Functional significance of nitrogen productivity of boreal forest plants

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Aim of the study

- to determine TRAITS of plant species explaining CHANGE of boreal forest vegetation

Focus:

- annual above-ground biomass production (NPP)
- nitrogen productivity (NP)
- nitrogen losses due leaf litter production
- residence time (MRT) of nitrogen in plant biomass

in plant species representing different functional groups

Definitions

- Nitrogen productivity (A) = annual biomass production per a nitrogen unit measured in the total living aboveground biomass (Aerts 1990)

  $A = NPP_A/N_{pool}$

- Resorption rate of leaf nitrogen = 1-(N content in senescent leaves/N content in green leaves)
- Mean residence time (MRT) = the time which nitrogen is bound in the plant biomass (on leaf level).

  MRT = average N pool (aboveground)/N loss (leaves)
- Nutrient use efficiency (NUT) = A * MRT

Plant functional groups

- *Vaccinium myrtillus*
- *Empetrum nigrum*

- *Vaccinium vitis-idaea*

- *Calluna vulgaris*

- *Maianthemum bifolium*

- *Deschampsia flexuosa*

- *Calamagrostis arundinacea*

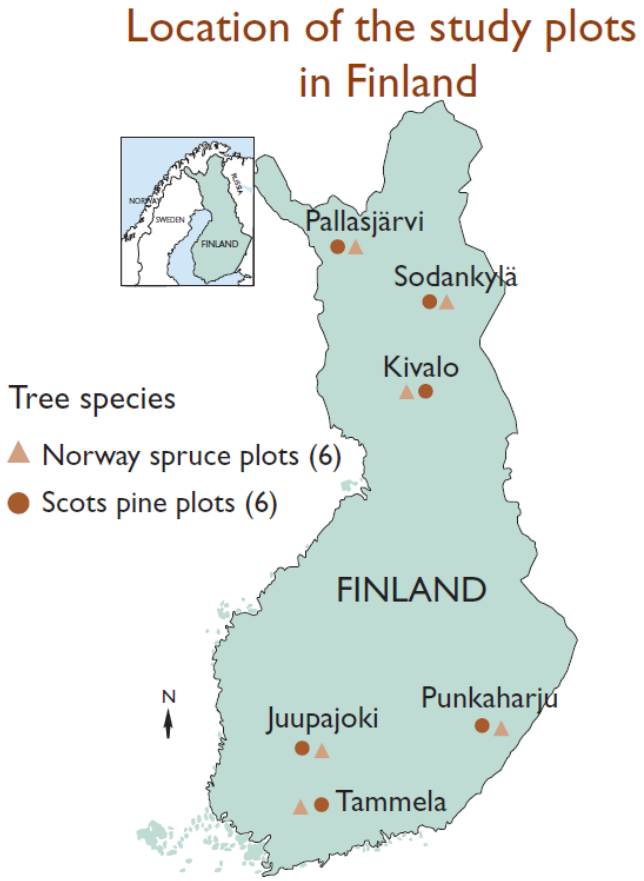
Hypothesis

- Grasses and herb species have higher nutrient productivity than dwarf shrubs both in nutrient-rich and nutrient-poor environment
- Nitrogen resorption from senescent leaves is higher in evergreen species than in deciduous species
- Evegreen species *Vaccinium vitis-idaea* has higher nutrient-use efficiency than deciduous *V. myrtillus* in nutrient-poor environment

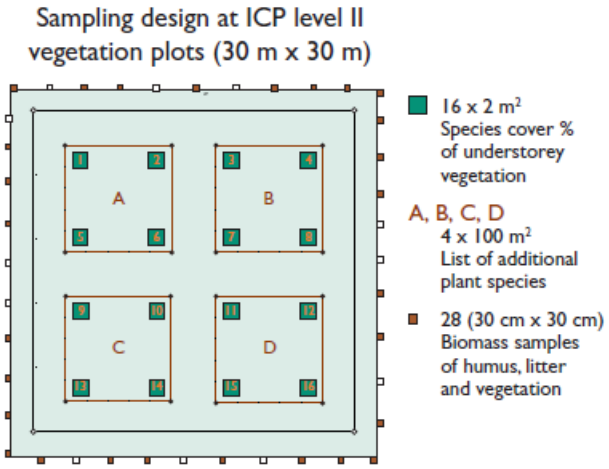
Eckstein & Karlsson 1997: Above-ground growth and nutrient use by plants in a subarcit environment: effects of habitat, life-form and species. Oikos 79:311-324.

