

Markets & Utilization



What do we do with these trees?
How do we do it?

S. Bick
May 2017

Northeast Forests, LLC

Full Presentation Here:

<http://bit.ly/BickMay2017>

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Topics

- New wood products
- Supply and demand trends
- Utilization standards (size and species)
- Economic analysis
- Discounted cash flow
- Stem quality & utilization
- Markets for wood products
- Harvesting systems as markets for treatment types

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Discounted Cash Flow in Forestry

$$\begin{aligned} \frac{\partial^2 LEV_1}{\partial t_1^2} &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) \\ &+ \left[\frac{\partial V_1(t_1, n_1)}{\partial t_1} + A_1(t_1) - r_1 V_1(t_1, n_1) - r_1 LEV_2 \right] (-r_1) \exp(-r_1 t_1) \\ &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) < 0 \end{aligned}$$

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Faustmann Formula (1849)

$$\begin{aligned}\frac{\partial^2 LEV_1}{\partial t_1^2} &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) \\ &\quad + \left[\frac{\partial V_1(t_1, n_1)}{\partial t_1} + A_1(t_1) - r_1 V_1(t_1, n_1) - r_1 LEV_2 \right] (-r_1) \exp(-r_1 t_1) \\ &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) < 0\end{aligned}$$

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Faustmann Formula Explained

$$\begin{aligned}\frac{\partial^2 LEV_1}{\partial t_1^2} &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) \\ &\quad + \left[\frac{\partial V_1(t_1, n_1)}{\partial t_1} + A_1(t_1) - r_1 V_1(t_1, n_1) - r_1 LEV_2 \right] (-r_1) \exp(-r_1 t_1) \\ &= \left[\frac{\partial^2 V_1(t_1, n_1)}{\partial t_1^2} + \frac{\partial A_1(t_1)}{\partial t_1} - r_1 \frac{\partial V_1(t_1, n_1)}{\partial t_1} \right] \exp(-r_1 t_1) < 0\end{aligned}$$

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Faustmann with more words...

$$\text{soil expectation value} = \frac{\text{cutting value at harvest age} - \text{planting costs} (1 + \text{discount rate})^{\text{harvestage}}}{(1 + \text{discount rate})^{\text{harvestage}} - 1}$$

OR

$$\text{Max } V_F = \frac{S(T) - w(1+r)^T}{(1+r)^T - 1}$$

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Variables – growth rates, stumpage prices, annual taxes, establishment & treatment costs, discount rate, rotation length

Fairly Certain:

- present costs
- growth rates
- discount rate
- rotation length/cutting cycle?

Uncertain:

- future costs
- future stumpage prices

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Discounted Cash Flow Approach

- Readily done in MS Excel
- If you can quantify an activity, you can model the cash flows
- Can you quantify future activities?



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Discount Rate

What is it?

- *the interest rate used in calculating the time value of money; rate selected is often that of the next best alternative investment*

Internal Rate of Return (IRR)

- *the discount rate at which the net present value of all the cash flows from a project or investment equal zero.*

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Scarcity



No

Value arises from scarcity.....



One 18" DBH, 2 log hard maple sawtimber tree is easily worth 20 pulpwood trees of the same size to a landowner
 $(0.240 \text{ MBF} \times \$375 = \$90; 0.453 \text{ cords} \times \$10 = \$4.53)$



No

Rule of Thumb

Since value arises from scarcity -long-term management to growing better timber will pay off.

- What's better?
- Why does it pay off?

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Utilization – trees to truckloads



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Location, species, size, shape, condition & stem position dictate market potential

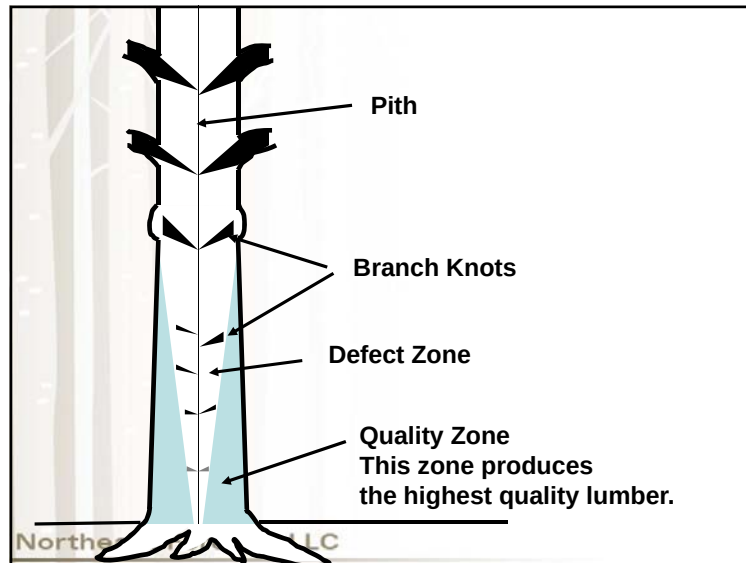


Nor

What, Where, How

- Stem characteristics & potential
- Primary markets
- Harvesting systems and productivity

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Knots

(next few slides from USFS WERC Hardwood Value Improvement Project)



- Cut or broken limbs or branch sprouts.
- Two types:
 - Sound
 - Unsound
- Knots are the most common grading defect.

Knot on the surface of the log always represents a defect in the underlying wood.

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Sound Knot

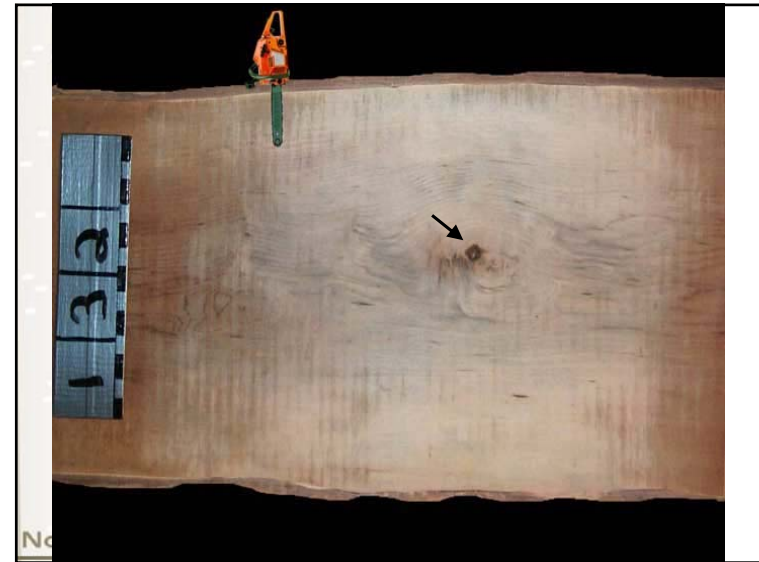


- Live branches cause sound defects with no associated rot.

