N regime in Northern Idaho Forest soils along elevation and influence of biochar application

Shan Shan
Graduate student of EnvS
shan5171@vandals.uidaho.edu

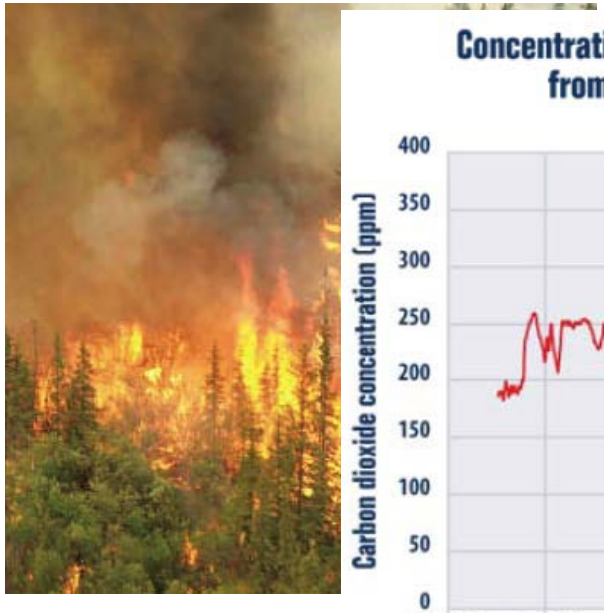
Content

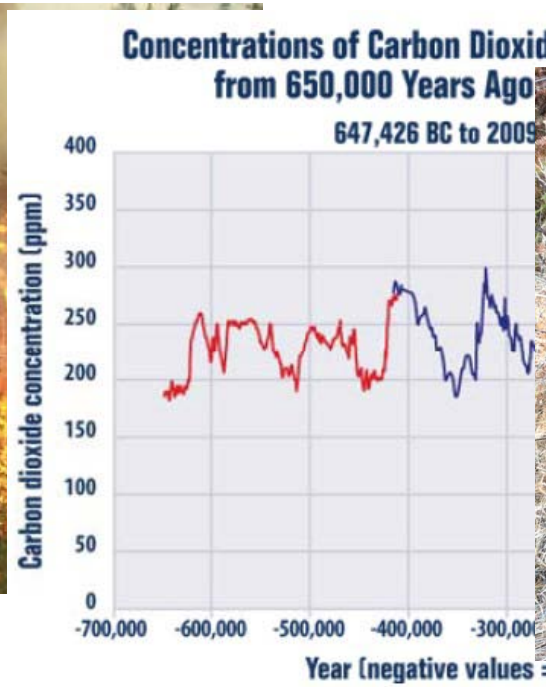
- Background and significance
- Study purpose
- Study contents
- Hypothesis
- Experiment design

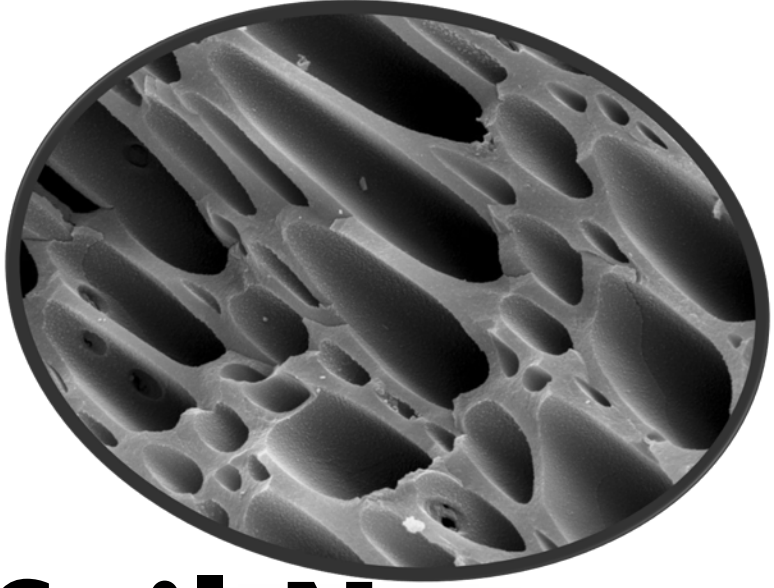
Background & Significance

- N is often a limited nutrient factor for natural forest ecosystems.
- Factors influencing soil N&Forest