Data

- The biomass samples were collected from six Scots pine and six Norway spruce plots in Finland (eleven plots belonged to ICP Forests Level II network) once in the years 2002 and 2003 .
- Half of the plots were located in the north and the other half in the south. The site types of the plots ranged from poor to rich fertility level.



Method 1: biomass samples in summer



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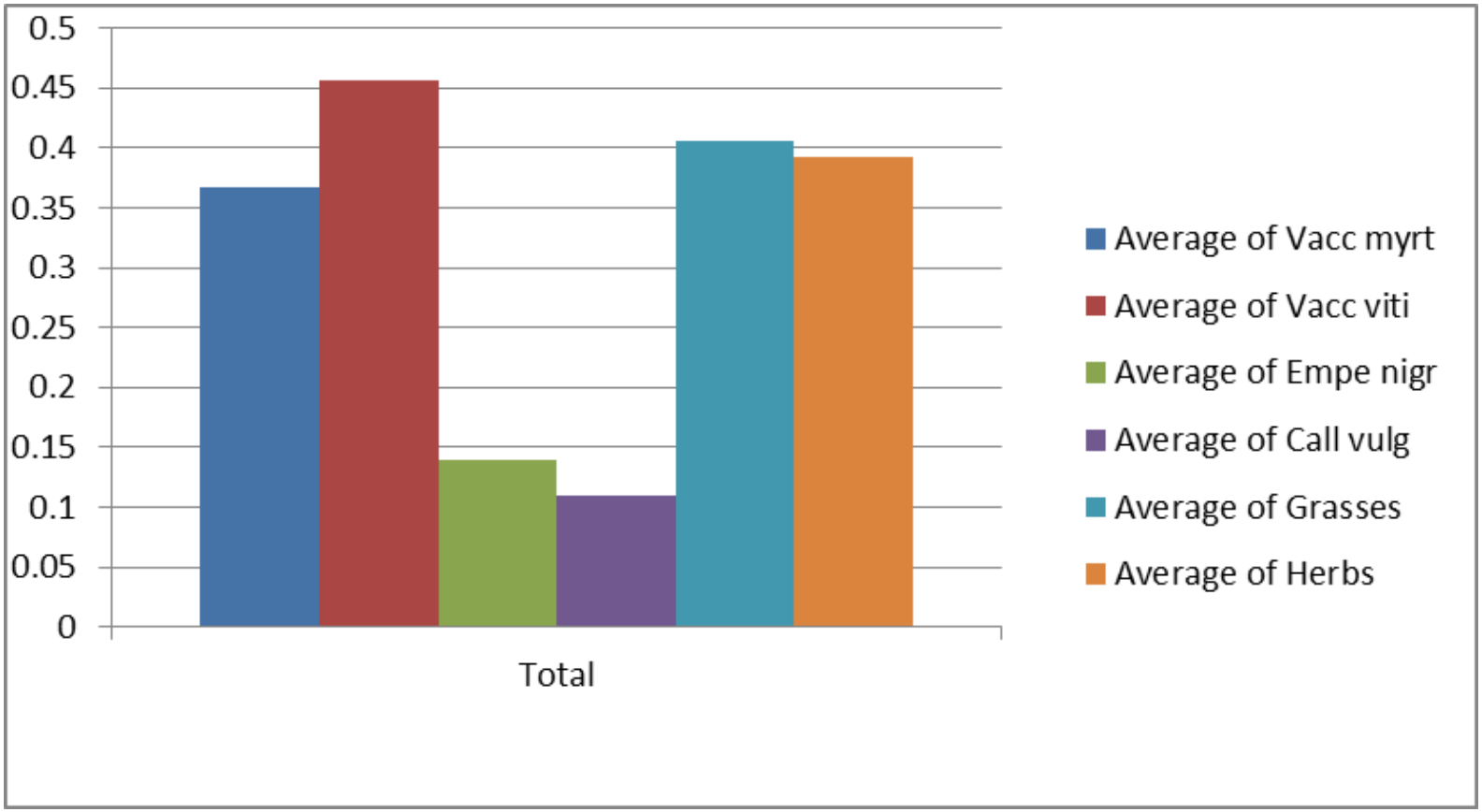
Result 1: Nitrogen productivity: biomass production g dw m^{-2} yr^{-1} / 1 g N in aboveground