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Tree Utilization & Value

- Butt log (16') usually contains 2/3 of the entire tree's value

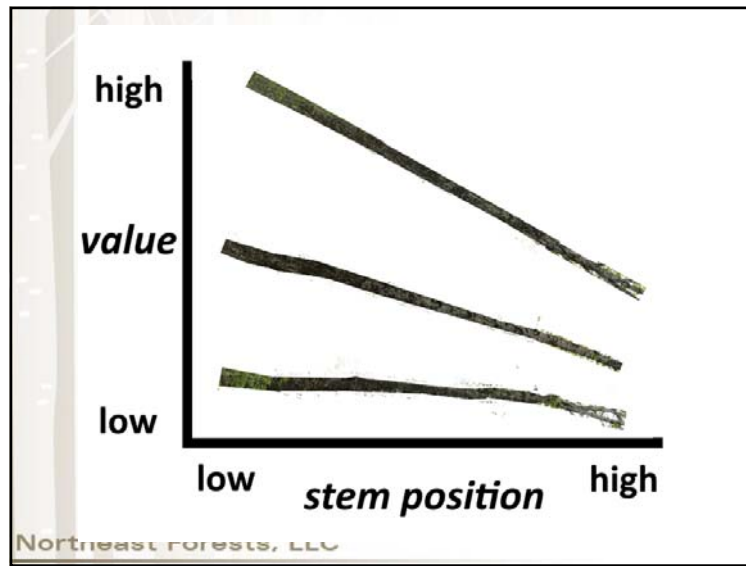
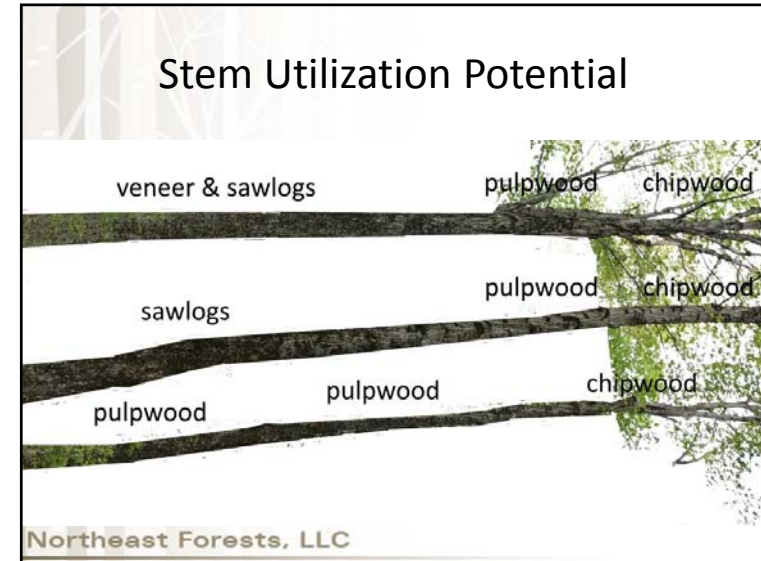


- In hardwood sawtimber, the 2 best logs (varying lengths) almost always contain 90% of the tree's value.

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Utilization & Market Deficiencies1

- Lack of destination markets for wood products leads to downgraded utilization

A photograph showing a red logging skidder operating in a forest clearing, surrounded by logs and debris. The skidder is positioned in the center, with its front end facing the viewer. The background shows a dense forest of green trees.

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Utilization & Market Deficiencies 2

- Lack of harvesting systems for wood products leads to incomplete utilization

A photograph showing a log lying on the forest floor next to a tree trunk. The log is cut at one end, showing a circular cross-section. The forest floor is covered with leaves and twigs.

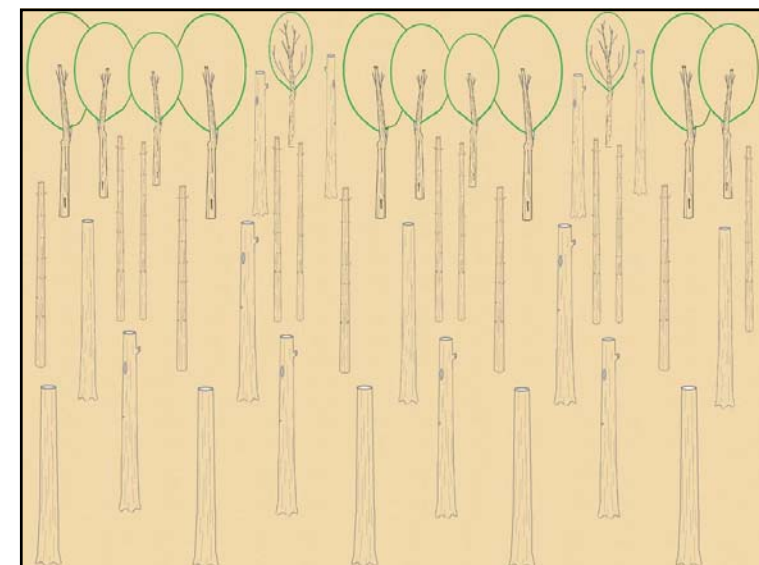
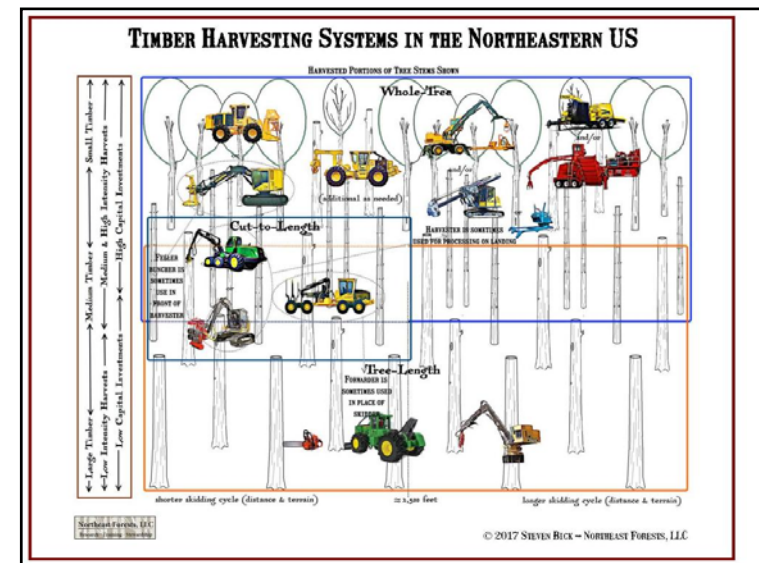
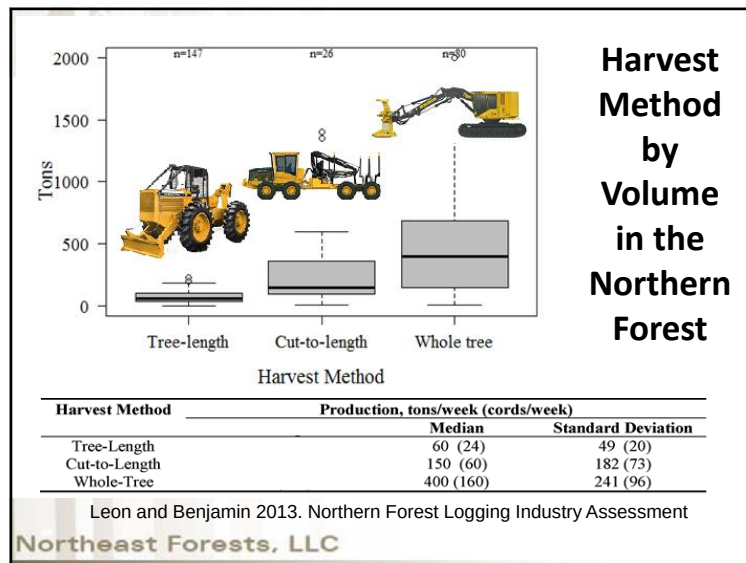
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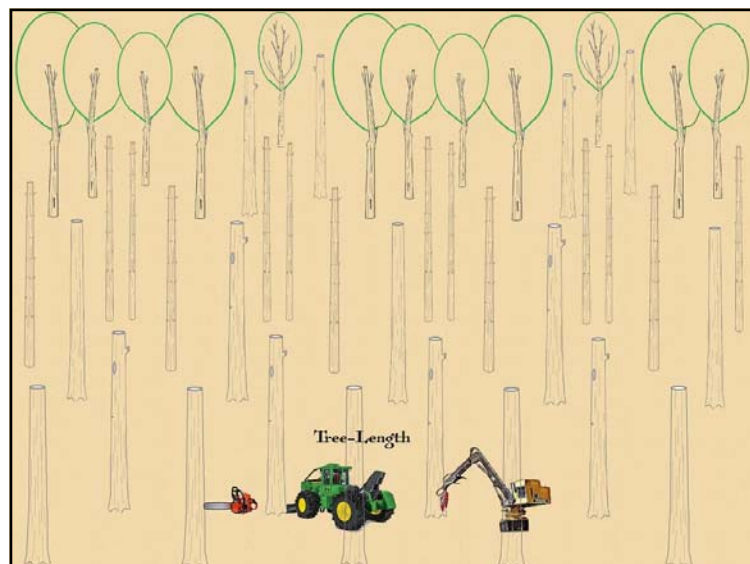
Timber Harvesting Systems in the Northeast

