VEGETATION AND SOIL DEVELOPMENT IN PLANTED PINE AND NATURALLY REGENERATED HARDWOOD STANDS 48 YEARS AFTER MINING

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Introduction

- Tree planting on severely disturbed or degraded lands can speed successional processes
- Small differences in the arrival time of species can have a significant “founder effect”
- Planting of vegetation in the initial stages of stand establishment may have significant effects on stand growth and development

Question

Does initial revegetation (specifically tree planting) result in long-term ecosystem recovery in a way that is similar to succession alone?

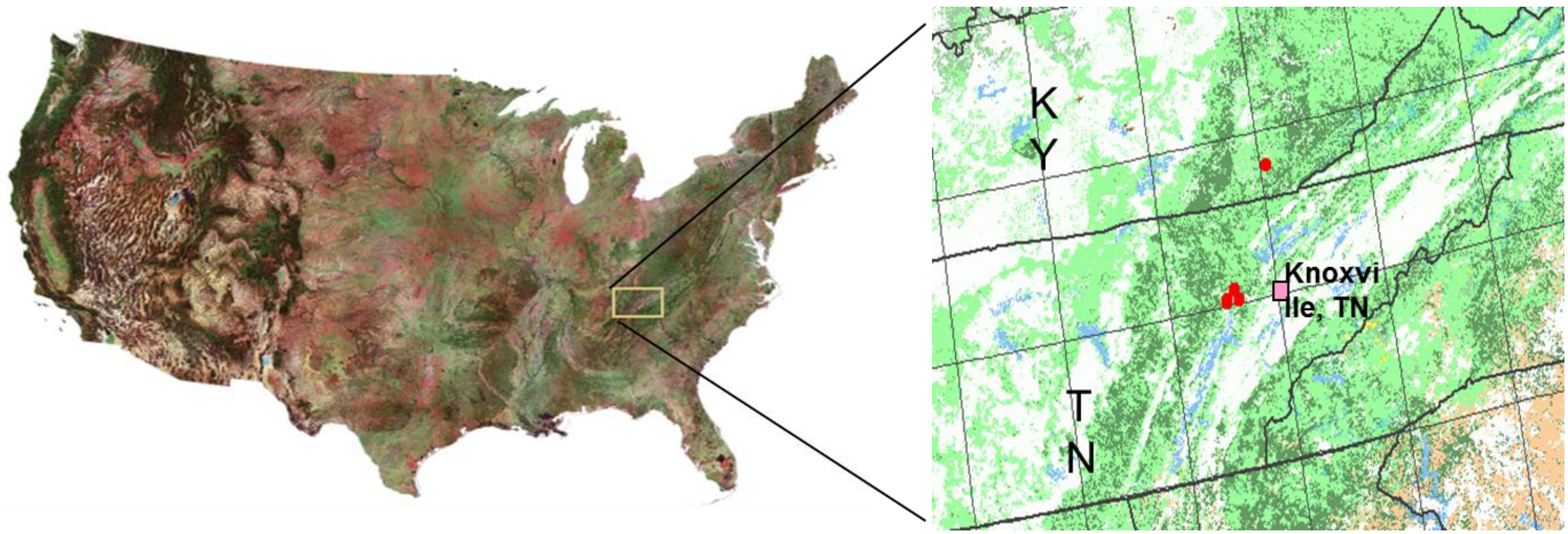
Young Science with changing reclamation methods

Old site unreclaimed

New site with compacted soil and grasses

Can we predict the speed at which ecological processes are re-established on sites reclaimed using the forestry reclamation approach?

