Effects of Logging Residue Removal on Forest Sites

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Factors Limiting Use of Forest Biomass for Energy Production

- Lack of knowledge of site impacts
- Collection inefficiencies
- Burning technologies and economies of scale

It is important to examine all three in an integrated fashion if society hopes to capitalize on this economic and energy opportunity within the limits of our forest resource base.

Logging Residue Removal Study

- Focus was to interpret basic research to create practical guidelines which could be implemented, in the field, by foresters and loggers.
- Involved a literature review focused on comparative treatments on similar sites.
- Involved interpretation of research results from around the world to Lake States conditions to the extent possible.

Report Outline

- Introduction
- Methods
- Soil Nutrients
  - Biomass and nutrient concentrations in merchantable stems and slash
  - Species and site influences on nutrient levels
  - Hydrologic losses of nutrients
  - Nutrient losses from organic matter

Report Outline (continued)

- Regeneration and Stand Development
- Wildlife and Microorganisms
- Conclusions
- Literature Cited and Other Literature Resources

Methods

- Internet searches were done but the indexes and other resources at the U of MN proved more useful.

- The most extensive research examined in this study has occurred in Canada, the Nordic Countries and in the Western US.

Reasons for this concentration:

Canada – strong history of consistent and continuing forest research and relatively poor soils

The Nordic Countries – strong history of intensive mgt. and use of logging residues for biomass energy production

Western US – residue reduction to influence subsequent fire regimes

Methods (continued)

- Focus was on studies which compared:
  - Uncut controls
  - Whole tree chipping
  - Spread retained residue
  - Chipped and spread retained residue
  - Residue removed
  - Burned windrowed or piled residue
  - Broadcast burned residue

Soil Nutrients in General

- Exist in three forms
  - **Inorganic or mineral** (rocks & soil particles) which are the least available and least impacted by harvest activities.
  - **Organic** which originate from living plants and animals which are released for plant growth by decay.
  - **Ionic** which are available immediately for up-take by plants as a result of weathering and decay.

Residue Harvest Impacts on These Three Sources of Nutrients

- **Inorganic** – Little short or long-term impact since these are inherent in sites of different soil types and rates of weathering.
- **Organic** – Removal may or may not impact site productivity in the medium/long term depending on how much is removed and of what type.
- **Ionic** – Removal will be short-term in nature by leaching, run off or subsequent re-growth of vegetation.

Generalities Regarding Biomass/Nutrient Removals From Whole Tree Chipping

- Removals of 90%+ of the above ground biomass caused reductions in:
  - 6% or less of the total site nutrient capital.
  - Anywhere from 30% to 100% of the available nutrient capital (for certain nutrients) within a short period of time after harvest.
  - Ionic and organic sources of nutrients rebounded fairly quickly in the years after harvest on all but the poorest sites.

Biomass & Nutrient Concentrations in Merchantable Stems and Slash

- 60% of biomass in hardwood stands and 80% of biomass in softwood stands is contained in the merchantable sawlog or pulpwood portions.
- This is somewhat consistent across species groups.
- In contrast, the average proportion of above ground nutrients in the merchantable portion of hardwood and softwood stands vary widely by species & stand age.

Proportion of Biomass & Nutrients in Tree Stems by Species

Species	Biomass in merchantable stem	Nutrients in merchantable stem
Alder in Washington	93%	82-91%
Mixed Hardwoods in New Hampshire	20%	21-38%

Total Above Ground Biomass (t/ha) & Nutrients (kg/ha) in 40 Year Old Adjacent Stands in MN.

Species	Biomass	N	P	K	Ca	Mg
Trembling Aspen	167	368	46	287	858	58
White Spruce	151	382	57	229	719	40
Red Pine	199	346	42	175	291	58
Jack Pine	147	259	25	97	199	38

Distribution Within 40 Year Old Aspen in Minnesota (kg/ha)

Component	Biomass	N	P	K	Ca	Mg
Foliage	3,600	87	9	47	37	6
Branches	16,600	82	11	42	215	12
Wood	119,000	84	10	112	171	19
Bark	27,600	115	16	86	435	20
Roots	3,800	89	20	80	216	18

Ionic Nutrient Losses

- Hydrologic losses of nutrients occur after harvests of all types.

- These losses are usually short-lived if:
  - Soil disturbance is minimized
  - Run off is minimized
  - Buffer strips are used along water bodies

Summary To Date

- Only organic sources of nutrients are likely to be impacted by slash removal.
- Proportions of biomass & nutrients contained in the merchantable part of a tree are highly variable depending on species & age.
- Different tree species “uptake” nutrients in different amounts regardless of site productivity.
- Different parts of a tree contain different proportions of nutrients.