- Tree-Length
- Cut-to-Length
- Whole Tree

A photograph of a yellow caution sign with black text that reads: 'CAUTION LOGGING IN PROGRESS TRUCK TRAFFIC'. The sign is mounted on a metal post in a forest setting.

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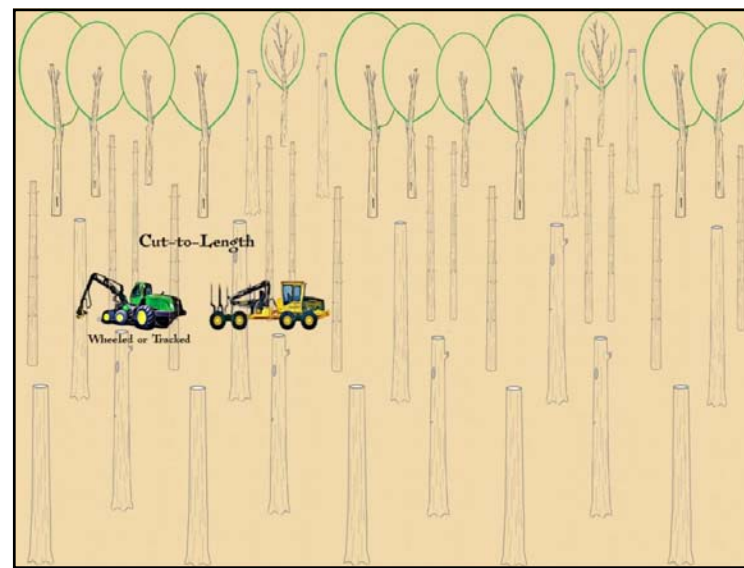
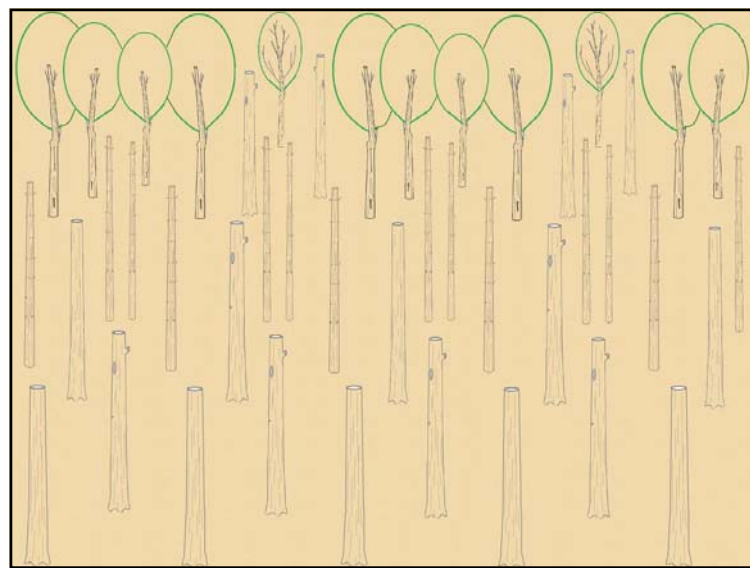
When is this system used?