Study sites



4 early (1960's) mine reclamation research sites: 3 in TN (R. Evans), 1 in KY (W. Vogul)

Methods

- On each mined site with research plots, 3 types of forest were identified, and 3 plots established in each:

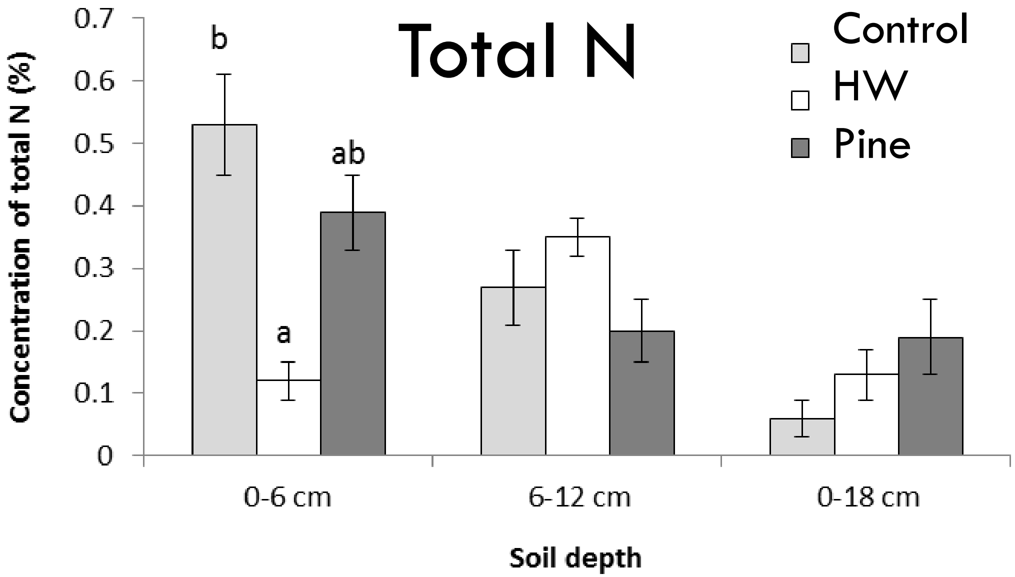
1. PINE - Pine plantings that were originally established as research plots.
2. HW - Naturally revegetated areas adjacent to the research plots.
3. CONT - Adjacent forest that was not disturbed by mining activities.

Methods

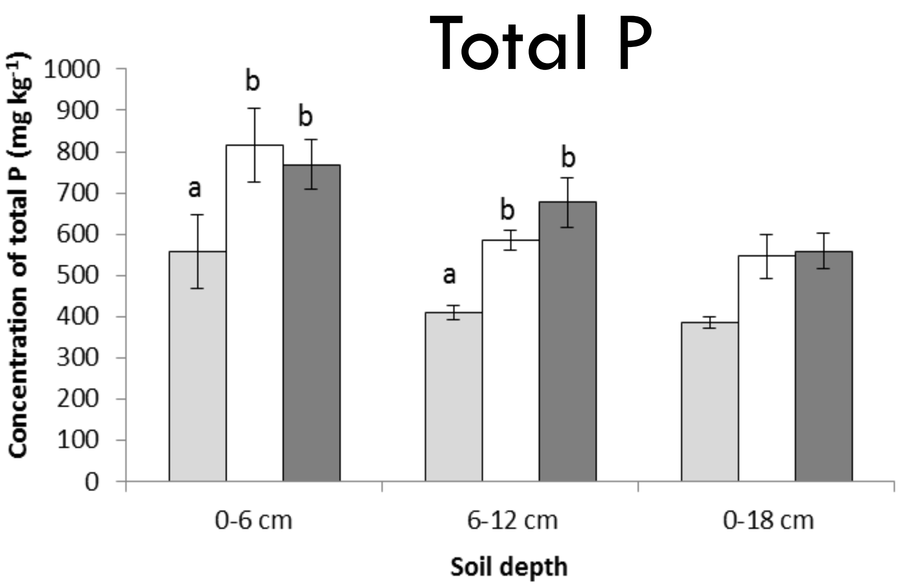
Measurements

- Field and lab soil respiration rates
- Soil temperature and moisture
- Overstory and understory species and BA
- Root mass
- Bulk density
- Soil chemistry
- Cellulose decomposition
- Soil invertebrates
- Site index