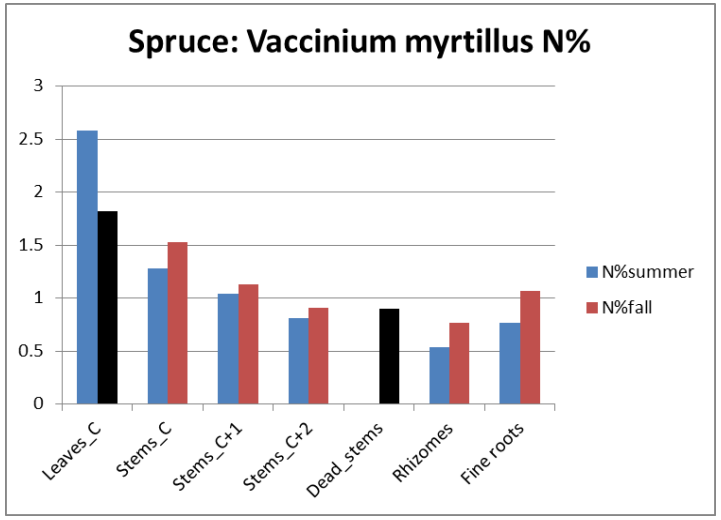


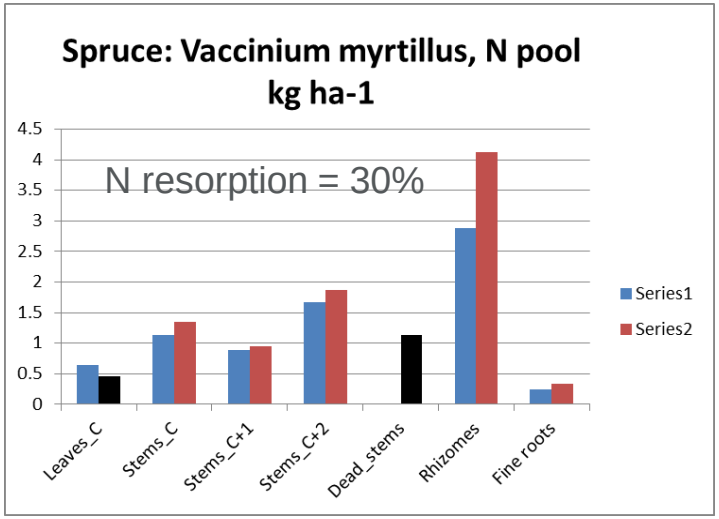
Method: sampling of plant litter in the fall
Data: Tammela spruce and pine plots
(ICP Level II: no 12, 13)

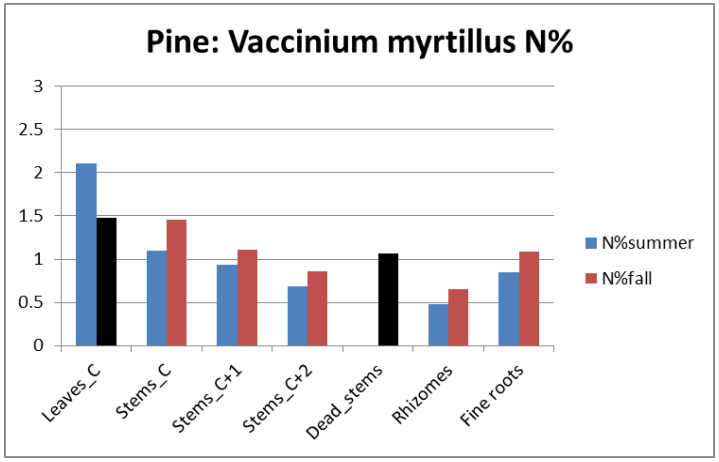
Vaccinium myrtillus in spruce (no12) and pine (no13) plots