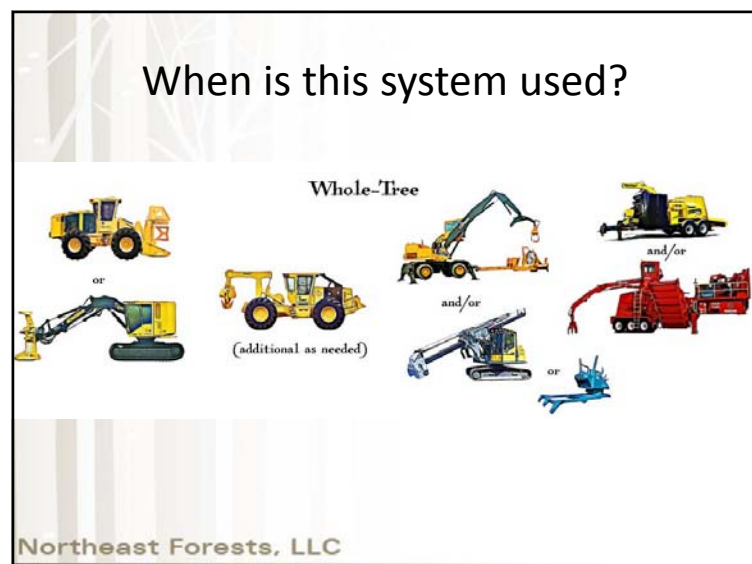
Cut-to-Length

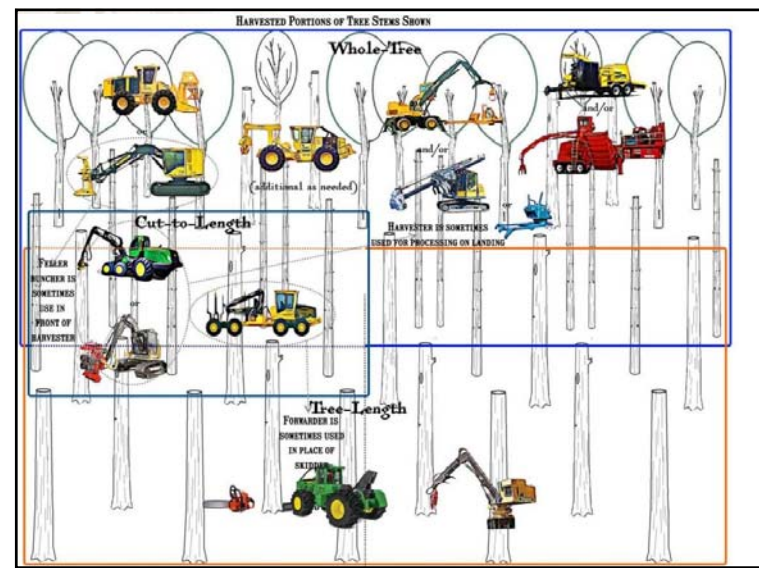
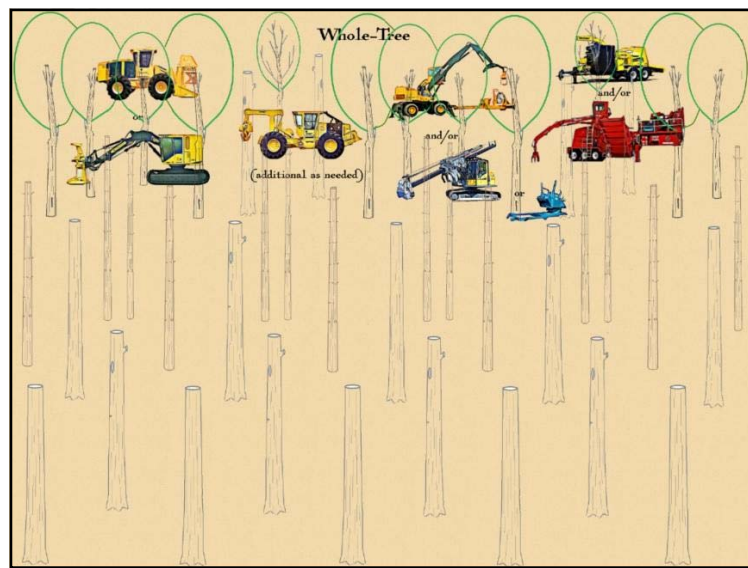
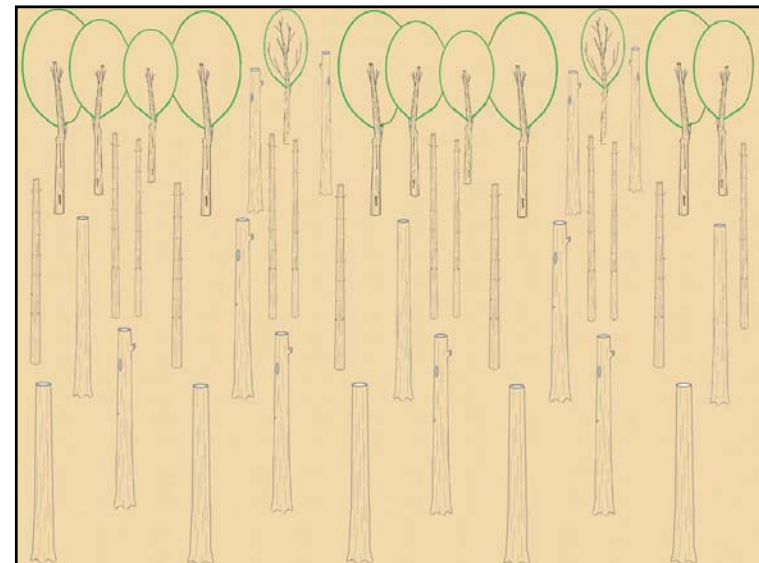


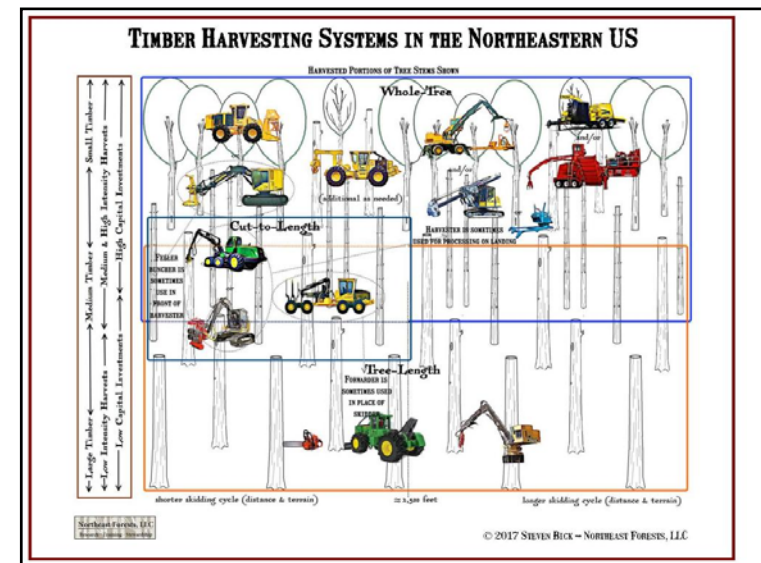
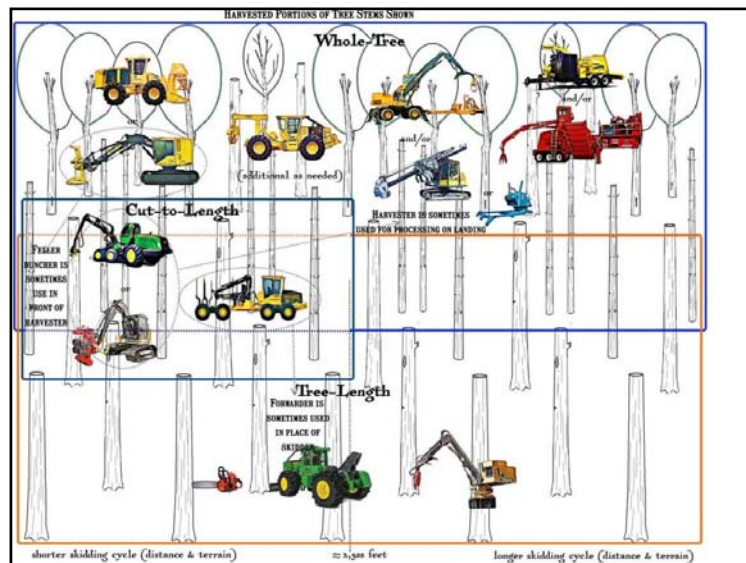
Wheeled or Tracked

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What is productivity?



