Tree regeneration before and after restoration treatments in managed boreal *Picea abies* stands

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B4

Vegetation Science

選んだきっかけ

- 卒論のテーマ
  - 再造林放棄地での更新状況評価
    →更新不良ならば更新補助作業の実施
- 更新補助作業
  - 効果の有無？
  - 作用？

Introduction①-1 background

- Microsite
  - local features of the forest floor (a scale of 10～cm) characterize the seedling's growing environment

- Natural disturbances
  - create microsite legasies
    ⇒altering post-disturbance seedlings distribution

Introduction①-2 background

- Management activities
  - important consequences for microsite diversity & relative abundance ⇒affects seedling species composition, abundance, distribution
  - no information available about how the restoration treatments affect seedlings abundance and distribution among microsites

Introduction②
objects

1. How seedlings distribution among microsites was affected ?
2. Are there the potential change in seedling distribution among microsites resulting from restoration treatments between upland & paludified biotopes ?
3. seedling density & distribution among microsites in managed *Picea abies* stands before & shortly after restoration treatments

Material&Methods②
Experimental design

- Field-2 type
  - upland, paludified
- Cutting-4 type
  - uncut, low-CWD, intermediate-CWD, high-CWD
- Fire-2 type
  - unburned, burned

Material&Methods①
Study area

- Location
  - Southern Finland(61°N, 25°E)
- *P. abeis* -dominated mature managed forests
  - Area: 1-3ha
  - Age: 60-80 year, Ave.80
  - Vegetation: *Mytillus* type (MT)
    Oxalis-Mytillus type (OMT)
  - Mixed species composition: Betula spp. etc.
  - Soil: upland biotopes→ mineral soil
    paludified biotopes→ peat soil

Oxalis-Mytillus type

Picea abies

Materials & Methods③ Sampling

- Time
  - Pre-: summer(2001), Post-:autumn(2003)
- Plot design
  - 30m×50m, including 5m buffer zone
  - Sampling area: 2m×40m
- Target
  - Seedlings(10-200cm）
- Contents
  - species, height, microsite, vitality, damege causes

Results①

seedling density & distribution among microsites prior to restoration treatments

- Density
  - no statistically significant differnces in total seedlings density between stands

- Distribution
  - 1. level ground
    2. mound
  - on or next to stumps (in paludified biotopes)

Table 1. Pre- and post-treatment seedling density (stems ha $^{-1}$) and standard error. Note: $n = 3$, except for the following pre-treatment combinations: unburned uncut in paludified biotopes, unburned and burned intermediate-CWD in both biotopes where $n = 2$, and burned uncut in both biotopes where $n = 1$.

	Upland				Paludified			
	Pre-treatment		Post-treatment		Pre-treatment		Post-treatment	
	Mean	Std err.	Mean	Std err.	Mean	Std err.	Mean	Std err.
Unburned								
Uncut								
P. abies	2125	1283	1375	617	17625	7250	9208	3759
Betula spp.	0	0	0	0	750	500	333	110
Deciduous	4458	1980	3333	1001	2375	1125	2833	1037
Low-CWD								
P. abies	4583	3667	5000	4206	5833	1158	5458	1417
Betula spp.	417	417	1708	758	1458	561	12417	3908
Deciduous	1917	671	2042	758	3667	1064	6125	1305
Intermediate-CWD								
P. abies	5188	3437	3333	1585	5042	1146	3875	1231
Betula spp.	125	125	3458	2842	708	522	1625	439
Deciduous	3438	1438	3167	1300	2792	491	2583	507
High-CWD								
P. abies	3417	712	2208	481	6458	1341	4542	1312
Betula spp.	3125	1665	1583	983	1125	331	5542	3949
Deciduous	4875	1231	4042	1086	2542	1341	1375	804
Burned								
Uncut								
P. abies	2667	1774	1333	712	9750	9000	9667	7619
Betula spp.	375	260	1333	686	1042	292	958	423
Deciduous	3208	726	3000	1422	1917	655	2000	947
Low-CWD								
P. abies	7500	3903	42	42	3208	1869	792	730
Betula spp.	1417	830	8125	6097	2125	1583	11167	5357
Deciduous	1000	315	1250	439	4417	1568	2250	732
Intermediate-CWD								
P. abies	8125	3514	0	0	9417	3908	4625	2940
Betula spp.	167	167	1083	417	4000	331	45042	15152
Deciduous	2708	1590	458	182	875	439	917	583
High-CWD								
P. abies	2750	629	42	42	4375	804	1167	1105
Betula spp.	167	110	875	696	708	273	8625	1134
Deciduous	1708	481	875	289	2750	1003	1125	382