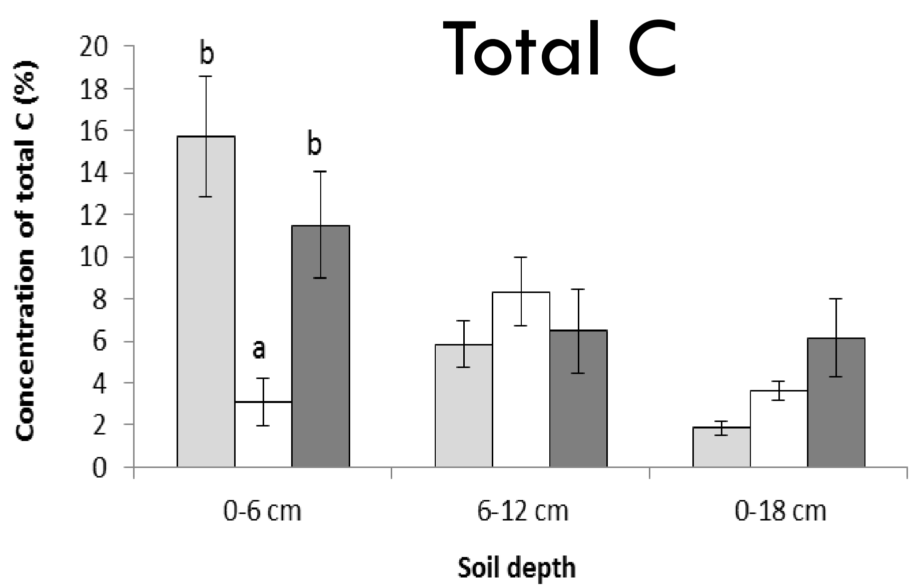
Results



Total N
Control
HW
Pine
Concentration of total N (%)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
b
a
ab
0-6 cm
6-12 cm
0-18 cm
Soil depth

