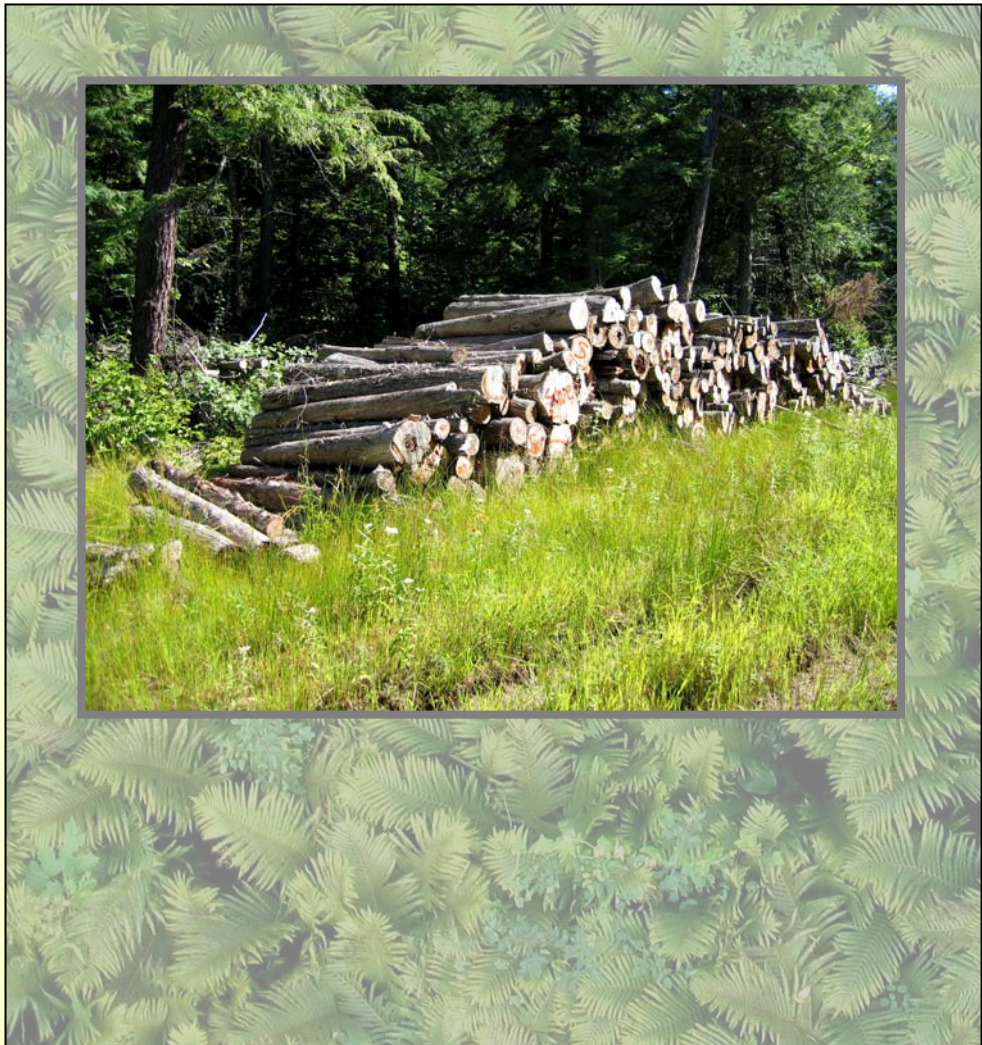
Proposed Biomass Harvesting Guidelines and Rationale

Soil Nutrient Considerations

April 29, 2008

Goals for site nutrients and biological cycling

- Retain site nutrients at levels that maintain site productivity and sustainability
- Support microbial populations that cycle nutrients and make them available in forms plants can use



Guidelines proposed primarily to address soil nutrient concerns

- ***3.A Retain 1/3 of harvested FWD on site. If possible, leave the material well-distributed throughout the site.***
- ***4.A Do not remove the forest litter layer, stumps, and/or root systems for utilization as biomass.***
- ***6.B Do not harvest woody biomass (over and above bolewood utilization) on shallow soils where bedrock is within 20 inches of the surface.***
- ***7.B Do not harvest woody biomass (over and above bolewood utilization) on nutrient-poor soils (i.e., soils that are low in exchangeable base cations). A list of soil series is [will be] attached. Exception: Jack pine stands may be harvested for woody biomass at rotations of 40 years or longer.***
- ***8.B Do not harvest woody biomass (over and above bolewood utilization) on organic soils deeper than 24 inches.***