Results②-1

Effect of cutting and fire on seedlings density & distribution among microsites

Density

- Cutting
  - *Betula* spp. (paludified): unburned × low-CWD ＋
    burned × intermediate-CWD
    ＋
    uncut －
- Fire
  - *P. abies* (upland): －
- No significant change
  - *P. abies* (paludified), other deciduous species

Results②-2

Effect of cutting and fire on seedlings density & distribution among microsites

P. abies

Betula spp.

Other deciduous species

Table 4. Differences between pre- and post-treatment seedling distribution among microsites, according to log-likelihood tests (G). Note: NS = not significant; – = could not be tested.

	Upland			Paludified		
	G	*df*	*p*	*G*	*df*	*P*
P. abies						
Unburned uncut	0.94	2	NS	51.55	5	<0.001
Unburned low-CWD	20.03	2	<0.001	37.07	5	<0.001
Unburned intermediate-CWD	46.27	3	<0.001	17.72	3	<0.001
Unburned high-CWD	31.47	5	<0.001	58.85	5	<0.001
Burned uncut	0.04	2	NS	42.95	5	<0.001
Burned low-CWD	–	–	–	17.00	1	<0.001
Burned intermediate-CWD	–	–	–	89.58	5	<0.001
Burned high-CWD	–	–	–	6.27	3	<0.05
Betula spp.						
Unburned uncut	–	–	–	–	–	–
Unburned low-CWD	0.80	1	NS	35.35	6	<0.001
Unburned intermediate-CWD	–	–	–	7.27	1	<0.005
Unburned high-CWD	68.45	4	<0.001	4.47	2	NS
Burned uncut	–	–	–	–	–	–
Burned low-CWD	17.65	3	<0.001	19.93	2	<0.001
Burned intermediate-CWD	–	–	–	155.31	7	<0.001
Burned high-CWD	–	–	–	25.14	2	<0.001
Other deciduous species						
Unburned uncut	3.51	2	NS	1.16	1	NS
Unburned low-CWD	8.74	2	<0.02	18.72	3	<0.001
Unburned intermediate-CWD	27.79	2	<0.001	20.59	2	<0.001
Unburned high-CWD	29.07	4	<0.001	11.53	2	<0.005
Burned uncut	4.02	1	<0.05	1.04	1	NS
Burned low-CWD	2.06	1	NS	8.30	2	<0.02
Burned intermediate-CWD	4.01	1	<0.05	18.85	2	<0.001
Burned high-CWD	3.86	1	<0.05	3.49	2	NS

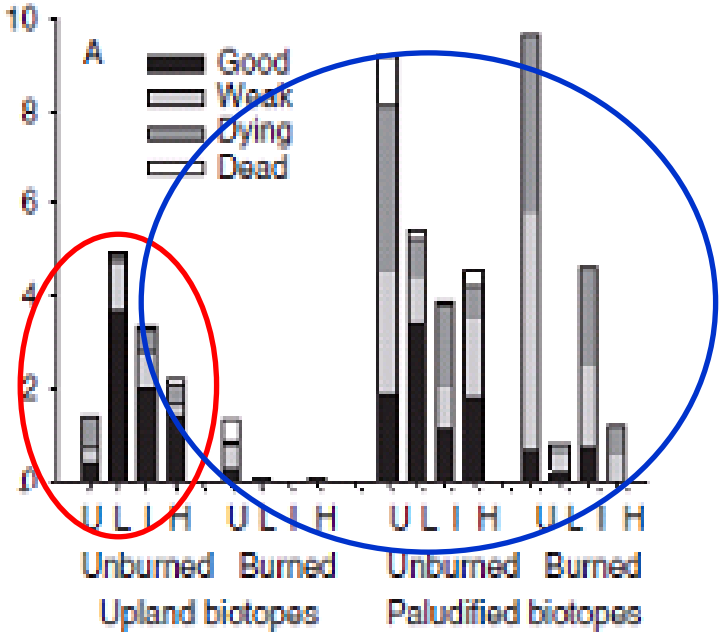
- *P.abies*
  - ground, mound: −
  - unburned: under crown +
    burned: under crown +
    (intermediate-CWD × paludified)
- *Betula* spp.
  - ground: +
  - mound, next to CWD, under crown: + (modest)
- Other deciduous species
  - ground, mounds: −
  - next to CWD, under crown: +