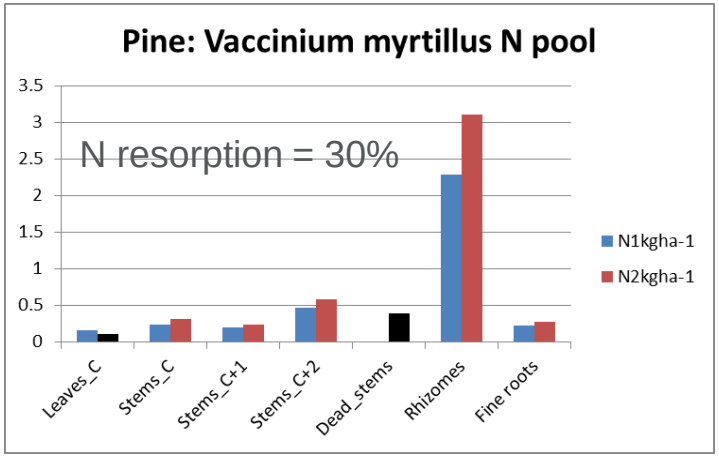
N% and N quantity in aboveground and belowground parts

Black bars = dead biomass = aboveground litter in fall









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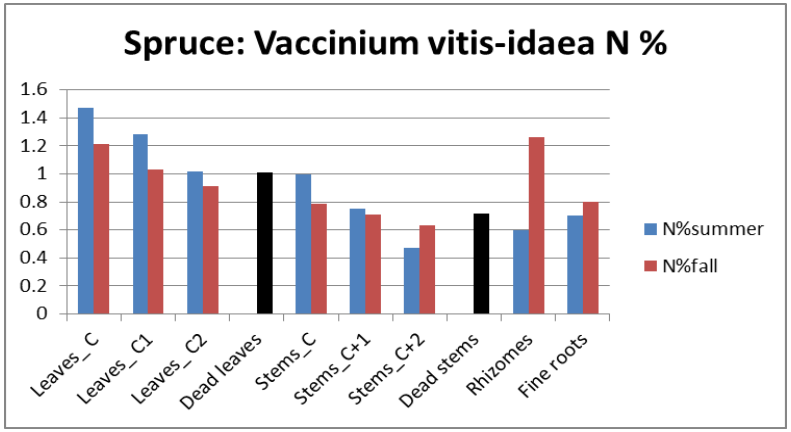
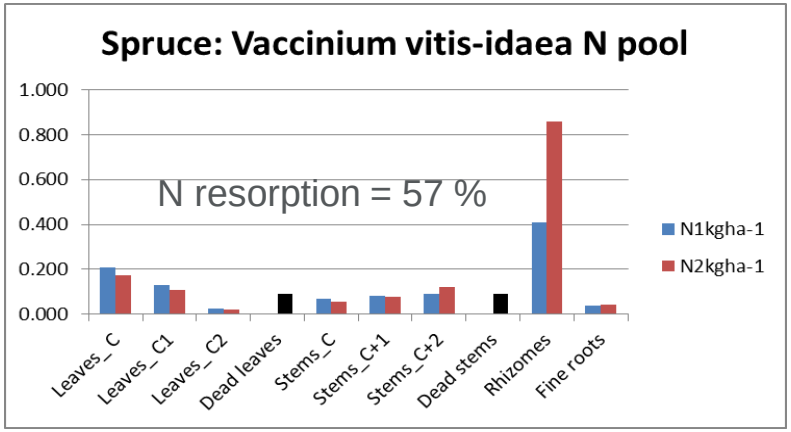
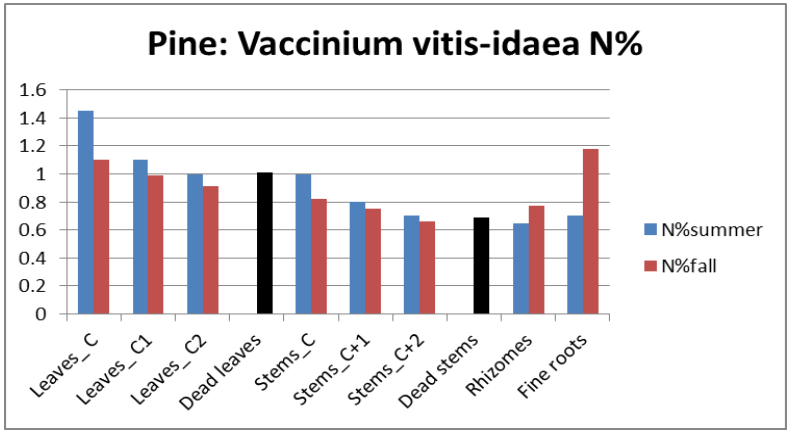
Vaccinium vitis-idaea in spruce (no12) and pine (no13) plots