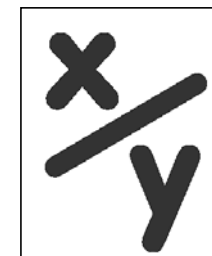
Logging
productivity is the
relationship
between output
(MBF, cords, tons)
and effort

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Production is a
measure of quantity



Productivity is a ratio



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Logging Productivity Notes

- Felling and bunching productivity is influenced by timber size, harvest intensity, terrain and operator skill;
- Skidding and forwarding productivity is influenced by distance, terrain, bunch (load) size and operator skill;
- Timber size and harvest intensity can compensate for skidding difficulty; and
- Skidding distance (or cycle time) can compensate for felling and bunching difficulty

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site potential for harvesting productivity



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Expressing Prescriptions in Terms of Productive Potential

Loads



Area



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Combined Hardwood Species TONS / Acre

Estimating
tons/acre

BA/Acre	30	50	65	80
30	17	26	34	41
40	22	35	45	55
50	28	44	57	69
60	33	53	68	83
70	39	62	79	97
80	44	70	90	110
90	50	79	102	124
100	55	88	113	138

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**Combined Hardwood Species
LOADS/ Acre(40 tons/load)**

tree height (ft)

Estimating loads/acre (40 tons)

BA/Acre	30	50	65	80
30	0.4	0.7	0.8	1.0
40	0.6	0.9	1.1	1.4
50	0.7	1.1	1.4	1.7
60	0.8	1.3	1.7	2.1
70	1.0	1.5	2.0	2.4
80	1.1	1.8	2.3	2.8
90	1.2	2.0	2.5	3.1
100	1.4	2.2	2.8	3.5

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**Combined Hardwood Species
LOADS/ Acre(30 tons/load)**

tree height (ft)

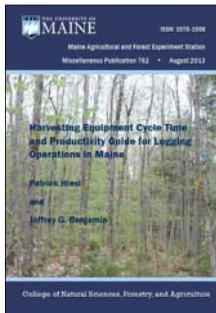
Estimating loads/acre (30 tons)

BA/Acre	30	50	65	80
30	0.6	0.9	1.1	1.4
40	0.7	1.2	1.5	1.8
50	0.9	1.5	1.9	2.3
60	1.1	1.8	2.3	2.8
70	1.3	2.1	2.6	3.2
80	1.5	2.3	3.0	3.7
90	1.7	2.6	3.4	4.1
100	1.8	2.9	3.8	4.6

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Productivity is the key any situation where prices are set by others.....

- Hiesl & Benjamin Pub
- Provides cycle time and productivity equations for various pieces of logging equipment
- An excellent resource to use in building a productivity index!



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Grapple Skidder Productivity

MAFES Miscellaneous Publication 762 21

Grapple Skidder Productivity (tons/PMH)
(total volume including biomass)

Distance (ft)	Bunch* size (tons)				
	2.0	3.0	4.0	5.0	6.0
100	24.4	33.8	46.9	65.2	90.5
200	23.2	32.2	44.7	62.0	86.1
300	22.0	30.6	42.5	59.0	81.9
400	21.0	29.1	40.4	56.1	77.9
500	19.9	27.7	38.4	53.4	74.1
600	19.0	26.3	36.6	50.8	70.5
700	18.0	25.1	34.8	48.3	67.0
800	17.2	23.8	33.1	45.9	63.8
900	16.3	22.7	31.5	43.7	60.6
1000	15.5	21.6	29.9	41.6	57.7
1100	14.8	20.5	28.5	39.5	54.9
1200	14.1	19.5	27.1	37.6	52.2
1300	13.4	18.6	25.8	35.8	49.7
1400	12.7	17.7	24.5	34.0	47.2
1500	12.1	16.8	23.3	32.4	44.9
1600	11.5	16.0	22.1	30.8	42.7
1700	10.9	15.2	21.1	29.3	40.7
1800	10.4	14.5	20.1	27.9	38.7
1900	9.9	13.7	19.1	26.5	36.8
2000	9.4	13.1	18.2	25.2	35.0
2100	9.0	12.4	17.3	24.0	33.3
2200	8.5	11.8	16.4	22.8	31.7
2300	8.1	11.3	15.6	21.7	30.1
2400	7.7	10.7	14.9	20.6	28.6
2500	7.3	10.2	14.1	19.6	27.2

*A bunch is also called a twitch or hitch.

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General WTH Logging Productivity Index

- Built from Hiesl & Benjamin Equations
- A value of 1 represents average conditions
- Other values are multiples or fractions of the average conditions, showing the effort needed in machine hours to equal average production
- A value of 0.5 is half as hard as average; a value of 2.0 is twice as hard as average

General Logging Productivity Index for Whole Tree Harvesting in the Northeast

lighter stocking (4" DBH) bunch size (bams) heavier stocking (10" DBH)

skidding distance (ft.)	2.0	2.0	3.0	3.0	4.0	4.0	5.0	5.0	6.0	6.0
100	1.4	1.4	1.2	1.1	0.9	0.8	0.7	0.7	0.5	0.4
200	1.4	1.4	1.2	1.1	1.0	0.8	0.7	0.7	0.5	0.5
300	1.5	1.4	1.2	1.1	1.0	0.8	0.7	0.7	0.5	0.5
400	1.5	1.4	1.3	1.1	1.0	0.8	0.7	0.7	0.5	0.5
500	1.5	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.5	0.5
600	1.6	1.5	1.3	1.2	1.0	0.9	0.8	0.7	0.5	0.5
700	1.6	1.6	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5
800	1.6	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	0.5
900	1.7	1.6	1.4	1.2	1.1	0.9	0.8	0.8	0.6	0.5
1000	1.7	1.7	1.4	1.3	1.1	1.0	0.8	0.8	0.6	0.5
1100	1.8	1.7	1.5	1.3	1.1	1.0	0.8	0.8	0.6	0.5
1200	1.8	1.8	1.5	1.3	1.2	1.0	0.9	0.8	0.6	0.6
1300	1.9	1.8	1.5	1.4	1.2	1.0	0.9	0.8	0.6	0.6
1400	1.9	1.9	1.6	1.4	1.2	1.1	0.9	0.8	0.6	0.6
1500	2.0	1.9	1.6	1.5	1.2	1.1	0.9	0.9	0.7	0.6
1600	2.0	2.0	1.6	1.5	1.3	1.1	0.9	0.9	0.7	0.6
1700	2.1	2.0	1.7	1.5	1.3	1.1	1.0	0.9	0.7	0.6
1800	2.2	2.1	1.7	1.6	1.3	1.2	1.0	0.9	0.7	0.7
1900	2.2	2.2	1.8	1.6	1.4	1.2	1.0	1.0	0.7	0.7
2000	2.3	2.2	1.8	1.7	1.4	1.2	1.0	1.0	0.7	0.7
2100	2.4	2.3	1.9	1.7	1.4	1.3	1.1	1.0	0.8	0.7
2200	2.4	2.4	1.9	1.8	1.5	1.3	1.1	1.0	0.8	0.7
2300	2.5	2.5	2.0	1.8	1.5	1.4	1.1	1.1	0.8	0.8
2400	2.6	2.6	2.1	1.9	1.6	1.4	1.2	1.1	0.8	0.8

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Example WTH Productivity index for long skids

- With skidding distances up to one mile
- 3-4 fold range in productivity levels
- Greatest increase in machine hours is in skidding
- Skidding conditions in northern forest region of NY, VT NH, and a portion of ME are considerably longer than in many other areas

Custom Productivity Index Contrast Logging on Company Levels (3,600', 10" DBH)