Results③-1

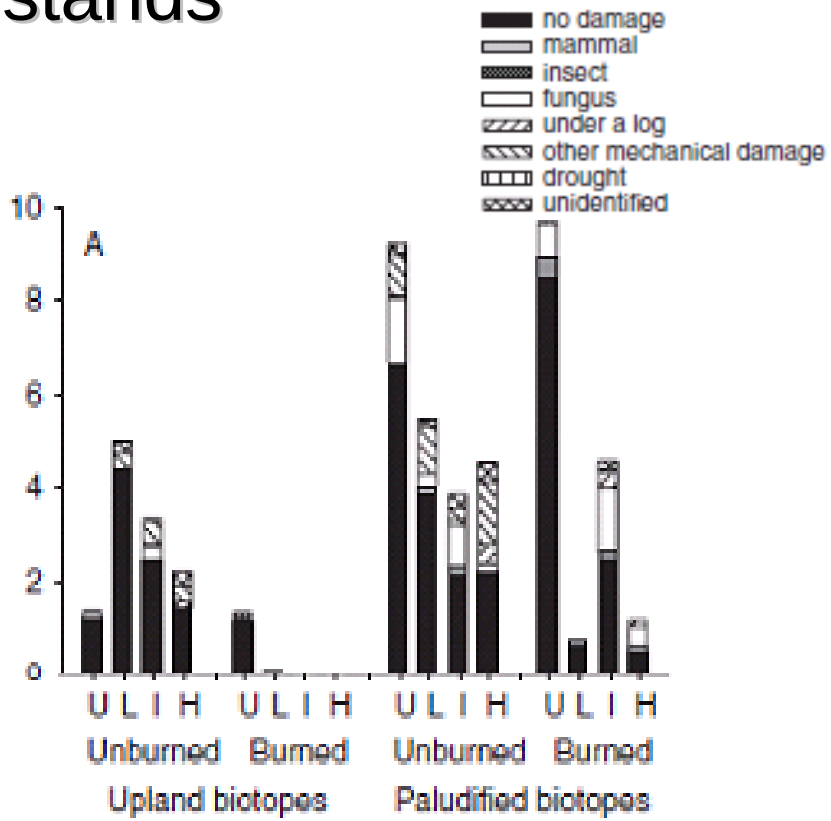
Seedlings vitarity & cause of damage in post-treatment stands

P.abies

seedling density (100 stems / ha)