Soil nutrient evaluations

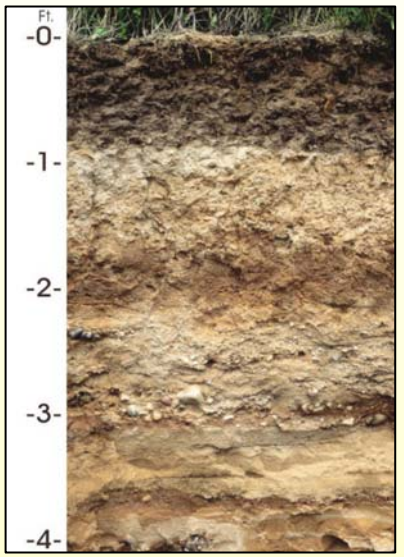
- Inputs - wet and dry deposition, mineral weathering, and N-fixation
- Outputs/losses – leaching and harvest removals
- Nutrient budgets (inputs and outputs) for different cover types and rotation lengths
- Availability to trees
- Soil nutrient capital

Literature

- Nutrient budgets for Wisconsin & the Lake States
  - Mineral weathering rates
  - Atmospheric deposition
  - Leaching
  - Nutrient content of tree components
  - Factors influencing nutrient budgets (e.g. age, site, season)
- Microbially mediated processes
  - N and P availability
  - N fixation

Nutrient budget for aspen biomass harvest – calcium, 40 year rotation, average inputs

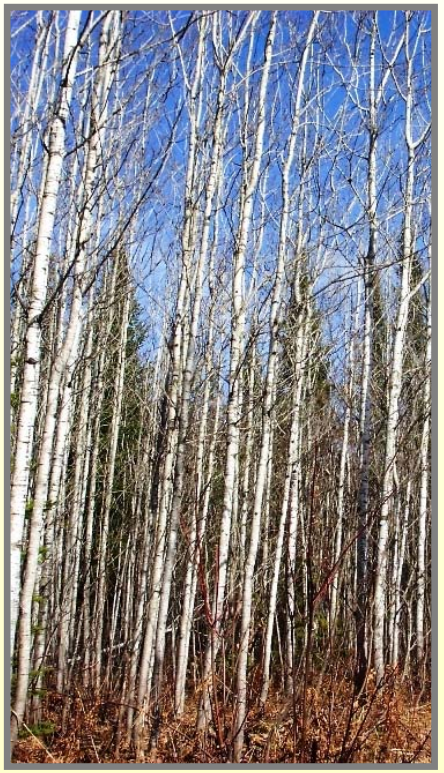
- Inputs
  - Atmospheric deposition: 3.4 lb/acre/year x 40 yrs = 137 lb/acre
  - Mineral weathering: 3.7 lb/acre/year x 40 yrs = 148 lb/acre
- Outputs/losses
  - Leaching: 55.6 lb/acre total
  - Harvest: 616 lb/acre Ca
- Budget
  - 137 + 148 – 616 - 56 = -387 lbs/acre Ca



Antigo silt loam - state soil

Nutrient budget for aspen biomass harvest – calcium, 40 year rotation, low inputs

- Inputs
  - Atmospheric deposition: 2.5 lb/acre/year x 40 yrs = 99 lb/acre
  - Mineral weathering: 1.7 lb/acre/year x 40 yrs = 68 lb/acre
- Outputs/losses
  - Leaching: 55.6 lb/acre total for first few years
  - Harvest: 616 lb/acre Ca
- Budget
  - 99 + 68 – 616 - 56 = -505 lbs/acre Ca



Nutrient budget for northern hardwood biomass harvest – calcium, 60 year rotation equivalent

- Inputs*
  - Atmospheric deposition: 3.4 lb/acre/year x 60 yrs = 204 lb/acre
  - Mineral weathering: 3.7 lb/acre/year x 60 yrs = 222 lb/acre
- Outputs/losses
  - Leaching: none in uneven-aged systems
  - Harvest: 714 lb/acre Ca
- Budget
  - 204 + 222 – 714 = -287 lbs/acre Ca

60-year rotation equivalent:

4 entries, 15 years apart, each removing 25%.