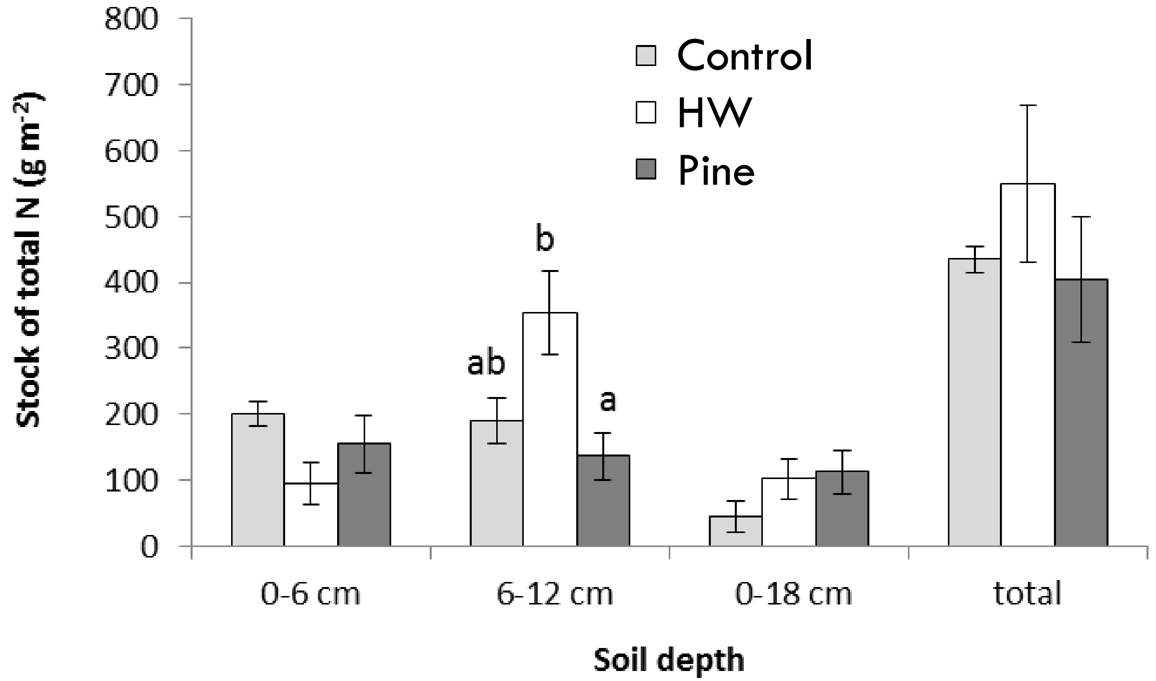


Total P
Concentration of total P (mg kg-1)
1000
900
800
700
600
500
400
300
200
100
0
a
b
b
a
b
b
0-6 cm
6-12 cm
0-18 cm
Soil depth

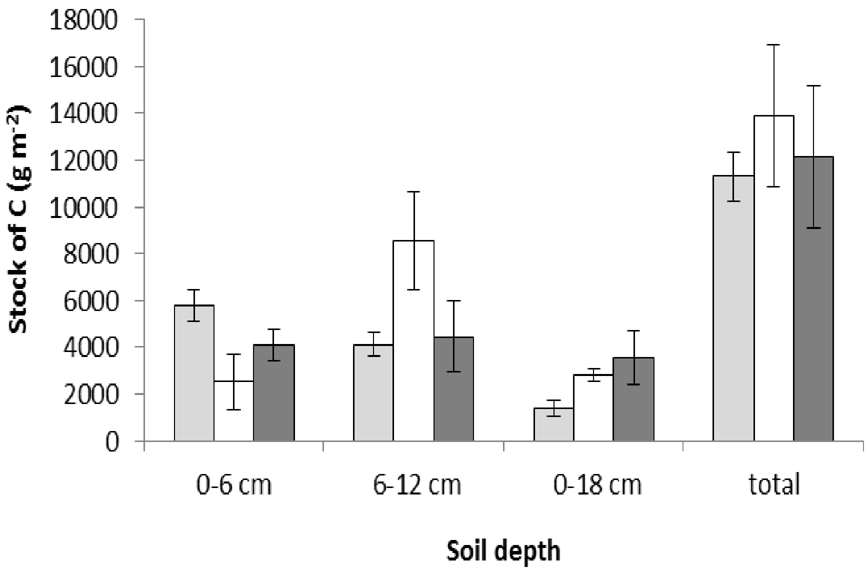


Total C
Concentration of total C (%)
20
18
16
14
12
10
8
6
4
2
0
b
a
b
0-6 cm
6-12 cm
0-18 cm
Soil depth

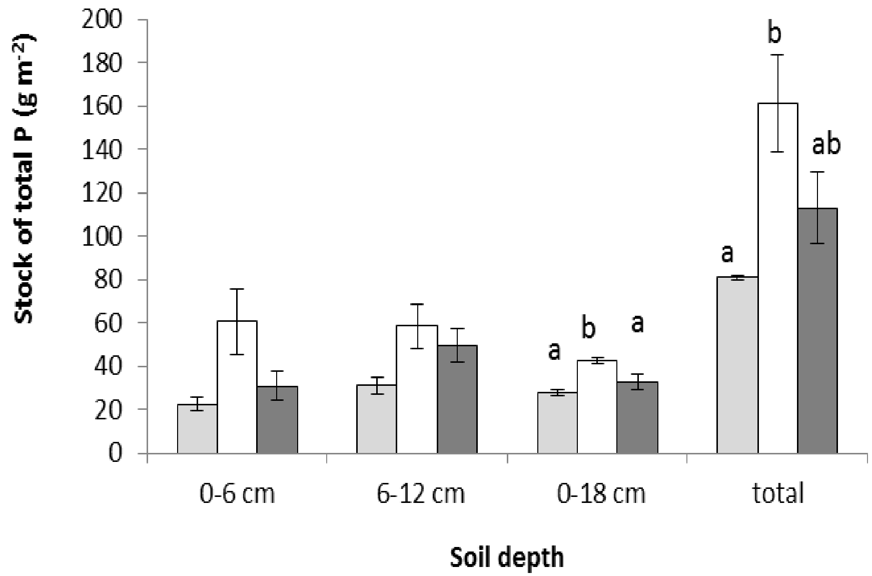
Results



Control
HW
Pine
Stock of total N (g m-2)
800
700
600
500
400
300
200
100
0
ab
b
a
0-6 cm
6-12 cm
0-18 cm
total
Soil depth