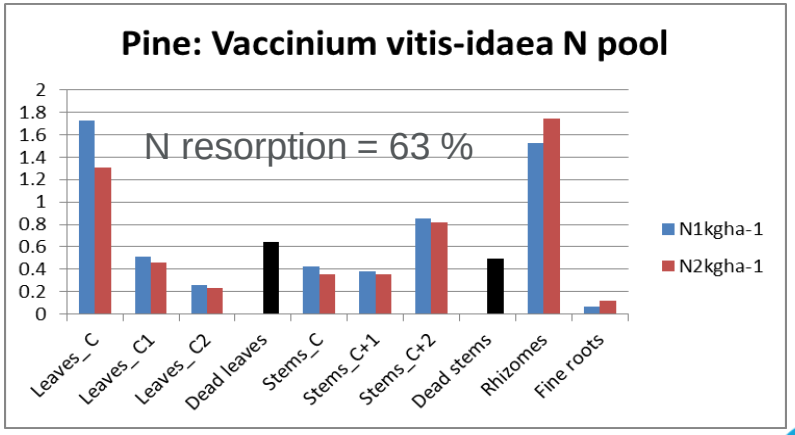
N% and N quantity in aboveground and belowground parts

Black bars = dead biomass = aboveground litter after winter









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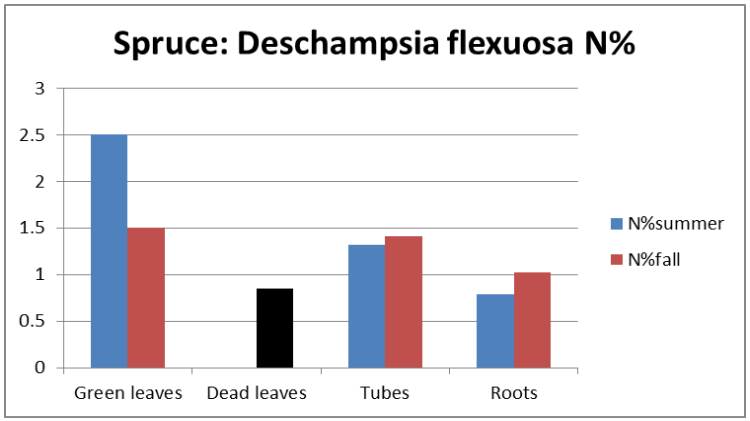
