Carbon Accounting

Tracking Carbon pools based on landscape management simulations linked to the findings in the CORRIM report

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Forests sequester carbon in several ways:

1. Standing forest
2. Forest products
3. Fossil fuel displacement
Objective

• Develop a carbon accounting system at the stand scale that can be integrated into the management of the standing forest at different spatial and temporal scales.

• Model is to be used with tree inventory data and growth and yield models.
The Landscape Management System (LMS) evaluates the performance of multiple forest stands over time.

- Inventory Information
- Stand Attributes
- Digital Elevation
- Spatial Characteristics

Link results of the CORRIM LCI Database to LMS for tracking carbon from the forest stand into products, fossil fuel displacement and product substitution.
LMS

Growth and Yield, Treatment Simulations, Tables, Graphs, Visualizations, More …
Silvicultural Pathways are Designed and Simulated

1999

- NO ACTION
- RETENTION
- DELAY
- THIN
- THIN, LATER RETENTION

2009

2049
Testing - Photorealistic Visualization

Visual comparison of photograph and visualization for Pack Forest. Visualization image is from (Wilson and McGaughey 2000)
LMS Outputs

- Volumes,
- Visuals
- Stand Structure Classes
- Habitat & Biodiversity Indices
- Economics
- Risk of Fire, Wind throw, Infestation, Disease
- Carbon
Carbon sequestered in Forests (Mt/ha)

40-year Rotation

80-year Rotation
Carbon sequestered in Products (Mt/ha)

40-year Rotation

80-year Rotation
Carbon sequestered in Forests & Products

40-year Rotation

80-year Rotation
Bio Fuel Displacement

Using Wood vs Fossil Fuel as energy

- Energy and emissions from wood boiler (lower efficiency) vs. natural gas boiler
- Fuel displacement is permanent and cumulative through time (renewable vs. non-renewable resources)

*Extreme case: burn all co-products for energy in the wood boiler*
Products Module: Displacement
Forests and Carbon Sequestration

- Carbon Calculations: Forest Resources
- Carbon Calculations: Forest Products
- Carbon as energy: biomass vs. fossil fuels
- Substitution when supply changes
Products Module: Substitution

• What happens when wood flow per hectare is increased or decreased (from the base)?

• Decreased wood available results in more steel houses and less wood houses (& vice versa)

• Substitution effect is the differential in carbon emissions when building Wood vs. Steel frame, i.e. from fossil fuel displacement.
Products Module:
Substitution effect from Base 40

-500 -300 -100 -500 -300 -100

Metric tons/ha

2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150 2160

40 year rotation
No Action
Substitution Sensitivity

- Carbon in forest, products and biomass displacement depends on CORRIM’s primary data.
- Carbon from substitution depends on secondary steel and concrete data and Int’l risk protocols.
- Interim to Final Report
  - Steel vs wood GWP down 82%
  - Concrete vs wood GWP down 38%
- Long rotations still not a solution in 100 years.
How does the intensity of management affect carbon sequestration?

- Is more carbon stored through thinning and fertilization?
- What do 10 more years of growth do to the carbon pools?
How does the intensity of management affect carbon sequestration?

The scenarios:

- 40 year BASE: PCT at age 15 to 680 TPHa.
- 40 high intensity: PCT at age 15 to 680 TPHa, CT at age 30 to 2/3 BA and fertilized.
- 50 high intensity: same as above grown extra 10 years.
- Intensity: function of CT & Fertilization.
Results Intensity Case

Metric tons/ha

40 BASE R
40 High R
50 High R

substitution
Last but not least:

Looking at Economics & C together

SEV calculation for all rotations

Guiding rate of 5%, with all tree management costs considered: $12/acre annual costs, $263.34/acre planting, $62.34 PCT, CT & H diameter specific cost, $45 fertilizer.
What about additionality?

More carbon with more intensive MNGT at essentially no cost

No Carbon increase from extra ten years

Long Term:

Differential in Ave. C = 7 Mt/ha
40 H SEV = $487
50 H SEV = $404

Differential in SEV = $83
Cost/ Mt of C = 83/7 = $12 / MT C
Current Environment
1.5 million acres of over-dense stands
Inland Washington - mostly federal
- Thousands of acres wildfires per year
- Habitat loss
- Costly post burn regeneration
- Sediment and erosion
- Aesthetic disaster - over-dense or burned

Future Environment
Thin stands to simulate earlier conditions
-use the small diameter material productively
- Habitat restoration
- Sustained over-story - leave trees
- Reduced magnitude disturbances
- Aesthetic restoration

Fire Risk Reduction and Carbon

Old Economics
Negative Returns for Thinning
(per acre at 3000 mbf/acre)

<table>
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<th></th>
<th>Revenue</th>
<th>Logging cost</th>
<th>Net</th>
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<td>Large Logs</td>
<td>$450</td>
<td>$-225</td>
<td>$+225</td>
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<tr>
<td>Small Logs</td>
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<td>Haul Cost</td>
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<tr>
<td>Haul Cost/ Acre</td>
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<td>$-345</td>
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</tbody>
</table>

Co-gen use of small diameter not economic
Many non market benefits ignored

Future Economics

Note: Co-gen investments will depend on stable supply

(1) Net thinning cost  $-345
(2) Reduced fire fighting  +200
(3) Reduced fatalities - value of life  +23
(4) Reduced facility losses  +15
(5) Community value for fire reduction  +20
(6) Carbon emission values at $5/ton  +45
(7) Electrical transmission cost reduction  +50
(8) Green energy credits  +50
(9) Regeneration savings  +200
(10) Tax receipts from economic activity  +100
(11) Water saved  +100

Net Value/Acre $+458

Co-gen use of small diameter not economic
Many non market benefits ignored
Thinning prescriptions

1) Remove 9” and below
2) Remove 50% Basal Area (BA) from below
3) Leave 45 ft²/acre BA from below
4) Remove 12” and greater (High Grade)
5) Wildfire Simulation
6) No Action
Forest Condition 2000

2010

Above 12”

Wildfire

No action

2035
Treatment Impacts on Costs & Revenues vs. Risk Reductions

Fire Risk Reduction Treatment Cost for Fremont National Forest

- Revenue ($)
- Fire Risk

Treatment: NA, higrade, below9, half_ba, ba_45

- Revenue Index:
  - high grade below: 45
  - half_ba: NA
  - ba_45: 0
Treatment Impacts on Carbon Sequestration

Total Metric Tons of Carbon in the Okanogan National Forest with Regen, Emissions, Displacement, and Substitution (20 year treatment schedule)
Carbon Policy Issues

- Afforestation sequesters carbon
  - Credits would increase the land value and acres
- Harvesting new forests at maturity adds to carbon pools
  - No management substitutes fossil fuel for renewable products.
- Intensive management sequesters more carbon
  - Costs too much to extend rotation even a little.
  - Credits could increase carbon from management
- Kyoto protocol ignores the biggest pools (products)

Surprises

- Long rotations that could be complimentary to other environmental values don’t help with carbon targets.
- No change to the optimum rotation- substitution drives the rotation age shorter.
- Bio fuels low efficiency only produces long term gains
The details:
Corrim:  WWW.CORRIM.ORG

Athena:  WWW.athenaSMI.ca

LMS:  http://LMS.cfr.washington.edu

USLCl database:  www.nrel.gov/lci