Soil Impact of Biomass Harvest

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The Main Concern

Additional removal of biomass from a logging site will reduce the productivity of the site

This impact could occur through:

Reduced soil nutrients

Reduced soil organic matter

Reduced macropores (compaction)

Topics

- General Introduction to Soils
- The Nutrients in Question
- The Potential Pools of the Nutrients
- Where these could be a problem

The Primary Soils

- The surface layers of soil can be composed of:
  - Till (primarily unsorted materials, in some areas it can be very deep)
  - Moraines (ridges formed at the edge of the glaciers)
  - Glacial lake beds (areas of sand and mud deposited as the glaciers melted)
  - Outwash (sand and gravel sorted by meltwater)

For nutrient depletion (note: these are big generalizations)

Outwash

- Generally sand or loamy sand
- Low CEC (potentially limited nutrient pool)
- Often have in aspen (high user of nutrients) and conifers (low users)
- Potential area of concern

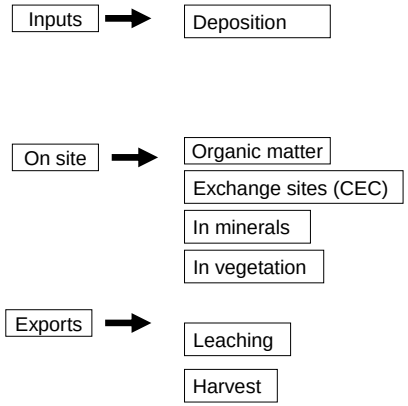
Till

- Often loamy sand/sandy loam
- Can be less susceptible to problems

Organic Site

- Can be nutrient sinks (often in brushland) and less susceptible
- Can have everything locked up (can be a problem)

Nutrient Pools



Nutrients (general)

- Calcium- cell wall, transport of nutrients, soil buffering
- Magnesium- chlorophyll, enzymes, soil buffering
- Potassium- proteins, photo, tightly cycled
- Nitrogen- protein, enzymes, chlorophyll (often limiting but deposition)
- Phosphorus- photosynthesis and many other reactions

Nutrients

- Calcium
- Magnesium
- Potassium
- Nitrogen
- Phosphorus

Grigal 2004

Soils Bases (Ca, Mg, K)

- Most likely to have problems
- Removed from site with logs
- More removed with biomass harvest than normal logging

Storage in trees

- K and Mg- leaves and branches
- Ca- also bark (wood is <1%, bark can be 2 or 3%)

Materials that could be harvested

- Possibly 60% more than pulp for conifers
- Possibly 100% for hardwoods (Keays 1975)
- This info will be available soon from DNR

- Tops contain higher level of soil nutrients
- 2X as much calcium (Bosman et al. 2001).

Biomass Harvest

- Potentially could remove twice as much bases with a biomass harvest
- On some sites this could be a lot and reduce future productivity

Grigal 2004 GEIS Update and Bockheim (UWM) research was used for much of this data

Nutrient Pools

Inputs → Deposition

On site → Organic matter
Exchange sites (CEC)
In minerals
In vegetation

Exports → Leaching
Harvest

Mostly Grigal 2004
Bockhiem
Others

Nutrient Pools

Inputs → Deposition

Ca	Mg	K	
2.8	0.4	0.4	(lbs/a/yr)

Not much to consider

On site → Organic matter
Exchange sites (CEC)
In minerals
In vegetation

Exports → Leaching
Harvest

Nutrient Pools

Inputs → Deposition

On site → Organic matter
Exchange sites (CEC)
In minerals
In vegetation

Ca
3000-1500 (lbs/a)
Mg
700-3700 (lbs/a)
K
195-1900 (lbs/a)

Exports → Leaching
Harvest

In Vegetation

- Conifers
  - 250 lbs/acre Ca
  - 30 lbs/acre Mg
  - 150 lbs/acre K
- Hardwoods
  - 600 lbs/acre Ca
  - 50 lbs/acre Mg
  - 200 lbs/acre K

Total on site (Grigal 2004)
Ca
3000-15000 (lbs/a)
Mg
700-3700 (lbs/a)
K
195-1900 (lbs/a)

Bosman et al. 2001,
Keays 1975,
Grigal 2004

Studies

- Olson et al. 1996 (Norway) reduction in pools in conifer site
- Federer et al. 1989 could reduce soil Ca by 20-60% over 120 years
- Silkworth and Grigal 1982 no diff on aspen
- Alban and Perala 1990 no diff spruce, aspen, pine
- Pennock and van Kessel 1997 no diff

Generally

- On many soils, even intensive harvest may not result in a problem
- The most likely place for problems are those with low levels of soil nutrient holding capacity

Potential Problem Sites

- Most likely
  - Organic soils for K and P (from Grigal 2004)
- Outwash sands (low nutrient holding capacity) with high nutrient demanding species (aspen/northern hardwoods)
- Shallow soils over bedrock (small amount of rooting medium)

One Additional Problem

- Reduced levels of soil organic matter could also alter nutrient cycling
- This could happen because the OM from the harvested material does not rot on site
- This is hard to measure and little is known (Johnson 1983)

Conclusions

- Nutrient impoverishment may be relevant on some sites
  - Nutrient poor outwash sands
  - Shallow soils
  - Some organic soils
- On many sites, this is less of a concern