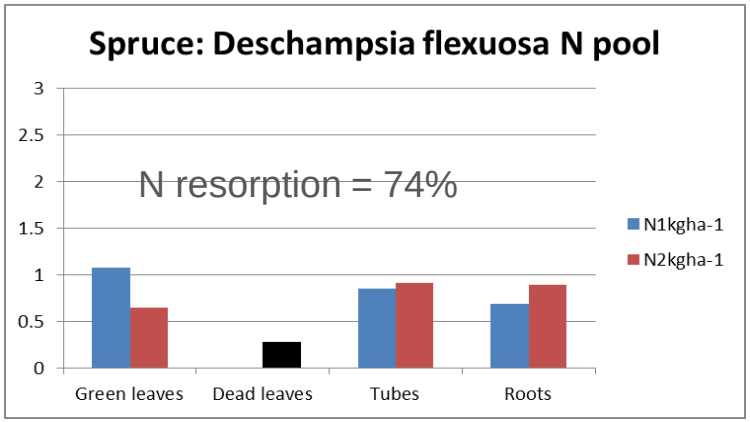
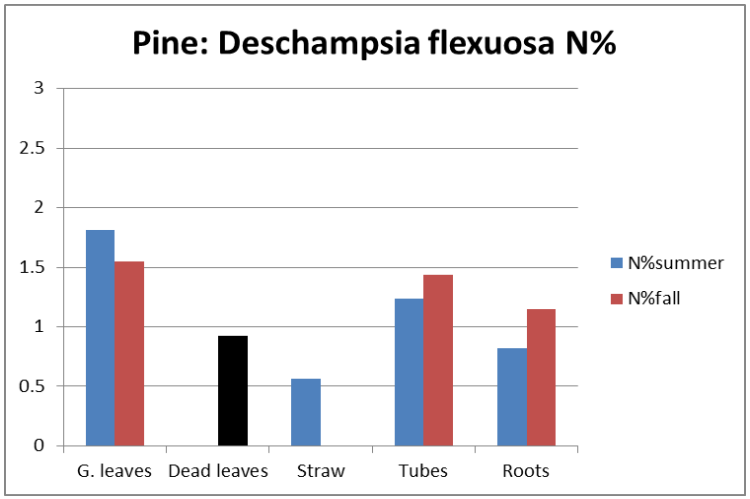
Deschampsia flexuosa (plots no12 and 13)

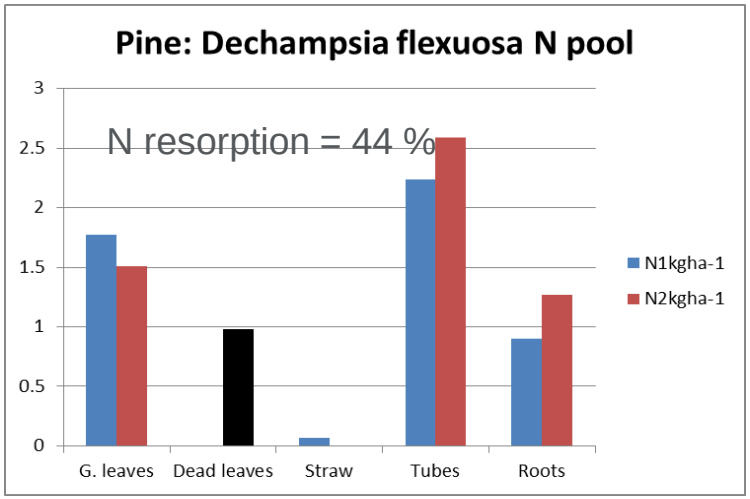
N% and N quantity in aboveground and belowground parts