*assumes average inputs from mineral weathering and atmospheric deposition

Cover type comparisons of net nutrient balances

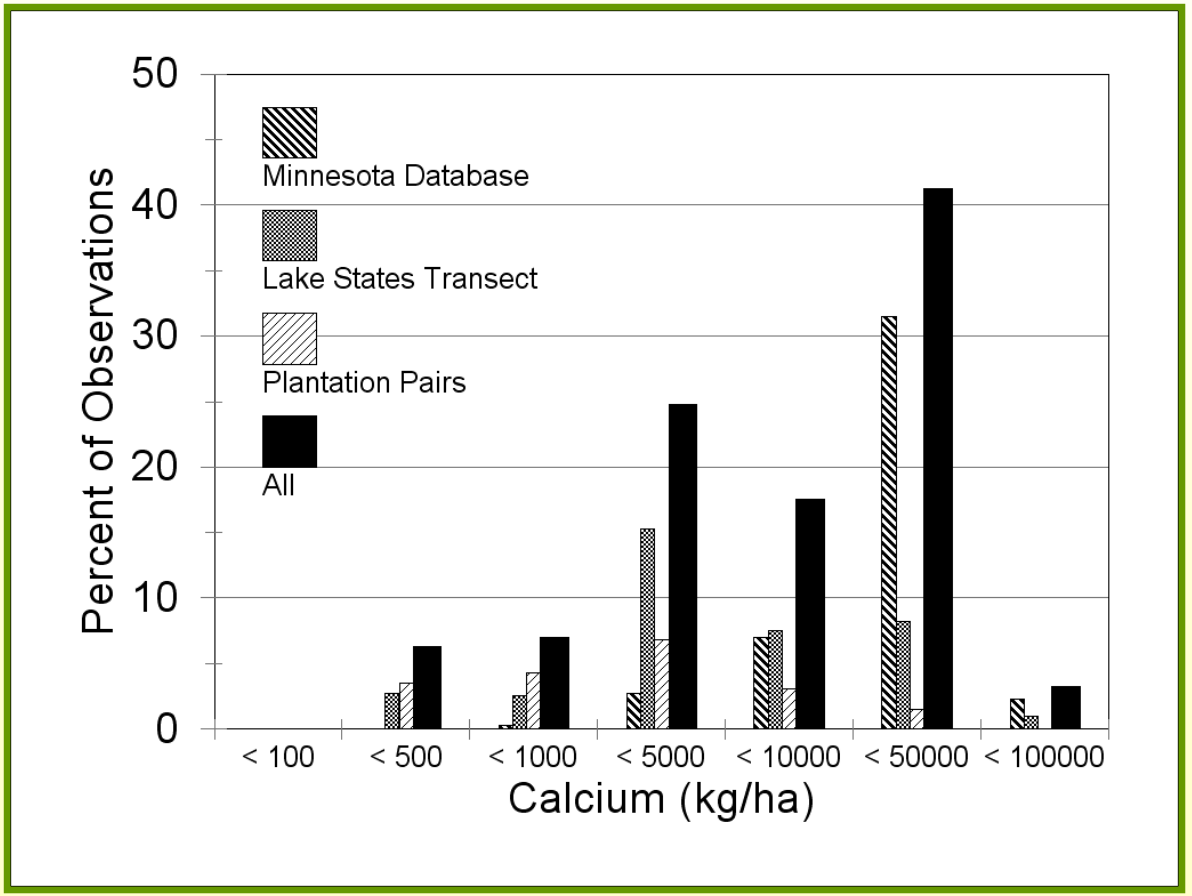
Biomass harvests over 120 yrs*

Forest type	*Ca, lb/acre*	*K, lb/acre*	*Mg, lb/acre*
JP, 40 yr rotation	384	15	102
RP, 120 yr rotation	216	-128	88
RP, 60 yr rotation	80	-140	48
NH, 60 yr equiv. (4-15 yr entries, 25%)	-574	-200	72
Aspen, 40 yr rotation	-1161	-417	-27