A clear picture of these influence on soil N & Forest helps us in prescribing and managing of these activities





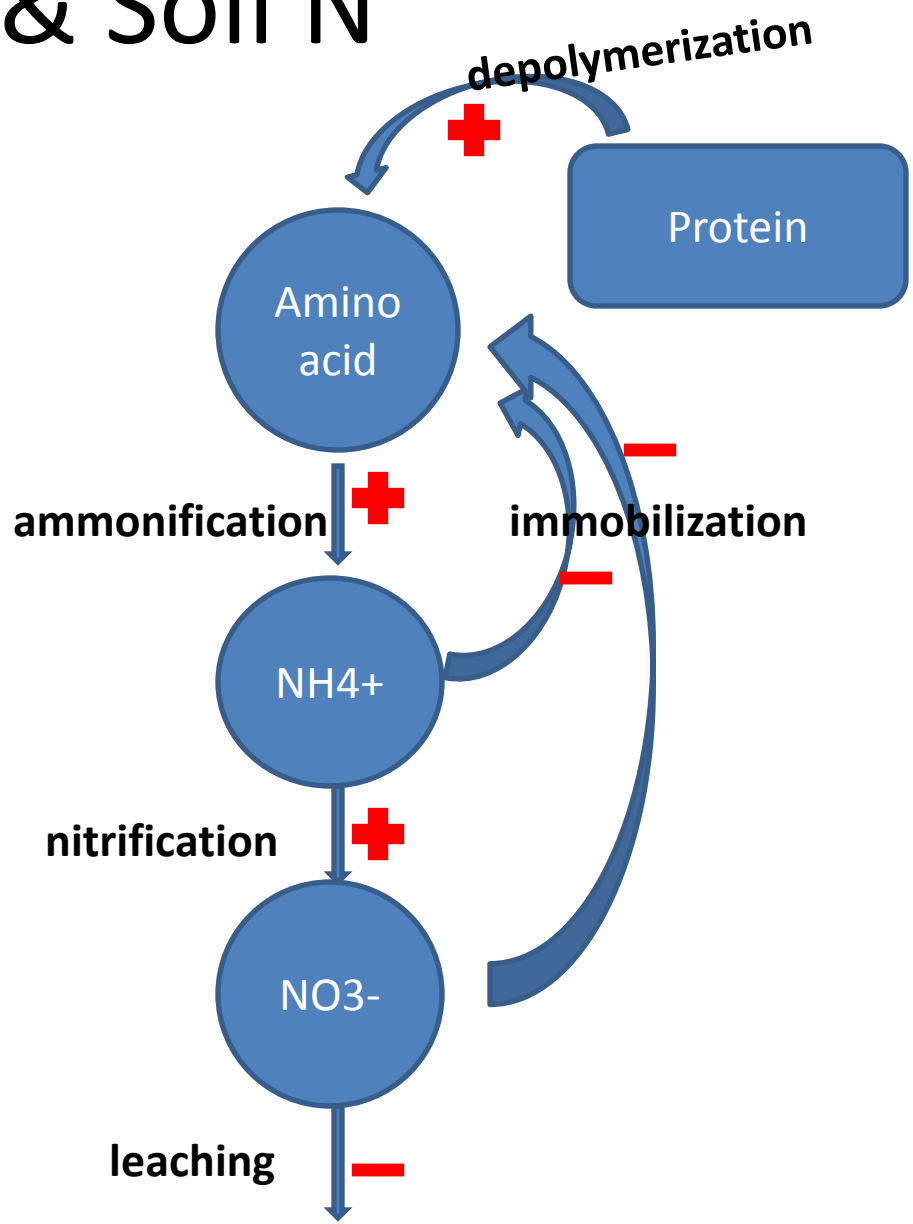


Biochar & Soil N

- Biochar is the carbon-rich solid created by pyrolysis, the thermal conversion of organic materials in an oxygen-depleted environment.
- The porous structure of biochar is related to charring temperature and feedstock materials.