Black bars = dead biomass = aboveground litter in fall









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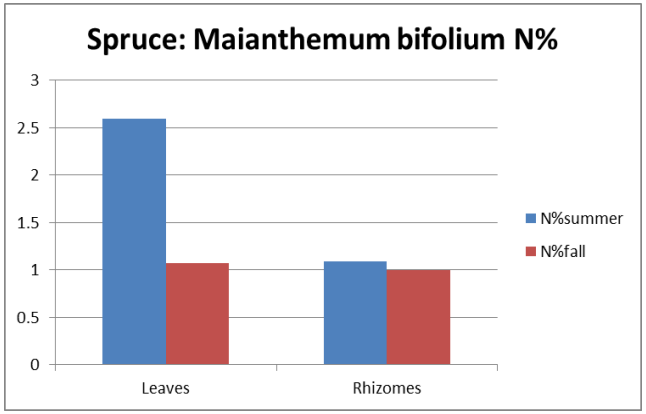
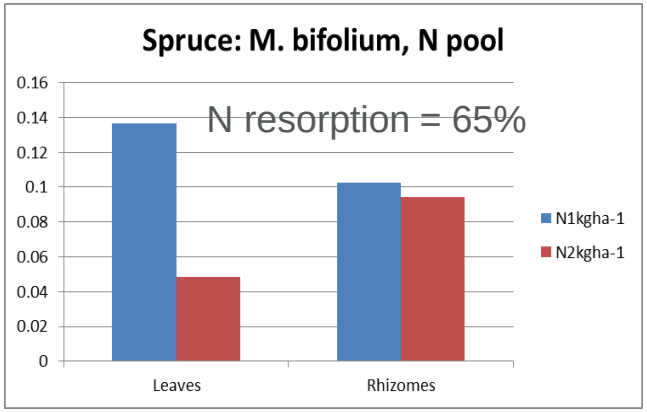
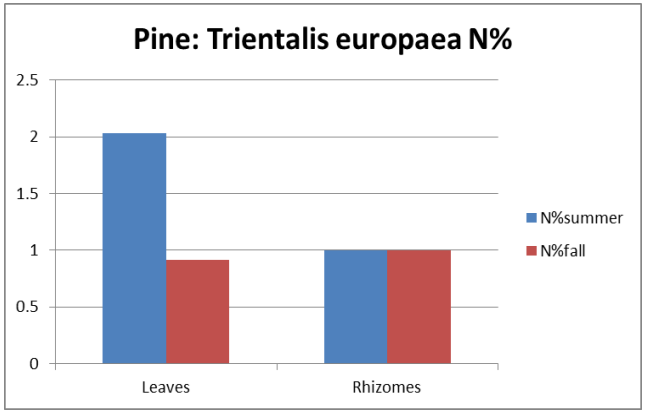
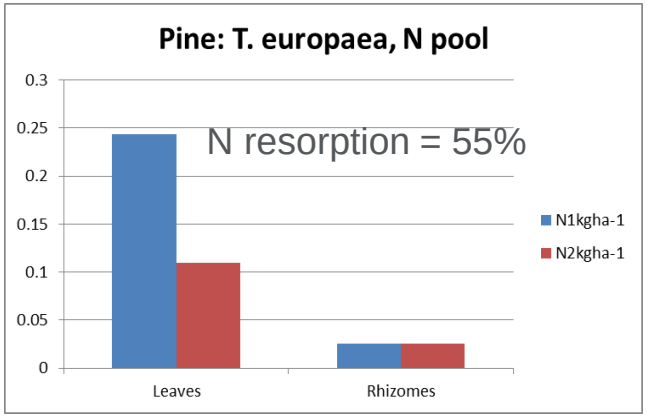
Two herb species (plots 12 and 13)

N% and N quantity in aboveground and belowground parts in summer and fall









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Answers to hypothesis

- Herbs and grasses had higher nutrient productivity than *Calluna vulgaris* and *Empetrum nigrum*, but also *Vaccinium* genera dwarf shrubs were effective in producing new biomass per a nitrogen unit in many plots. (1st hypothesis partly accepted).
- Evegreen species *Vaccinium vitis-idaea* and winter-green grass *Deschampsia flexuosa* were effective in resorpting nitrogen from leaf litter (50-60%). Also deciduous herbs uptook 60% of nitrogen, but *Vaccinium myrtillus* was most uneconomic (30%). (2st hypothesis partly accepted)
- Evegreen species *Vaccinium vitis-idaea* had higher nitrogen use efficiency than deciduous *V. myrtillus* both in nutrient-rich and nutrient-low sites in southern Finland.

Conclusions

- Global climate change and forest management are rapidly altering soil nutrient availability in forests.
- The quality and nutrient composition of the litter produced by different plant species provides information about the functional biodiversity of ecosystems because the litter affects the growing preconditions of the plant itself and of other groups of organisms
- Species having higher nitrogen productivity or nitrogen use efficiency may receive competition advantage resulting in increase of dominance
- Fast colonizing nitrophilic species may shift their geographic range northwards.

Kiitos!

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