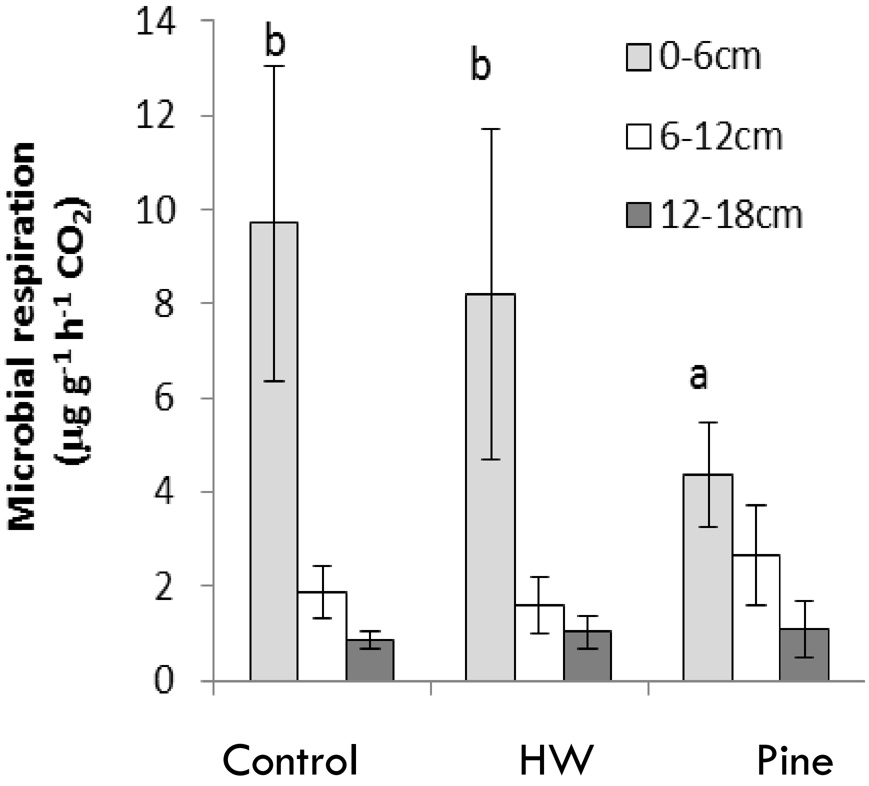


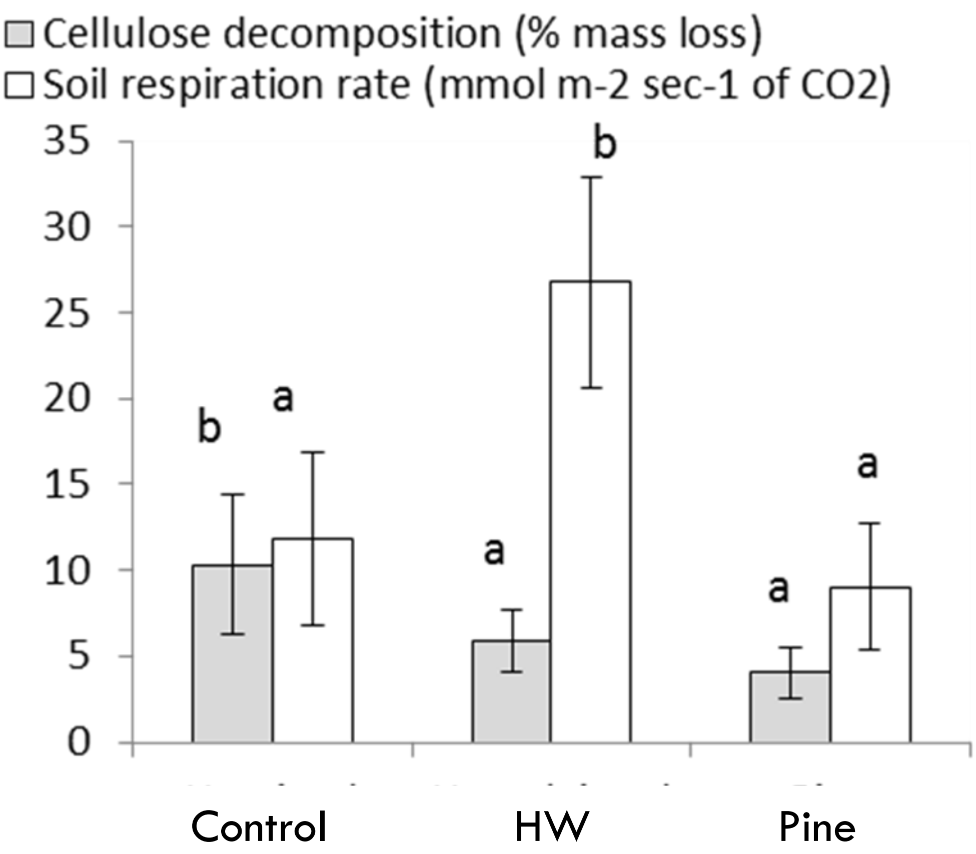
Stock of C (g m-2)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0-6 cm
6-12 cm
0-18 cm