Biochar & Soil N

- Enhance nitrification& aminopeptidase activity , reduce NO3- leaching decrease immobilization.
- Elevated inorganic N concentrations and N turnover.
- Adsorb NH3-N which is bio-available.
- Adsorb phenolic comounds or tannins that have negative effects on nitrification.



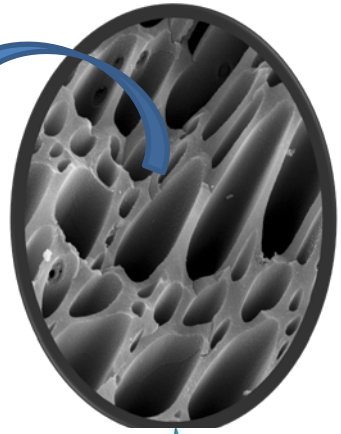
Biochar & Soil Physic-chemical Properties

- Increase cation and anion exchange capacity.
- Increase pH.

Biochar & Mycorrhizal fungi

Abuscular Mycorrhizal Fungi (AM)

Porous structure (refuge site/absorb phenolic compounds)



Poly-aromatic hydrocarbon in the residual bio-oils (Toxic)

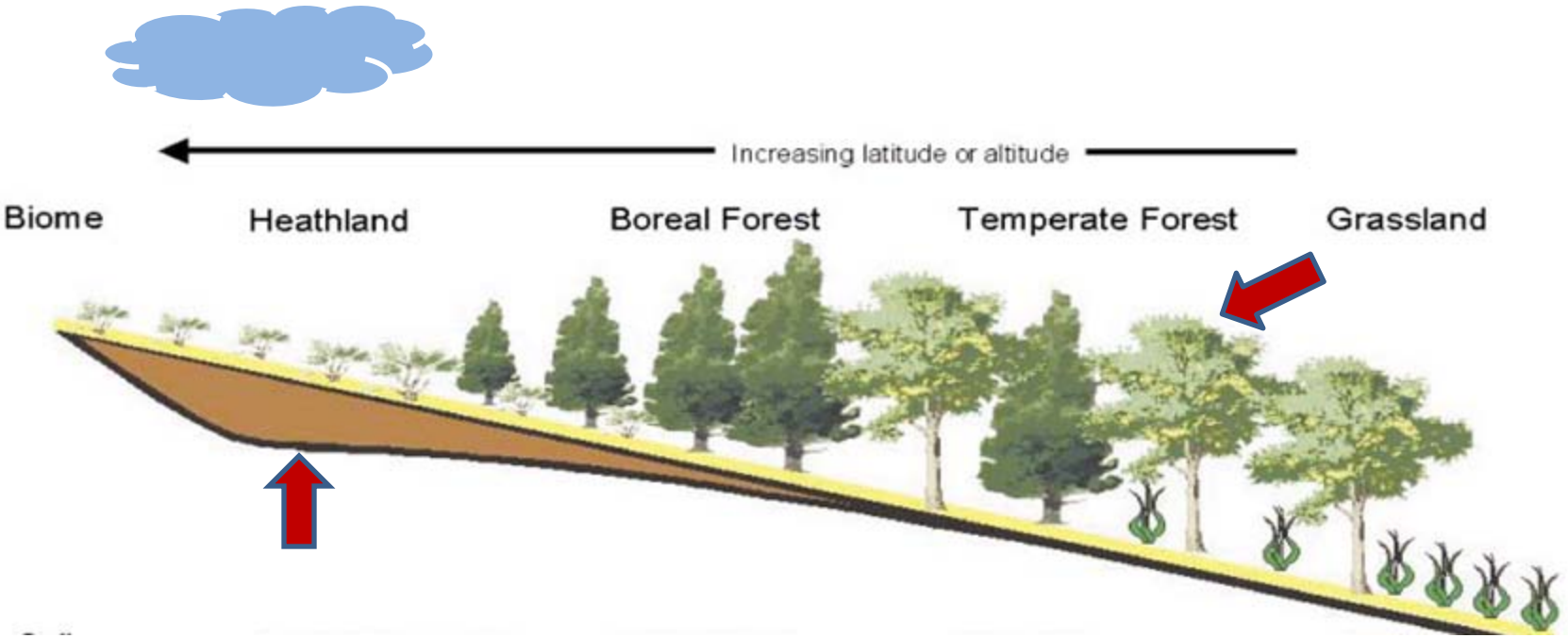
Ectomycorrhizal Fungi (ECM)