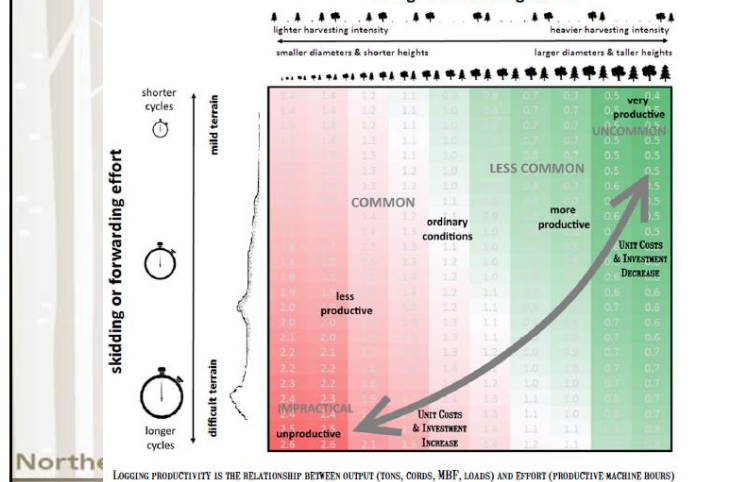
Index numbers tell the ratio of effort (in P&H) necessary to achieve an average level of production.

skidding distance (ft.)	6	7	8	9	10	11	12	13	14	15	16
200	0.61	0.57	0.44	0.41	0.32	0.30	0.29	0.23	0.21	0.17	0.16
400	0.65	0.60	0.47	0.44	0.34	0.32	0.30	0.24	0.23	0.18	0.17
600	0.68	0.64	0.49	0.46	0.36	0.34	0.32	0.25	0.24	0.19	0.18
800	0.73	0.68	0.52	0.50	0.38	0.36	0.35	0.27	0.26	0.20	0.20
1000	0.77	0.73	0.56	0.53	0.41	0.39	0.37	0.29	0.27	0.22	0.21
1200	0.83	0.78	0.60	0.57	0.43	0.41	0.40	0.31	0.29	0.23	0.22
1400	0.88	0.84	0.64	0.61	0.46	0.44	0.43	0.33	0.32	0.24	0.24
1600	0.95	0.91	0.68	0.65	0.50	0.48	0.46	0.35	0.34	0.26	0.25
1800	1.02	0.98	0.73	0.71	0.53	0.51	0.50	0.38	0.37	0.28	0.27
2000	1.10	1.05	0.79	0.76	0.57	0.55	0.54	0.41	0.40	0.30	0.29
2200	1.18	1.14	0.85	0.82	0.62	0.60	0.58	0.44	0.43	0.33	0.32
2400	1.28	1.23	0.92	0.89	0.67	0.65	0.63	0.47	0.46	0.35	0.34
2600	1.38	1.34	1.00	0.97	0.72	0.70	0.69	0.51	0.50	0.38	0.37
2800	1.50	1.46	1.08	1.05	0.78	0.76	0.75	0.56	0.55	0.41	0.40
3000	1.63	1.58	1.17	1.14	0.85	0.83	0.81	0.60	0.59	0.44	0.44
3200	1.77	1.73	1.27	1.25	0.92	0.90	0.89	0.66	0.65	0.48	0.48
3400	1.92	1.88	1.39	1.36	1.00	0.98	0.97	0.72	0.70	0.53	0.52
3600	2.10	2.05	1.51	1.48	1.09	1.07	1.06	0.78	0.77	0.57	0.56
3800	2.29	2.25	1.65	1.62	1.19	1.17	1.16	0.85	0.84	0.62	0.62
4000	2.50	2.46	1.80	1.77	1.30	1.28	1.27	0.93	0.92	0.68	0.67
4200	2.73	2.69	1.97	1.94	1.42	1.40	1.39	1.02	1.01	0.74	0.74
4400	2.99	2.95	2.16	2.13	1.56	1.54	1.52	1.12	1.10	0.81	0.81
4600	3.28	3.23	2.36	2.33	1.71	1.69	1.67	1.22	1.21	0.89	0.88
4800	3.59	3.55	2.59	2.56	1.87	1.85	1.84	1.34	1.33	0.97	0.97
5000	3.94	3.90	2.84	2.81	2.05	2.03	2.01	1.47	1.46	1.07	1.06

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NORTHEASTERN LOGGING PRODUCTIVITY SPECTRUM

felling and bunching effort



Example WTH Productivity index for long skids

- With skidding distances up to one mile
- 3-4 fold range in productivity levels
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600	0.68	0.64	0.49	0.46	0.36	0.34	0.32	0.25	0.24	0.19	0.18
800	0.73	0.68	0.52	0.50	0.38	0.36	0.35	0.27	0.26	0.20	0.20
1000	0.77	0.73	0.56	0.53	0.41	0.39	0.37	0.29	0.27	0.22	0.21
1200	0.83	0.78	0.60	0.57	0.43	0.41	0.40	0.31	0.29	0.23	0.22
1400	0.88	0.84	0.64	0.61	0.46	0.44	0.43	0.33	0.32	0.24	0.24
1600	0.95	0.91	0.68	0.65	0.50	0.48	0.46	0.35	0.34	0.26	0.25
1800	1.02	0.98	0.73	0.71	0.53	0.51	0.50	0.38	0.37	0.28	0.27
2000	1.10	1.05	0.79	0.76	0.57	0.55	0.54	0.41	0.40	0.30	0.29
2200	1.18	1.14	0.85	0.82	0.62	0.60	0.58	0.44	0.43	0.33	0.32
2400	1.28	1.23	0.92	0.89	0.67	0.65	0.63	0.47	0.46	0.35	0.34
2600	1.38	1.34	1.00	0.97	0.72	0.70	0.69	0.51	0.50	0.38	0.37
2800	1.50	1.46	1.08	1.05	0.78	0.76	0.75	0.56	0.55	0.41	0.40
3000	1.63	1.58	1.17	1.14	0.85	0.83	0.81	0.60	0.59	0.44	0.44
3200	1.77	1.73	1.27	1.25	0.92	0.90	0.89	0.66	0.65	0.48	0.48
3400	1.92	1.88	1.39	1.36	1.00	0.98	0.97	0.72	0.70	0.53	0.52
3600	2.10	2.05	1.51	1.48	1.09	1.07	1.06	0.78	0.77	0.57	0.56
3800	2.29	2.25	1.65	1.62	1.19	1.17	1.16	0.85	0.84	0.62	0.62
4000	2.50	2.46	1.80	1.77	1.30	1.28	1.27	0.93	0.92	0.68	0.67
4200	2.73	2.69	1.97	1.94	1.42	1.40	1.39	1.02	1.01	0.74	0.74
4400	2.99	2.95	2.16	2.13	1.56	1.54	1.52	1.12	1.10	0.81	0.81
4600	3.28	3.23	2.36	2.33	1.71	1.69	1.67	1.22	1.21	0.89	0.88
4800	3.59	3.55	2.59	2.56	1.87	1.85	1.84	1.34	1.33	0.97	0.97
5000	3.94	3.90	2.84	2.81	2.05	2.03	2.01	1.47	1.46	1.07	1.06

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WTH Productivity Example

Suppose that average conditions for an operation involved cutting 10" DBH trees and skidding them 3,400'.

- Harvesting 12" trees and skidding them 4,400' will take 50% more effort in machine hours (index is 1.52)
- Harvesting 14" trees and skidding them 2,600' will take 50% less effort in machine hours (index is 0.5)
- Harvesting 14" trees and skidding them 4,200' is very similar to your average conditions (index is 1.1)
- Harvesting 9" trees and skidding them 4,800' will take a great deal more effort in machine hours (index is 2.56)

What are the financial consequences of each situation?