vitality

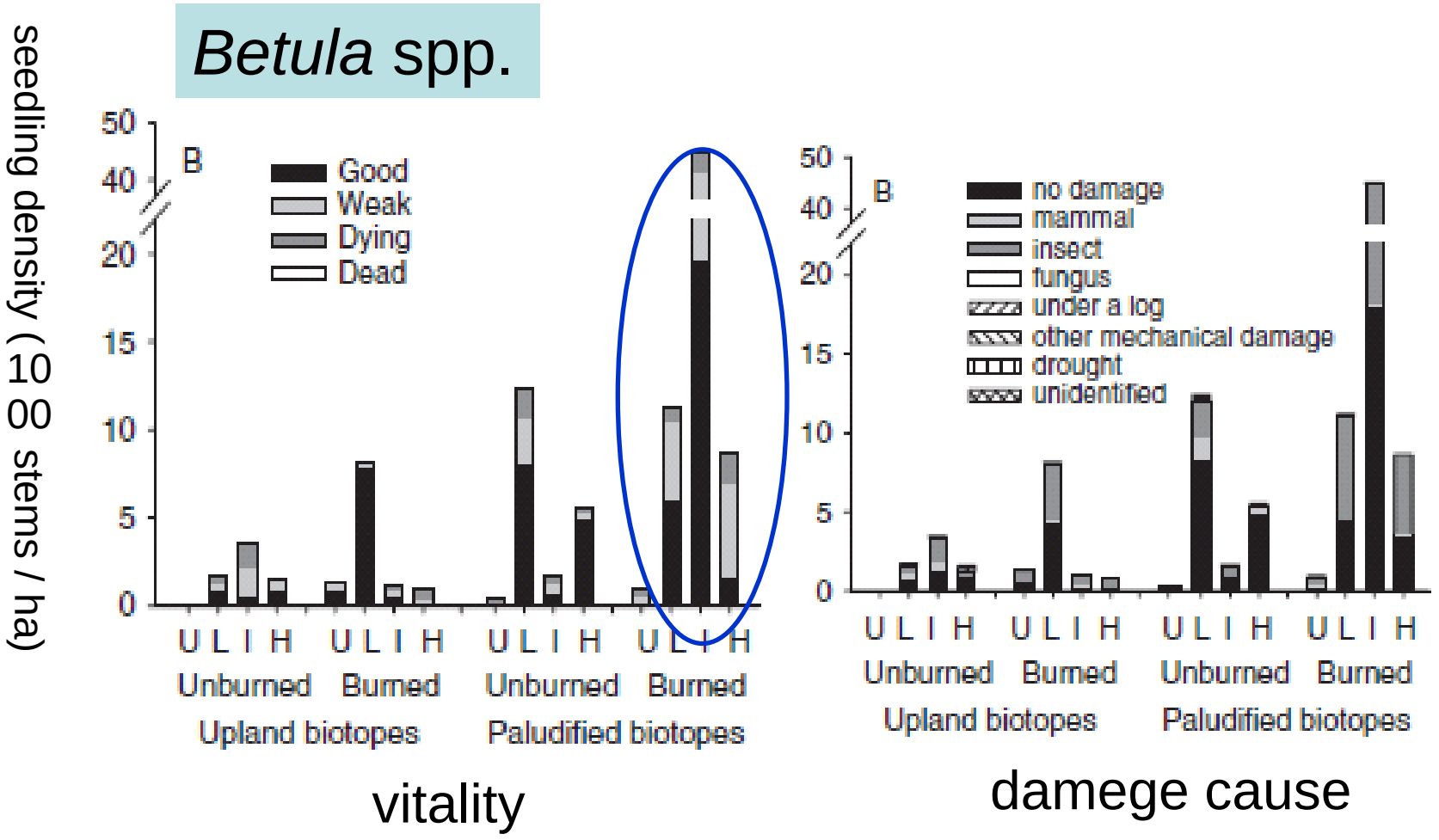


damege cause

Results③-2

Seedlings vitarity & cause of damage in post-treatment stands

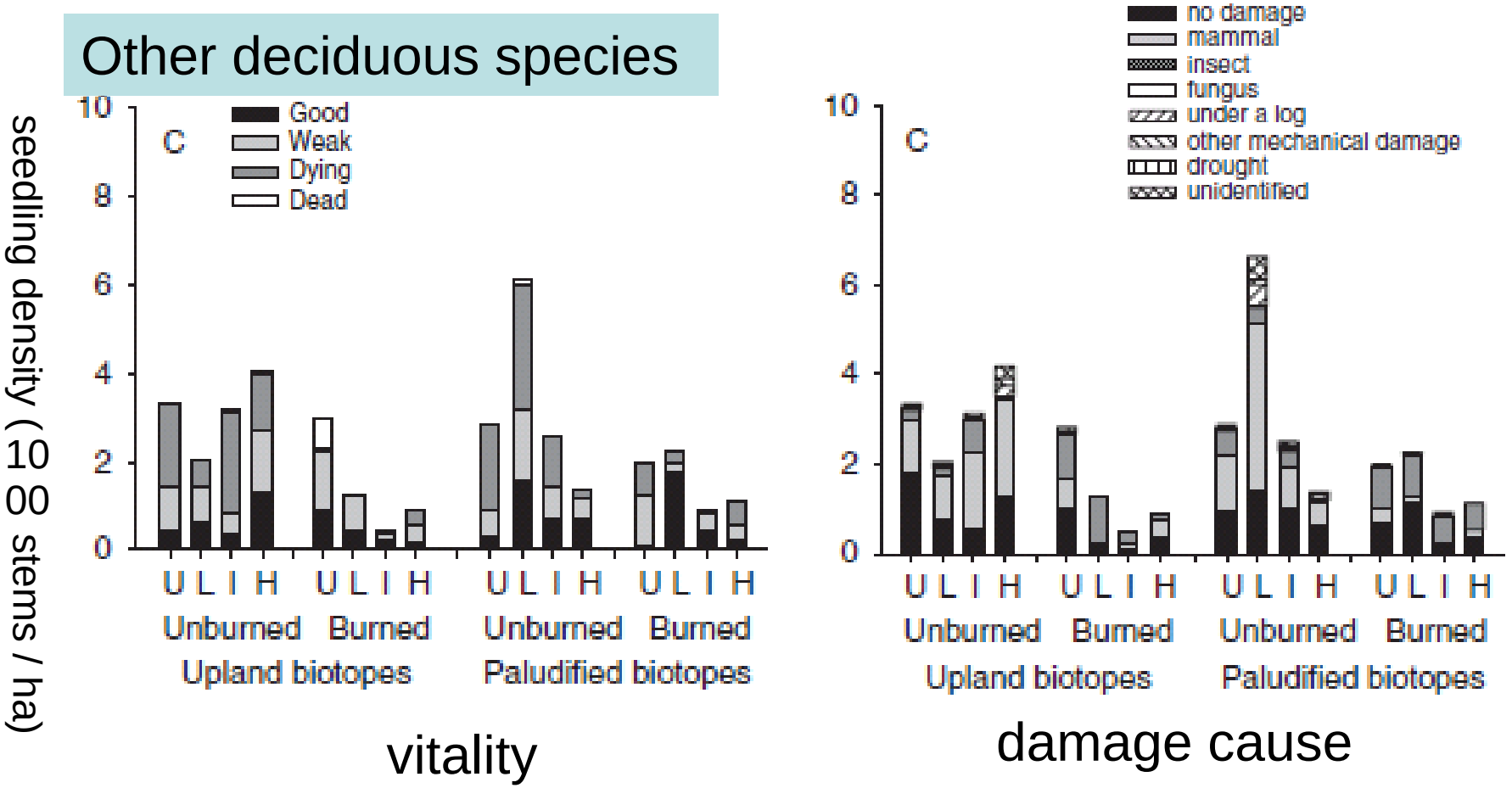
Betula spp.



Results③-3

Seedlings vitality & cause of damage in post-treatment stands

Other deciduous species



vitality

damage cause

Discussion①-1
Pre-treatment patterns

- Level ground
  - most abundant microsite class
- Mound
  - favorable for seedlings establishment in wet habitat
  - reduce competition with other vegetation
- On or next to stumps/uprooting spots
  - decayed stumps
  - exposed mineral soil (good for seedling emergence)

Discussion①-2
Pre-treatment patterns

- Depression in paludified biotopes
  - too wet to sustain living seedlings

- On or next to CWD
  - too small-diameter for seedlings to establish or to offer protection

Discussion②-1

Post-treatment patterns

- CWD
  - protect from fire, against herbivory
  - post-treatment CWD→ decay stage was earlier

    ⇒not a suitable substrate
- Fire
  - thin humus layer, release of soil nutrients, reduce competition between other vegetation ⇒enhance regeneration conditions
- Paludified biotopes
  - colonization center and seed sources after fire treatment

Discussion②-2

Post-treatment patterns

- Few seedlings growing on the uprooting spots
  - few burned & exposed soil→ too dry
  - ash→ the substrate toxic to seedlings hydrophobic
- Damage causes
  - burning: destroy injured seedlings
  - insects: attracted by warm places (e.g. burned forest)
  - animals: unburned
  - fungi: only *P. abies*, moist conditions

Conclusions

- Density
  - cutting: no change
  - fire: *P. abies*, *Betula* spp. …change
  - other deciduous species …no change
- Distribution
  - among more classes of microsite after restoration treatments

- Imitate natural processes ⇒Variability
- Importance of paludified biotopes
- To achieve the goals set for restoration at the stands & landscape levels