- Activated carbon addition is also reported to benefit ECM fungi (Herrmann et al., 2004).

- Biochar is reported to both increase and decrease AM fungi growth and root colonization (Warnock et al., 2007).

N Distribution in Ecosystems

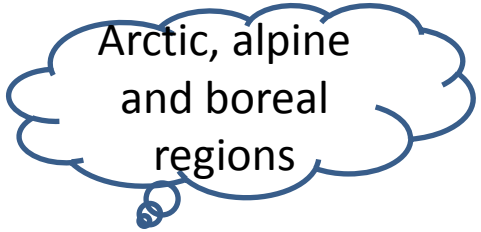
Factors Influence N Distribution



- ✓Climate (moisture, temperature)
- ✓Plant coverage type (mycorrhizal associations)
- Soil condition
- …

N Distribution With Climate

N deficient systems (cold, dry climate)



- Low N input;
- Slow decomposition and N mineralization ;
- High immobilization;
- Organic N is significant in the soil.

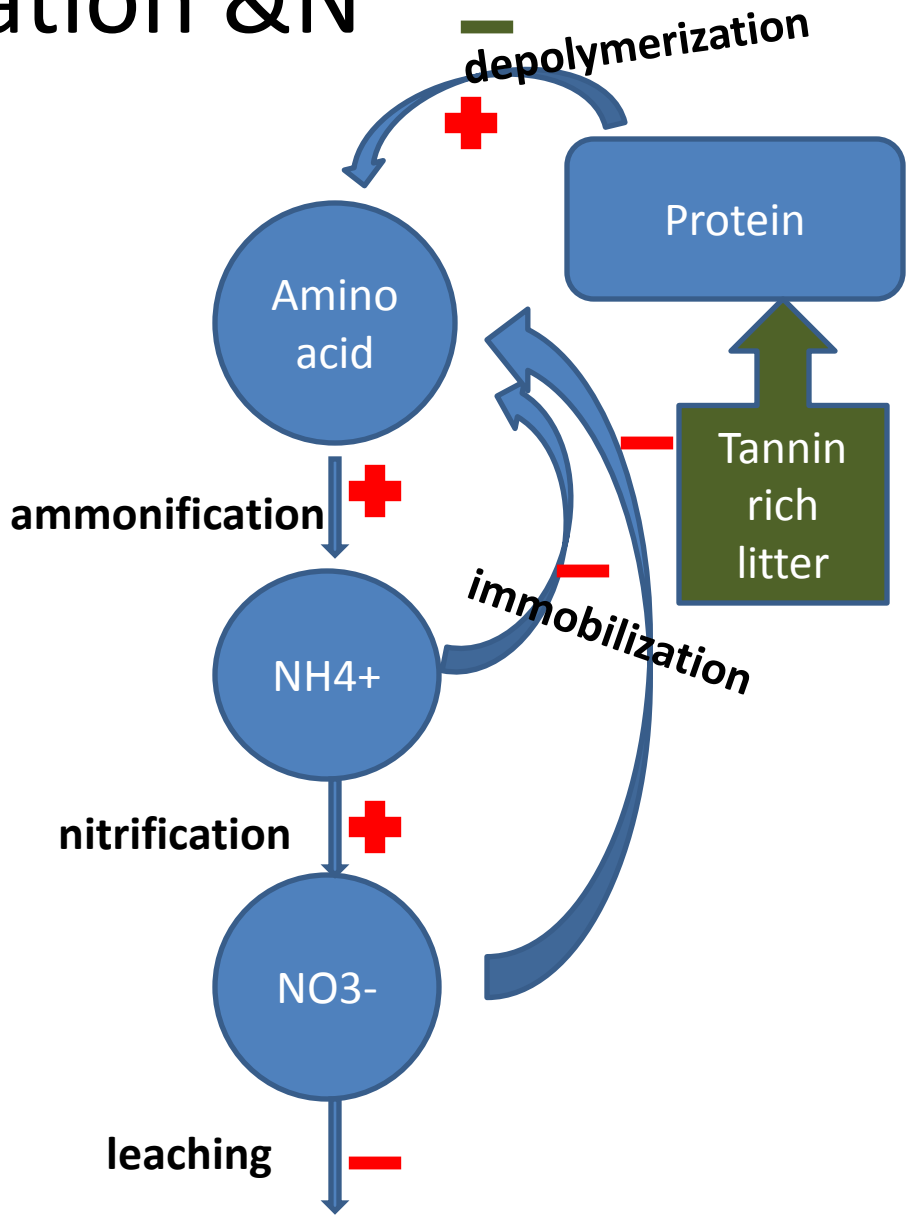
N ample systems (warm, wet climate)