total
Soil depth



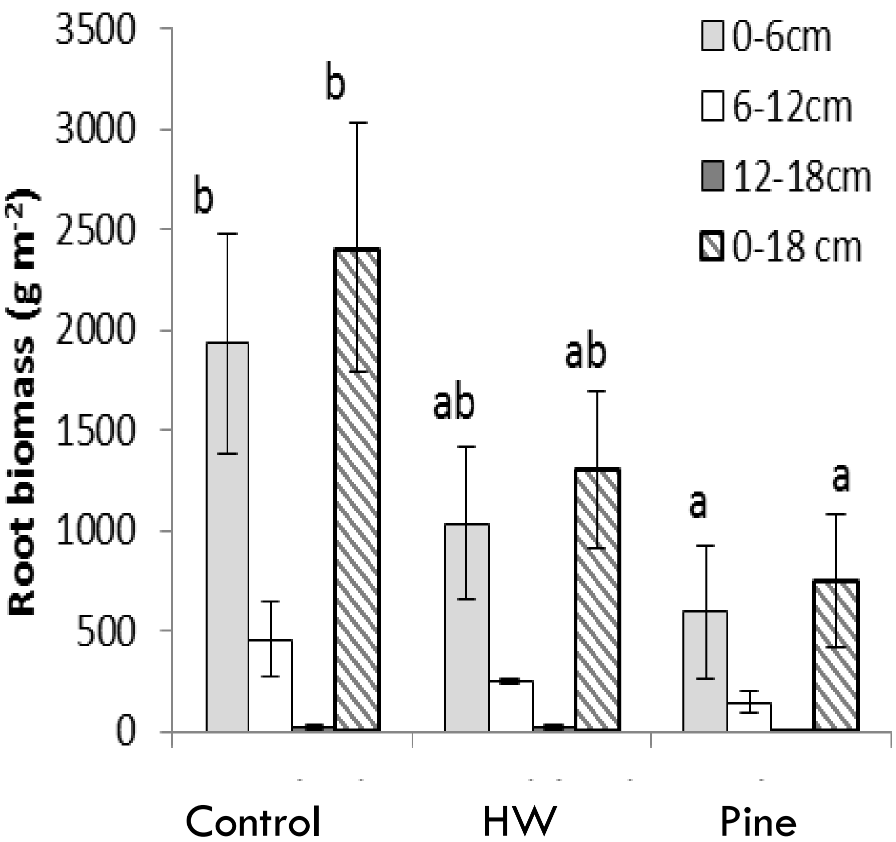
Stock of total P (g m-2)
200
180
160
140
120
100
80
60
40
20
0
a
b
a
a
b
ab
0-6 cm
6-12 cm
0-18 cm
total
Soil depth