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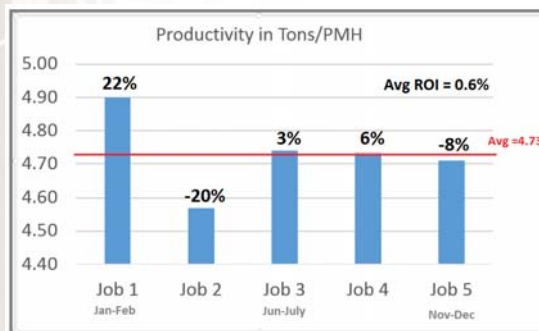


PATH 2.1 WTH Example

- Mechanized harvesting crew
- 1 tracked feller buncher, 2 grapple skidders, stroke delimber, loader with slasher, bulldozer
- pulpwood & sawlog production
- financial measurements for various harvesting situations over one year

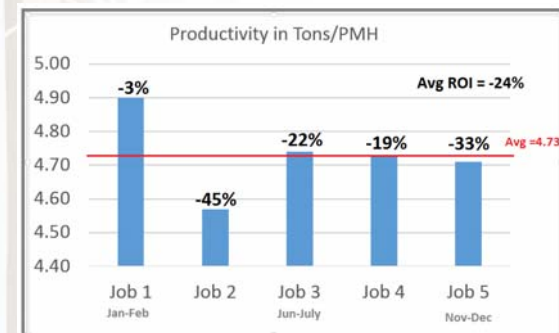
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Baseline Production



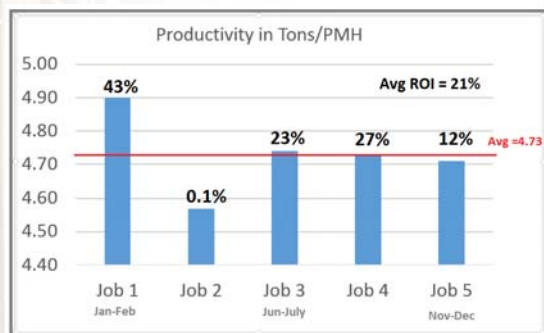
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What if the fuel price goes up by \$1/gallon?



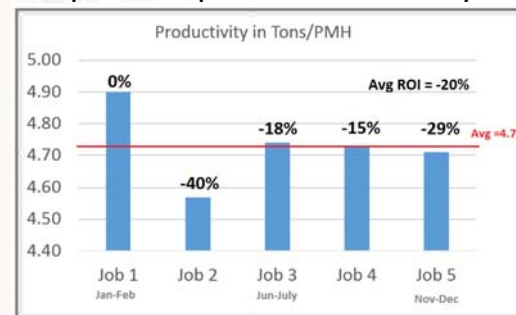
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What if product prices increase by \$1/ton?



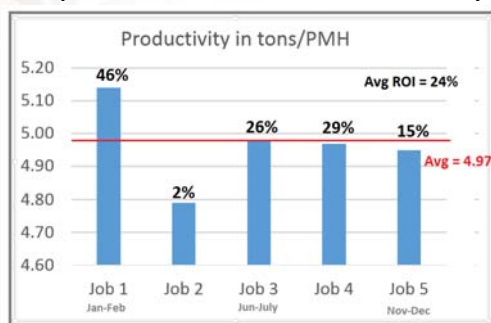
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What if product prices decrease by \$1/ton?



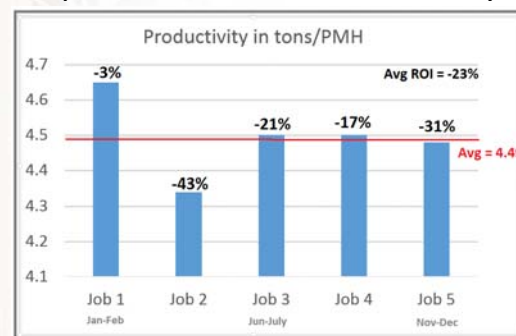
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What if production rates increase by 5%?



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What if production rates decrease by 5%?



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Summary

- Normal-ish conditions: ROI = 0.6%
- Fuel price increase by \$1/gallon: ROI = -24.4%
- Product prices increase by \$1/ton: ROI = 21%
- Product prices decrease by \$1/ton: ROI = -20.4%
- Production increases by 5%: ROI = 23.6%
- Production decreases by 5%: ROI = -23%

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Tree-Length System Productivity



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Chainsaw Productivity

CF/PMH 15 trees per acre				Loads/PMH 15 trees per acre				PMH per Load 15 trees per acre			
Hgt.				Hgt.				Hgt.			
DBH	50'	60'	70'	DBH	50'	60'	70'	DBH	50'	60'	70'
10	515	570	619	10	0.52	0.57	0.62	10	1.9	1.8	1.6
11	544	601	650	11	0.54	0.60	0.65	11	1.8	1.7	1.5
12	570	629	678	12	0.57	0.63	0.68	12	1.8	1.6	1.5
13	596	654	703	13	0.60	0.65	0.70	13	1.7	1.5	1.4
14	619	678	725	14	0.62	0.68	0.73	14	1.6	1.5	1.4
15	642	700	744	15	0.64	0.70	0.74	15	1.6	1.4	1.3
16	663	719	760	16	0.66	0.72	0.76	16	1.5	1.4	1.3
17	682	736	773	17	0.68	0.74	0.77	17	1.5	1.4	1.3
18	700	751	784	18	0.70	0.75	0.78	18	1.4	1.3	1.3
19	716	764	791	19	0.72	0.76	0.79	19	1.4	1.3	1.3
20	731	775	795	20	0.73	0.77	0.80	20	1.4	1.3	1.3
21	744	784	797	21	0.74	0.78	0.80	21	1.3	1.3	1.3
22	756	790	795	22	0.76	0.79	0.80	22	1.3	1.3	1.3

from Wang, et al, 2004 Productivity Equation

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Cable Skidder Productivity

CF/PMH					Loads/PMH					PMH/load				
cycle time					cycle time					cycle time				
Hitch Size (cubic feet)					Hitch Size (cubic feet)					Hitch Size (cubic feet)				
50	100	150	200		50	100	150	200		50	100	150	200	
15	200	400	600	800	15	0.20	0.40	0.60	0.80	15	5.0	2.5	1.7	1.3
30	100	200	300	400	30	0.10	0.20	0.30	0.40	30	10.0	5.0	3.3	2.5
45	67	133	200	267	45	0.07	0.13	0.20	0.27	45	15.0	7.5	5.0	3.8
60	50	100	150	200	60	0.05	0.10	0.15	0.20	60	20.0	10.0	6.7	5.0
75	40	80	120	160	75	0.04	0.08	0.12	0.16	75	25.0	12.5	8.3	6.3
90	33	67	100	133	90	0.03	0.07	0.10	0.13	90	30.0	15.0	10.0	7.5
105	29	57	86	114	105	0.03	0.07	0.10	0.13	105	35.0	17.5	11.7	8.8
120	25	50	75	100	120	0.03	0.05	0.08	0.10	120	40.0	20.0	13.3	10.0

*1,000 cubic feet = one 48' trailer load of logs, pulpwood, firewood or any combination of these products;