- Higher N input, microbial activity and mineralization rates.
- Moderately fertile temperate forests should be dominated by NH4+;
- Agricultural systems and tropical forests the dominant form is NO3-.

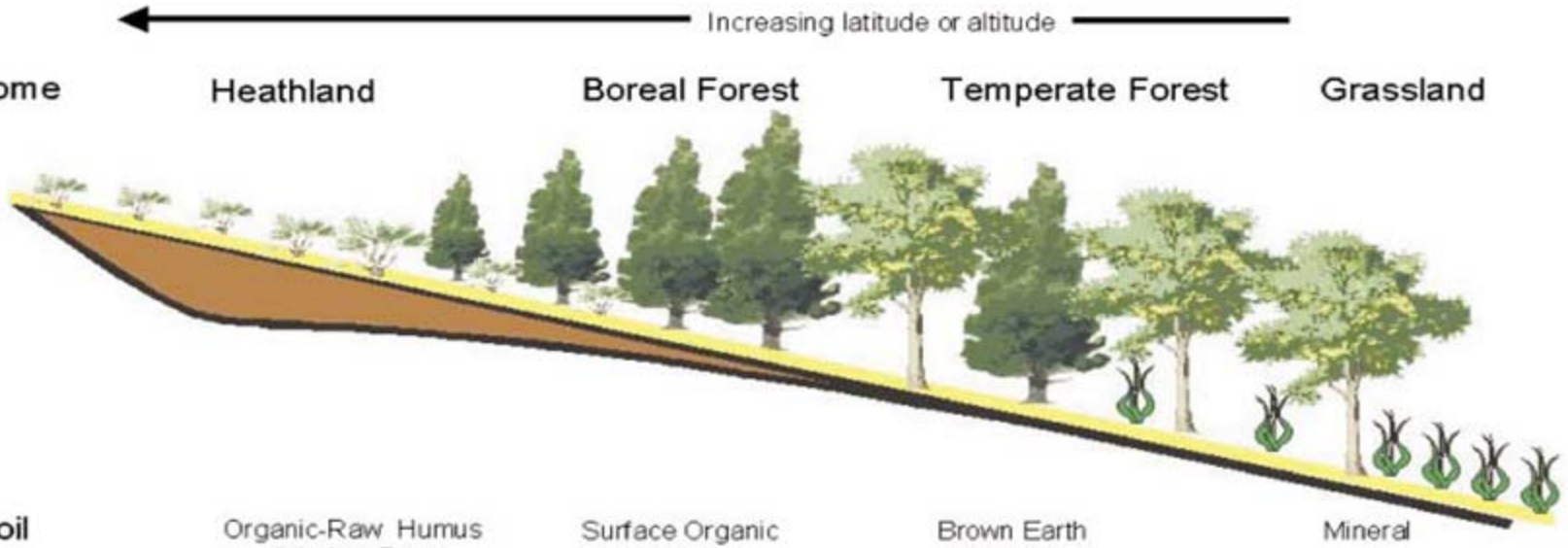
(Paungfoo-Lonhienne et al., 2008; Schimel and Bennett, 2004)