*assumes average inputs from mineral weathering and atmospheric deposition

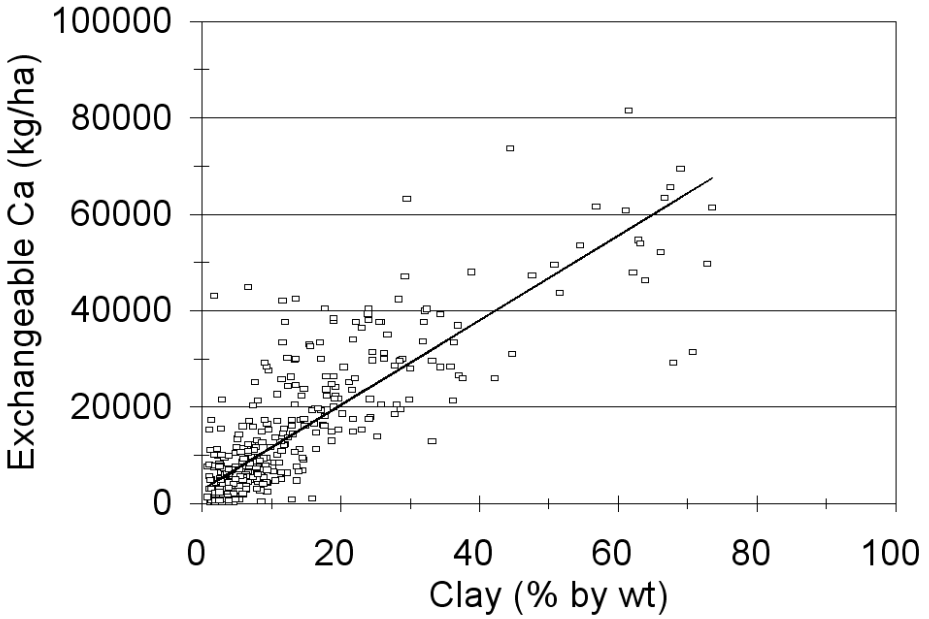
Soil nutrient capital

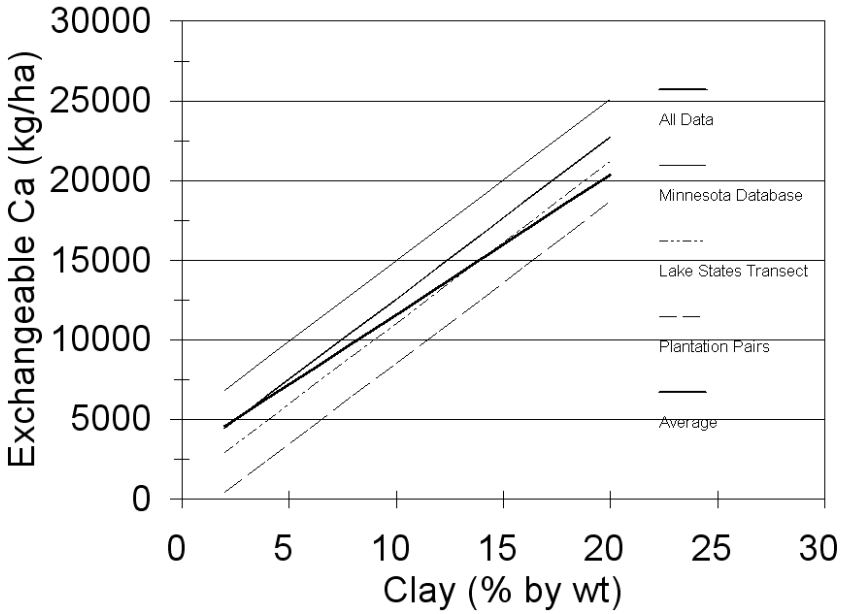
- Dr. Grigal analyzed his research data set (~400 pedons) to show soil distributions based on calcium.



Soil nutrient capital

- Clay content & Ca were correlated.
- Soils with ~3% clay correlated with ~1000 kg/ha Ca. (Mg, K, Na are correlated with Ca)