Results


Microbial respiration (μg g-1 h-1 CO2)
14
12
10
8
6
4
2
0
b
b
a
0-6cm
6-12cm
12-18cm
Control
HW
Pine

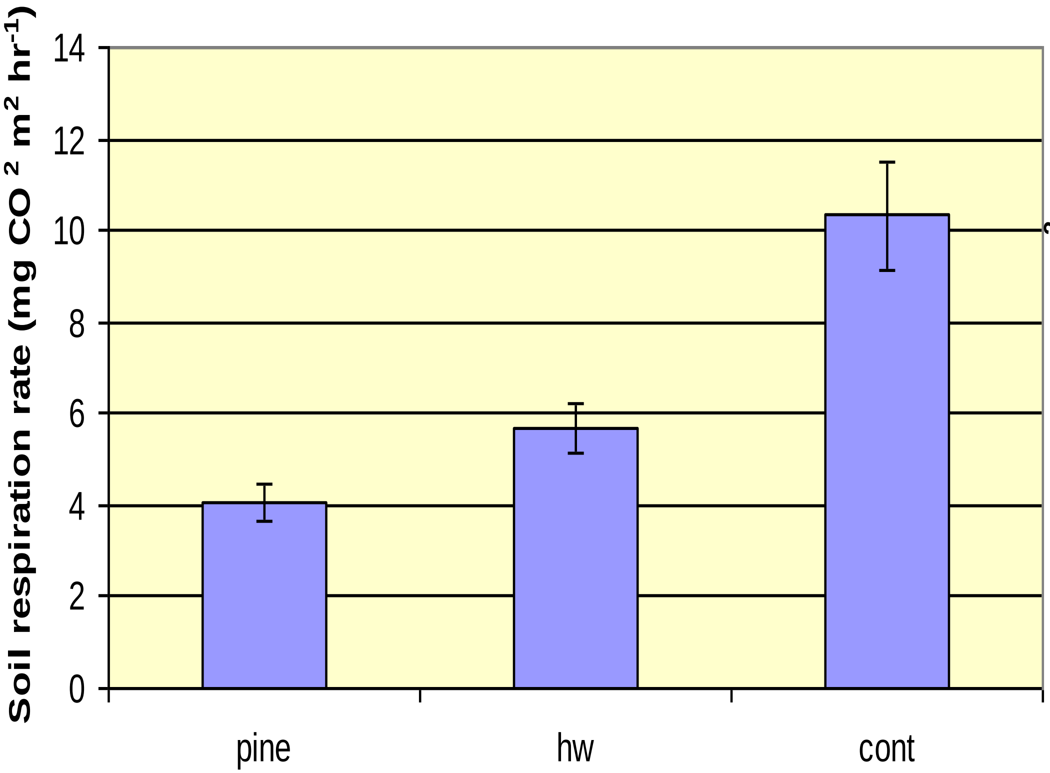

Cellulose decomposition (% mass loss)
Soil respiration rate (mmol m-2 sec-1 of CO2)
35
30
25
20
15
10
5
0
b
a
a
b
a
a
Control
HW
Pine