Mycorrhizal Assoication &N

- ECM and ericoid mycorrhizal fungi (ERM) often possess the enzymes to degrade recalcitrant forms of nitrogen.
- AM lack such enzymatic capabilities and enable the host plants to have access to inorganic N forms.
- ERM and ECM species are linked to low and AM species to high turnover of nutrients ecosystems.
- Ericaceous plant produce tannin rich litter. Tannin combined with protein and precipitate organic N, which is available to ERM and their host, less available to others.



N Regime With Vegetation Coverage Transition



Biome	Heathland	Boreal Forest	Temperate Forest	Grassland
Soil	Organic-Raw Humus (Mor) or Peat	Surface Organic (Mor-Moder)	Brown Earth (Moder-Mull)	Mineral
Nitrogen Source	Organic-Protein Little mineralisation No nitrification	Organic - NH_4 Limited mineralisation	NH_4 - NO_3 Mineralisation	NO_3 Nitrification dominates
Mycorrhizas	Ericoid (some Ecto-)	Ecto-(Ericoid understory)	Ecto-(AM understory)	AM- (scarce Ecto-)
Fungal Symbiont Activity	Extensive abilities to degrade structural and nutrient containing polymers	Considerable saprotrophic capabilities in both Ericoid and Ecto-fungi	Ecto-fungi of reduced saprotrophic capabilities +AM largely non saprotrophic.....	AM fungi with little or no saprotrophic abilities

Read and Perez-Moreno, 2003

Study Purpose

1. Depict a clear picture of the N regime along elevation under different vegetation types of Northern Idaho forests.
2. Understand influence of elevation and plant coverage types on this regime.
3. Examine biochar application's influence on this regime.