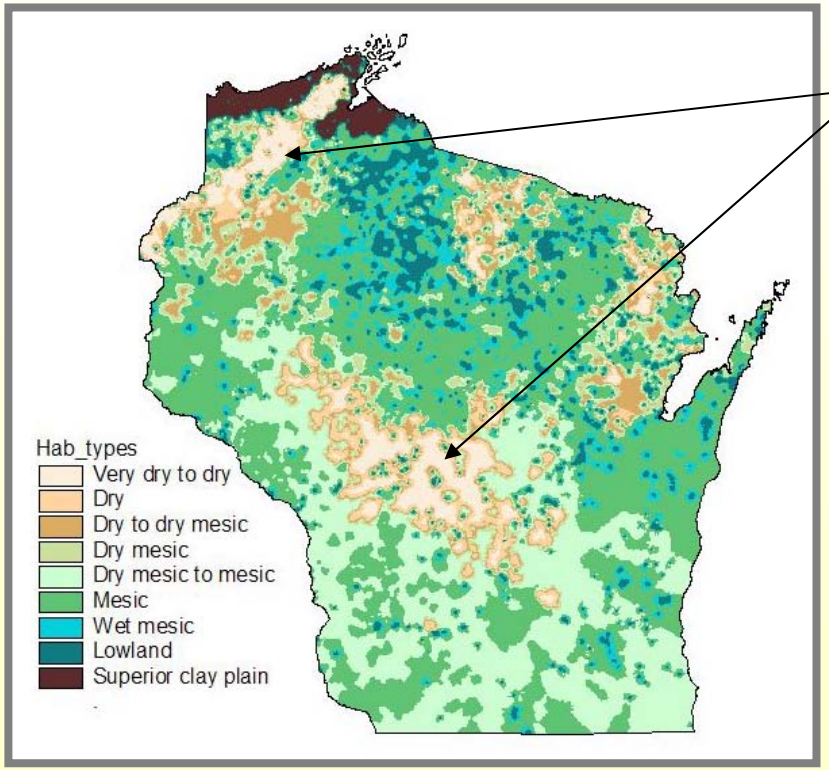
Low-nutrient soils

- **NRCS, Soil Data Mart – soil pedon descriptions used to identify low-nutrient soils (clay content of 3% or less, averaged to 40" depth).**

Tarr sand

Horizon name	Horizon top, cm	Horizon bottom, cm	Texture	Clay	Silt	Sand	Depth avg to 100 cm
A	0	10	Loamy sand	4	4.2	91.8	40.0
Bw1	10	23	Sand	3.9	3.6	92.5	50.7
Bw2	23	56	Sand	1.7	3.9	94.3	56.1
BC	56	69	Sand	0.2	2.3	97.5	2.6
C	69	152	Sand	--	0.8	99.2	0.0
							1.5

Low-nutrient sands, Jack pine biomass harvest



Low nutrient sands are portions of the areas shown in beige. A detailed analysis using SSURGO data is in progress. These areas are proposed for jack pine biomass harvest.

1A. Reminder – Follow Silviculture Hndbk. recommendations for tree and snag retention in managed stands

- Retention of trees and snags maintains a proportion of site nutrients.
- Living root systems and inputs of litter and woody debris support microbial populations.

2A. Retain and limit disturbance to down coarse woody debris (CWD) already present.

- CWD is important for supporting microbial decomposers that mineralize nutrients, especially N and P.
- Retaining CWD maintains a proportion of site nutrients.

3.A - Retain 1/3 of harvested FWD on site. If possible, leave the material well-distributed throughout the site.

Slash and CWD retained on site

High level of biomass utilization

Photos - MN DNR Forestry

Roles of Fine Woody Debris

- On a weight basis, contains a large amount of nutrients. For NH, approximately 40% of Ca is in tops and foliage.
- Provides available N during early periods of stand growth following harvest.
- Sites for N fixation.

4.A - Do not remove the forest litter layer, stumps, and/or root systems for utilization as biomass.

- Forest litter layers contain high levels of soil nutrients. Root systems and stumps contain additional nutrients.
- Removing roots and stumps would cause considerable soil disturbance.

Sampling forest litter layer in Michigan

Site preparation

- ***Some silvicultural prescriptions call for disturbance of the forest floor, or for moving stumps. The intention of the guideline is that these materials should not be removed from the site because of the large nutrient pool they represent.***

Site prep on Black River State Forest

6.B - Do not harvest woody biomass (over and above bolewood utilization) on shallow soils where bedrock is within 20 inches of the surface.

- Shallow-to-bedrock soils have fewer nutrient reserves than deep soils. Nutrient capital calculations are based on 40" depth.
- Shallow soils are susceptible to compaction and surface displacement by vehicle traffic.

Bedrock and shallow soil exposed in a roadcut, southwest Wisconsin.

7.B - Do not harvest woody biomass (over and above bolewood utilization) on nutrient-poor soils (i.e. soils that are low in exchangeable base cations).

- Exception: Jack pine stands may be harvested for woody biomass at rotations of 40 years or longer.
- These soils have parent materials inherently low in base cations.
- A list of soil series or map units will be provided.

A nutrient-poor sandy soil in Upper Michigan.

8.B - Do not harvest woody biomass (over and above bolewood utilization) on organic soils deeper than 24".

- Ombrotrophic – black spruce, tamarack, jack pine. Minerotrophic – white cedar, black ash. Many intermediates; no good way at present to clearly define and train users to recognize them.

Ombrotrophic wetland

Organic soils

Black ash swamp

- Potassium and phosphorus depletion more likely to occur here than in upland soils
- 24” thickness limits rooting
- Physical properties – rutting, displacement

Research needs

- Gather additional data on nutrient content of tree components
- Assemble soils data from research studies in Wisconsin to better characterize nutrient capital
- Investigate supplies of micronutrients and effects on tree growth
- Study amounts of woody material removed in biomass harvests in different forest types, seasons, and sites
- Determine whether calcareous material is present below 6 feet in deep sands
- Set up plots for long-term, low-intensity monitoring


Thank you