Results

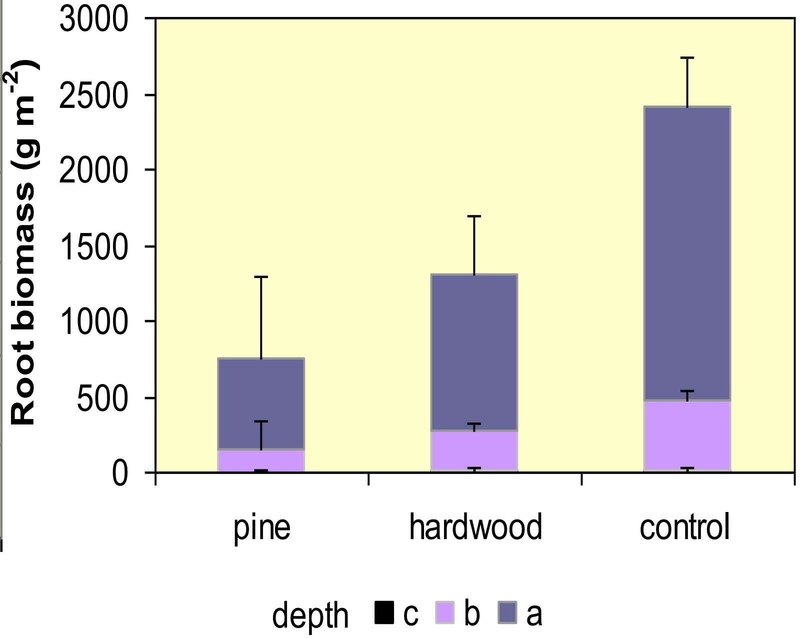


Corr. with field soil resp.	r	p
temperature at 6 cm	0.307	ns
moisture in 0-6 cm	0.033	ns
root biomass m^{-2} in 0-6 cm	0.485	0.0038
root biomass m^{-2} in 0-18 cm	0.496	0.0030
microbial respiration m^{-2} in 0-6 cm	0.093	Ns
microbial respiration m^{-2} in 0-18 cm	0.051	ns
microbial respiration CO^2 g^{-1}	0.327	ns

Results



Soil respiration rate (mg CO 2 m2 hr-1)
14
12
10
8
6
4
2
0
pine
hw
cont



Root biomass (g m-2)
3000
2500
2000
1500
1000
500
0
pine
hardwood
control
depth
c
b
a

Forest composition (basal area)

	Control		HW		Pine	
Pinus virginiana	1.30	±1.27 a	0	±0 a	8.33	±3.87 b
Liriodendron tulipifera	0.01	±0.01 a	6.47	±2.50 b	0.03	±0.03 a
Acer rubrum	12.45	±2.55 b	26.15	±4.37 c	3.11	±1.71 a
Quercus montana	18.48	±7.66 b	5.62	±5.62 ab	0	±0 a
Pinus strobus	0.96	±0.55 a	0	±0 a	5.44	±2.55 b
Total	39.60	±8.52 ab	50.63	±8.95 b	19.37	±3.34 a

Soil fauna

	Un-mined	Un-reclaimed	Pine	
Lumbricidae	0±0	26±17	32±19	*
Aranea	9±7	6±4	18±11	
Opilionidae	0±0	6±4	0±0	
Pseudoscorpiones	0±0	20±11	15±11	*
Chilopoda	67±34	53±13	44±34	
Diplopoda	6±4	55±33	9±7	
Diplura	6±4	9±7	12±5	
Symphyla	12±10	23±15	50±47	
Blatodea	0±0	3±3	3±3	
Isoptera	0±0	0±0	64±65	
Sternorhyncha	0±0	3±3	6±4	
Lepidoptera	26±20	35±22	6±7	
Formicidae	239±156	175±111	548±274	
Colleoptera	178±64	140±33	131±34	
Diptera	38±17	26±11	6±8	
Total macrofauna	580±164	580±138	942±310	

Conclusion

- Planting of trees can have a long-term impact on the development of the forest and soil community.
- In relatively narrow disturbances where natural forest regeneration occurs readily, tree planting may be of little long-term benefit to forest development.
- Below-ground biomass production may recover more slowly than above-ground productivity, and measurements of root mass or below-ground processes should be considered when developing long-term monitoring plans.
- Consider the potential that earthworms and other soil biota may be introduced through topsoiling or planting, as these may have long-term consequences on nutrient cycling.

Acknowledgements

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