Study Content

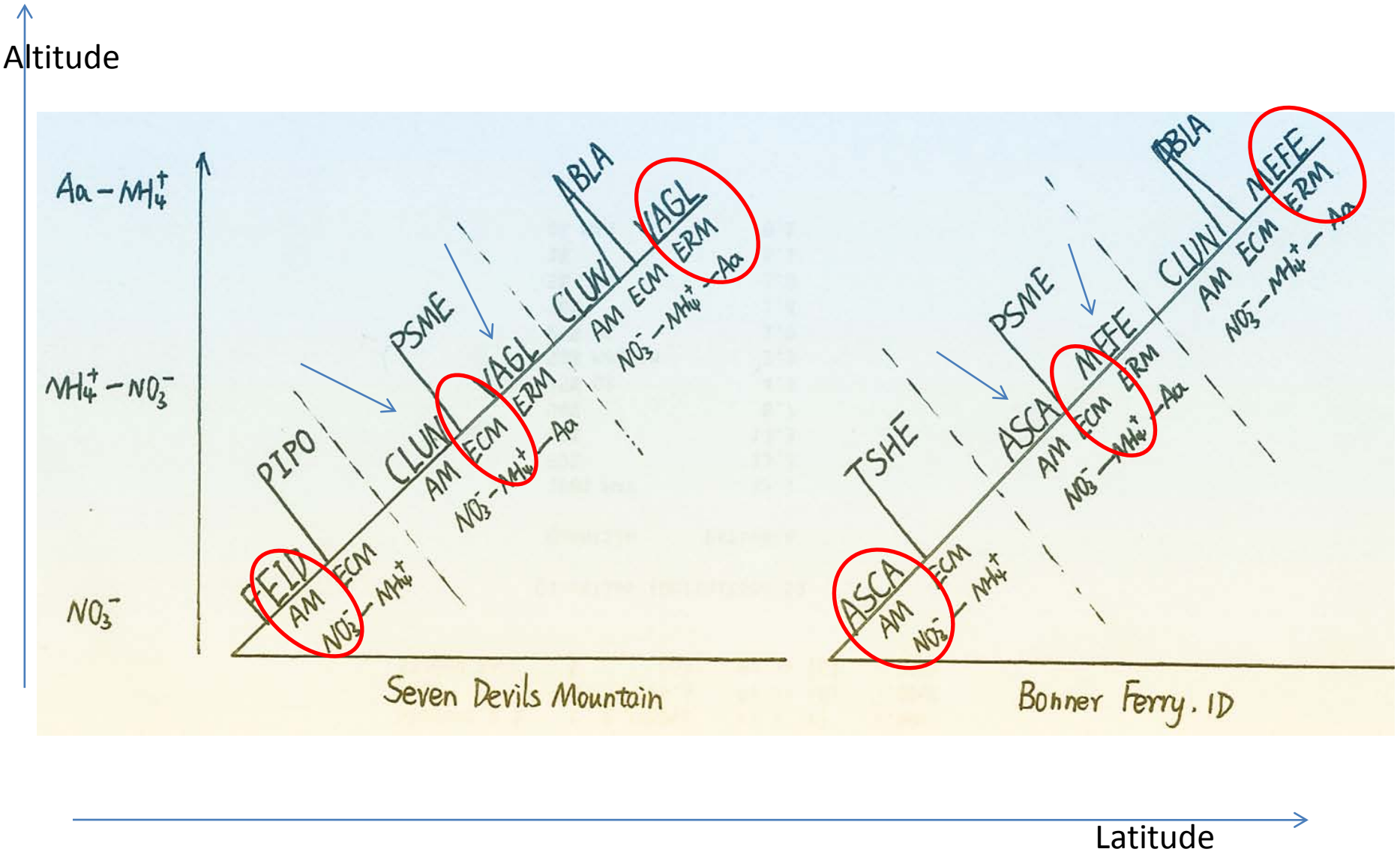
A. N pools (Amino acid, NH_4^+, NO_3^-) distribution and N fluxes (depolymerization, mineralization)along elevation with different mycorrhizal associated plant coverage types.

