth)	–	10.4 ± 3.2		11.3 ± 2.5	ns
N_{10} (15–20 cm depth)	–	10.4 ± 3.0		12.4 ± 3.7	ns
Nitrogen content	mg kg^{-1}	1.3 ± 0.5	>	0.2 ± 0.1	*

N_{10}' represents the soil hardness (knock frequencies demanded for every 5-cm penetration with a 10-kg weight). Asterisks indicate a significant difference at $P < 0.05$ (Wilcoxon test)

ns not significant

Soil properties in the soil-replaced site were preferable to the normal scarification site

Results

Table 2 Mean density and basal area of trees established in the 5-year-old soil-replaced site in comparison with the 6-year-old normally treated scarification site

	Soil-replaced site	Normally treated site	
Overstory trees (trees with height equal to or larger than 130 cm)			
Density (m^{-2})			
Betula ermanii	9.51 ± 4.32	0.15 ± 0.08	*
Salix sp.	0.17 ± 0.26	0.00	
Others	0.18 ± 0.22	0.01 ± 0.04	*
Total	9.86 ± 4.30	0.17 ± 0.06	*
Basal area (cm^2 m^{-2})			
Betula ermanii	657.7 ± 137.2	2.1 ± 3.7	*
Salix sp.	77.0 ± 207.4	0.0	
Others	12.0 ± 22.3	3.1 ± 9.2	*
Total	746.6 ± 202.6	5.2 ± 9.2	*
Saplings (trees with height smaller than 130 cm)			
Density (m^{-2})			
Acer mono	15.5 ± 13.6	12.2 ± 8.7	ns
Tilia japonica	2.2 ± 3.2	1.6 ± 1.3	ns
Betula ermanii	1.3 ± 1.3	0.8 ± 0.7	ns
Abies sachalinensis	0.8 ± 0.7	0.2 ± 0.3	*
Others	2.4 ± 3.3	1.9 ± 1.3	ns
Total	22.2 ± 20.4	16.6 ± 7.9	ns

Salix consists of *S. miyabeana* and *S. hultenii* var. *angustifolia*. Others in overstory trees include *Sambucus sieboldiana*, *Phellodendron amurense*, and *Tilia japonica*. Others in saplings include *Sorbus commixta*, *Kalopanax pictus*, and *Quercus crispula*

ns not significant

*Indicate a significant difference at $p < 0.05$ (Wilcoxon test)

Results(stem analysis)

- Significant differences in height growth

- The very slow height growth for 3 years after the soil scarification

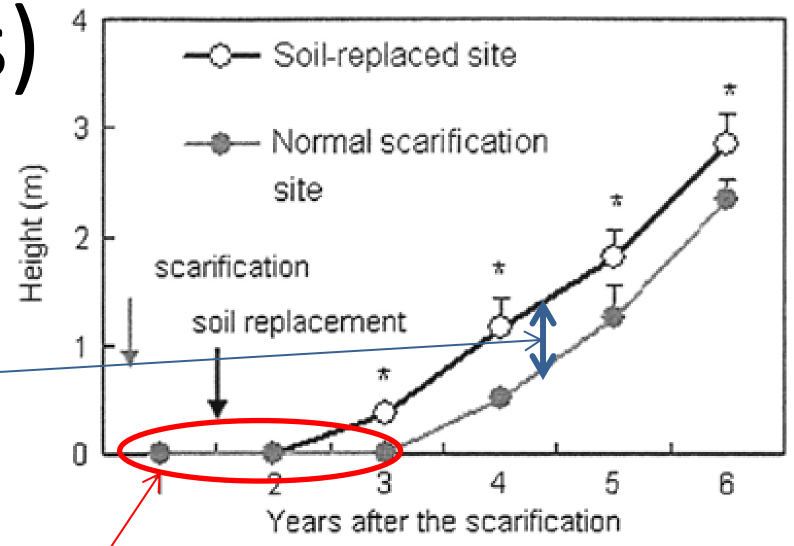
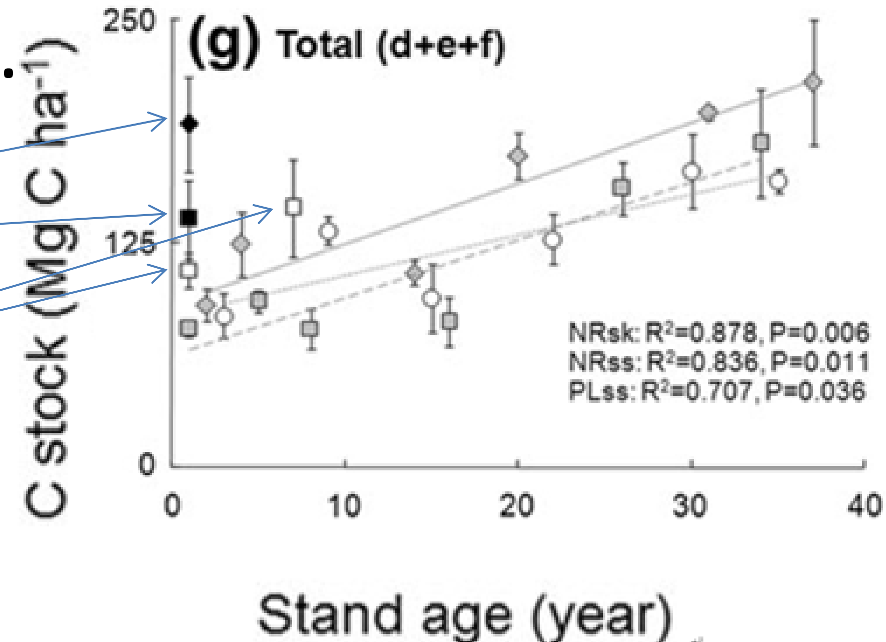


Fig. 1 Mean height growth of the highest *Betula ermanii* individuals in eight plots, respectively, for the soil-replaced site and the normally treated scarification site. *Asterisks* indicate significant difference between the treatments ($p < 0.05$; Wilcoxon test). *Bars* indicate standard deviations

Conclusion

- The soil replacement was effective in rapid vegetation recovery at least in this study .
- No difference in plant species diversity between the treatments.



Sasa sp. stand

Soil replacement site

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Conclusion

- The soil replacement treatment is in the trial stage.

- Extended censuses should be conducted.