Nutrient Losses from Organic Matter

- Aside from trees, Organic matter in the following are important for maintaining site nutrient sinks:
  - Understory vegetation
  - That contained in the duff layer
  - That contained in the surface horizons of mineral soil

Nutrient Losses from Organic Matter

- Residue treatments impact the amount of residual organic matter.
- Broadcast burning generally produces the most nutrient content of the surface organic horizon immediately after treatment compared to residue removal.
- Residue removal may have impacts years after harvest on site productivity on poor sites.

The Bottom (Nutrient) Line

- Retention of leaves, needles and small branches is most important to maintaining soil productivity over time.
- More slash should be left on nutrient poor sites.
- The majority of sites in the Lake States have sufficient nutrient sinks to allow harvest of a high proportion of logging slash.
- Only Calcium has been shown to become limiting on most Lake States sites when residue is removed (aspen sites in particular).

Regeneration & Stand Development

- Physical barrier
- Microclimate impacts
- Short vs long-term impacts on stand establishment and development
- Similar to retained nutrient stocks, impacts on regen. & subsequent development are very site specific and temporal in nature!!

Wildlife

- Impacts on wildlife vary by species.
- Residue retention provides cover for small mammals & birds but damage to new regeneration may result.
- Residue retention discourages larger ungulates due to the physical barrier it presents.
- Residue removal will result in faster development of forbs and favor species dependant on them.

Microbes

- Nitrogen availability is especially sensitive to microbial activity.
- Fine residue in close contact or incorporated in the soil will speed microbial activity.
- Large amount of residue will result in a build-up of microbial activity which can result in temporary nitrogen deficiency.

Conclusions

- The majority of studies on alternative residue treatments have not been conducted in the Lake States.
- The most concentrated period of research on this topic occurred in the 1970's and 1980's.
- Most research suggests that removal of residue on nutrient budgets are short-term in nature *if the site has adequate reserves or will obtain them through weathering or deposition.*

Conclusions (continued)

- On nutrient poor sites with little organic matter in the mineral soil, the impact of slash removal will be more severe and long-term.
- Organic matter in the duff layer and first 5 cm of mineral soil are the most critical to maintaining soil productivity.
- Incorporation of fine material into mineral soil will increase microbial activity and fixation of available nutrients (especially nitrogen) but may also increase hydrological losses of available nutrient.

Conclusions (continued)

- Distribution of biomass and nutrients in different parts of a tree vary between species but not within species.
- Different species “up take” different volumes of nutrients. In the Lake States, research has shown that aspen’s high up take of calcium may lead to depletion on some sites.
- Nitrogen availability seems to be the most critical nutrient in ensuring adequate stand reproduction and growth following harvest.

Management Implications

- Everything is relative.
- Inherent site productivity is important in determining how much slash to harvest.
- Maintenance of the finest components of the logging slash on-site is most important.
- Research vs. real world field experience.
- In the vast majority of cases, harvest of logging slash either partially or almost entirely will not impact site productivity in the short or long-term.

Prior Investigation

- Targeted toward three possible sites.
- Explored use of mill residue and market dynamics.
  - Competing uses and users.
  - Existing market flows from generators and to users.
  - Competitive prices within those markets.

Prior Investigation (continued)

- Started investigating use of logging slash.
- Conducted economic analysis of Timberjack's wood energy harvester.
- Investigated hybrid poplar plantations for the site with the most surrounding farmland.

Logging slash looked the most promising

Follow-up Investigation

- **Collection questions**.
  - How much slash could realistically be harvested at any one site?
  - How much increased biomass could be generated from a sale by harvesting slash?
  - How much in a given area is available?
  - What is the best manner of collection?
  - How much would loggers have to receive for the harvested biomass to make it economically viable?
  - What barriers exist in making this viable?

Follow-up Investigation (continued)

- Documented 10 year logging history.
- Determined cuts by ownership.
- Verified amt. of slash available and how much should be left.
- Examined slash management contract requirements & ownership issues.
- Explored optimal collection methods and wood chip supply chain.

Realistic Harvest Amounts

- Closest estimate is 60 to 70% of total logging slash based on information supplied by Timberjack and loggers that chip on the landing or in woods.
- Various sources report that the amount of biomass removed from a site can increase 25 to 50% if logging slash is harvested depending on stand characteristics, species and sale layout.

In Summary

- Harvest of logging slash has the potential of generating a lot of usable biomass.
- In the Lake States this should not cause any loss of site productivity.
- Some changes would need to be made in state policy regarding payment of severance on the slash to make this viable.
- Loggers can collect this slash using existing available equipment.
- The whole system is not economically viable yet but its getting close!!!

Thank You

If you would like copies of the full “Logging Residue Removal” report or the other two mentioned, email me at:

resanalytics@att.net

(yes, I know it’s a funny email address but with Hacker for a last name… need I say more!)