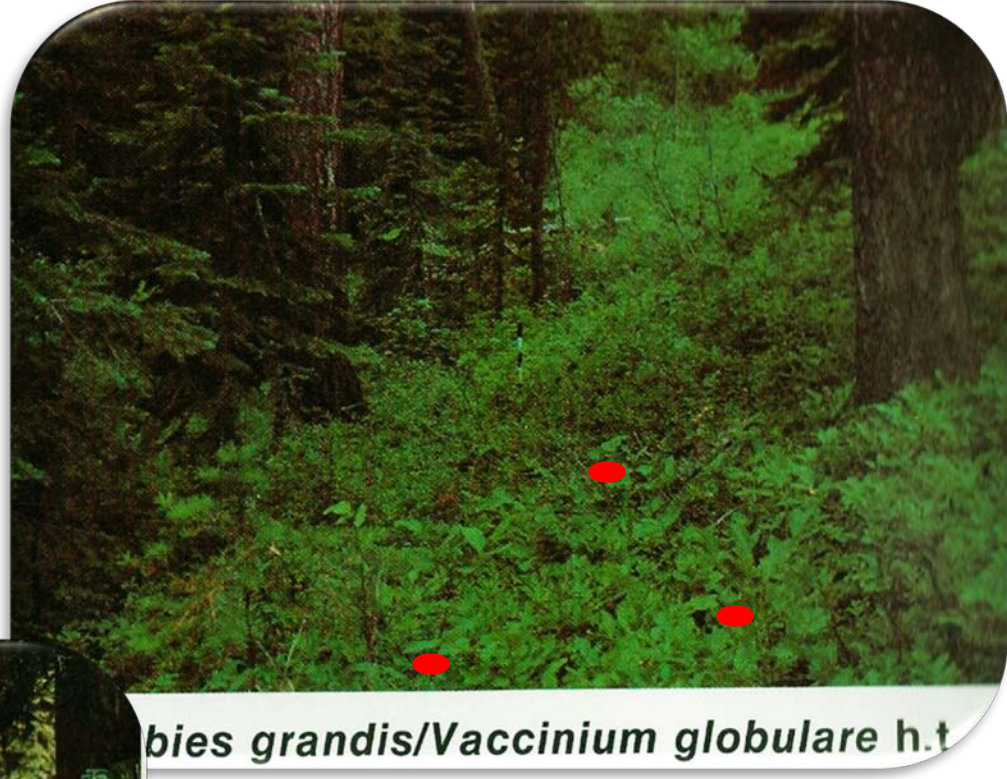
B. Influence of biochar application.

Hypothesis:

- Low elevation ecosystems are dominated by AM associated plants with NO_3^- in soil; Middle elevation is dominated by ECM associated fir and pines with NH_4^+ in soil; High elevation is dominated by ericaceous plants with amino acid in soil.
- At every elevation, principal N forms shift from NO_3^- to NH_4^+ to Amino acid from AM, ECM, to ERM sites.
- Biochar relieves retention of organic nitrogen by ERM, affecting competitions among three mycorrhizal associated plant types.

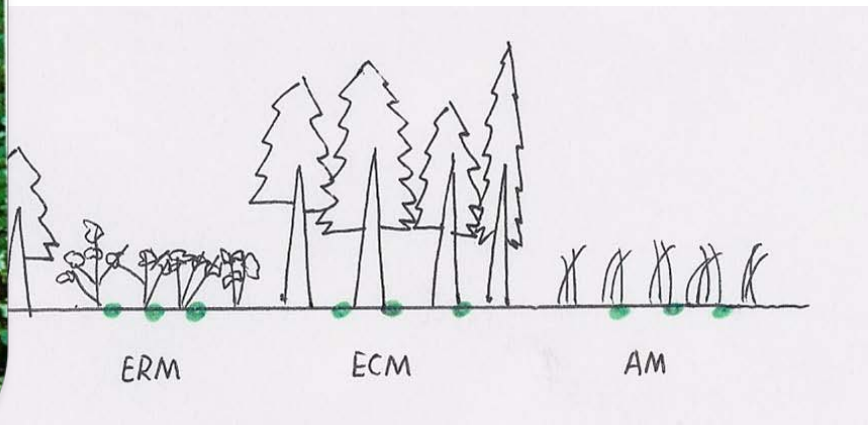
Experiment Design





bies grandis/Vaccinium globulare h.t

Abies lasiocarpa/Menziesia ferruginea h.t.



Elevation		low			middle			high		
Parameters\Mycorrhizal type		AM	ECM	ERM	AM	ECM	ERM	AM	ECM	ERM
Site characters	Elevation									
	Precipitation									
	Temperature									
	Soil type									
	Soil moisture									
	Soil pH									
N pools	SOM									
	Amino acid									
	NH4+									
	NO3-									
N fluxes	Aminopeptidase activity									
	Net mineralization									
	Net ammonification									
	Net nitrification									
	Phenol oxidase /peroxidase activity									

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QUESTIONS?