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Tree-Length Productivity

Tree-Length Felling & Skidding PMH per Load for Northeastern Hardwood Stands*

Cycle Time (min)	DBH classes	50' hgt; 10 hitches/load				60' hgt; 6-7 hitches/load				70' hgt; 5 hitches/load			
		felling PMH	skidding PMH	total PMH	f/s ratio	felling PMH	skidding PMH	total PMH	f/s ratio	felling PMH	skidding PMH	total PMH	f/s ratio
15'	small (14")	1.6	2.5	4.1	0.64	1.5	1.7	3.2	0.88	1.4	1.3	2.7	1.08
	medium (18")	1.4	2.5	3.9	0.56	1.3	1.7	3.0	0.76	1.3	1.3	2.6	1.00
	large (22")	1.3	2.5	3.8	0.52	1.3	1.7	3.0	0.76	1.3	1.3	2.6	1.00
30'	small (14")	1.6	5.0	6.6	0.32	1.5	3.3	4.8	0.45	1.4	2.5	3.9	0.56
	medium (18")	1.4	5.0	6.4	0.28	1.3	3.3	4.6	0.39	1.3	2.5	3.8	0.52
	large (22")	1.3	5.0	6.3	0.26	1.3	3.3	4.6	0.39	1.3	2.5	3.8	0.52
45'	small (14")	1.6	7.5	9.1	0.21	1.5	5.0	6.5	0.30	1.4	3.8	5.2	0.37
	medium (18")	1.4	7.5	8.9	0.19	1.3	5.0	6.3	0.26	1.3	3.8	5.1	0.34
	large (22")	1.3	7.5	8.8	0.17	1.3	5.0	6.3	0.26	1.3	3.8	5.1	0.34
60'	small (14")	1.6	10.0	11.6	0.16	1.5	6.7	8.2	0.22	1.4	5.0	6.4	0.28
	medium (18")	1.4	10.0	11.4	0.14	1.3	6.7	8.0	0.19	1.3	5.0	6.3	0.26
	large (22")	1.3	10.0	11.3	0.13	1.3	6.7	8.0	0.19	1.3	5.0	6.3	0.26
75'	small (14")	1.6	12.5	14.1	0.13	1.5	8.3	9.8	0.18	1.4	6.3	7.7	0.22
	medium (18")	1.4	12.5	13.9	0.11	1.3	8.3	9.6	0.16	1.3	6.3	7.6	0.21
	large (22")	1.3	12.5	13.8	0.10	1.3	8.3	9.6	0.16	1.3	6.3	7.6	0.21
90'	small (14")	1.6	15.0	16.6	0.11	1.5	10.0	11.5	0.15	1.4	7.5	8.9	0.19
	medium (18")	1.4	15.0	16.4	0.09	1.3	10.0	11.3	0.13	1.3	7.5	8.8	0.17
	large (22")	1.3	15.0	16.3	0.09	1.3	10.0	11.3	0.13	1.3	7.5	8.8	0.17
105'	small (14")	1.6	17.5	19.1	0.09	1.5	11.7	13.2	0.13	1.4	8.8	10.2	0.16
	medium (18")	1.4	17.5	18.9	0.08	1.3	11.7	13.0	0.11	1.3	8.8	10.1	0.15
	large (22")	1.3	17.5	18.8	0.07	1.3	11.7	13.0	0.11	1.3	8.8	10.1	0.15
120'	small (14")	1.6	20.0	21.6	0.08	1.5	13.3	14.8	0.11	1.4	10.0	11.4	0.14
	medium (18")	1.4	20.0	21.4	0.07	1.3	13.3	14.6	0.10	1.3	10.0	11.3	0.13
	large (22")	1.3	20.0	21.3	0.07	1.3	13.3	14.6	0.10	1.3	10.0	11.3	0.13

*1,000 cubic feet = one 48' trailer load of logs, pulpwood, firewood or any combination of these products;
= conditions under which productivity potential is less than one load per 10 PMH day

Northeast Forests, LLC

Tree-Length Felling & Skidding PMH per Load for Northeastern Hardwood Stands*

Cycle Time (min)	DBH classes	50' hgt; 10 hitches/load				60' hgt; 6-7 hitches/load				70' hgt; 5 hitches/load			
		felling PMH	skidding PMH	total PMH	f/s ratio	felling PMH	skidding PMH	total PMH	f/s ratio	felling PMH	skidding PMH	total PMH	f/s ratio
15'	small (14")	1.6	2.5	4.1	0.64	1.5	1.7	3.2	0.88	1.4	1.3	2.7	1.08
	medium (18")	1.4	2.5	3.9	0.56	1.3	1.7	3.0	0.76	1.3	1.3	2.6	1.00
	large (22")	1.3	2.5	3.8	0.52	1.3	1.7	3.0	0.76	1.3	1.3	2.6	1.00
30'	small (14")	1.6	5.0	6.6	0.32	1.5	3.3	4.8	0.45	1.4	2.5	3.9	0.56
	medium (18")	1.4	5.0	6.4	0.28	1.3	3.3	4.6	0.39	1.3	2.5	3.8	0.52
	large (22")	1.3	5.0	6.3	0.26	1.3	3.3	4.6	0.39	1.3	2.5	3.8	0.52
45'	small (14")	1.6	7.5	9.1	0.21	1.5	5.0	6.5	0.30	1.4	3.8	5.2	0.37
	medium (18")	1.4	7.5	8.9	0.19	1.3	5.0	6.3	0.26	1.3	3.8	5.1	0.34
	large (22")	1.3	7.5	8.8	0.17	1.3	5.0	6.3	0.26	1.3	3.8	5.1	0.34
60'	small (14")	1.6	10.0	11.6	0.16	1.5	6.7	8.2	0.22	1.4	5.0	6.4	0.28
	medium (18")	1.4	10.0	11.4	0.14	1.3	6.7	8.0	0.19	1.3	5.0	6.3	0.26
	large (22")	1.3	10.0	11.3	0.13	1.3	6.7	8.0	0.19	1.3	5.0	6.3	0.26
75'	small (14")	1.6	12.5	14.1	0.13	1.5	8.3	9.8	0.18	1.4	6.3	7.7	0.22
	medium (18")	1.4	12.5	13.9	0.11	1.3	8.3	9.6	0.16	1.3	6.3	7.6	0.21
	large (22")	1.3	12.5	13.8	0.10	1.3	8.3	9.6	0.16	1.3	6.3	7.6	0.21
90'	small (14")	1.6	15.0	16.6	0.11	1.5	10.0	11.5	0.15	1.4	7.5	8.9	0.19
	medium (18")	1.4	15.0	16.4	0.09	1.3	10.0	11.3	0.13	1.3	7.5	8.8	0.17
	large (22")	1.3	15.0	16.3	0.09	1.3	10.0	11.3	0.13	1.3	7.5	8.8	0.17
105'	small (14")	1.6	17.5	19.1	0.09	1.5	11.7	13.2	0.13	1.4	8.8	10.2	0.16
	medium (18")	1.4	17.5	18.9	0.08	1.3	11.7	13.0	0.11	1.3	8.8	10.1	0.15
	large (22")	1.3	17.5	18.8	0.07	1.3	11.7	13.0	0.11	1.3	8.8	10.1	0.15
120'	small (14")	1.6	20.0	21.6	0.08	1.5	13.3	14.8	0.11	1.4	10.0	11.4	0.14
	medium (18")	1.4	20.0	21.4	0.07	1.3	13.3	14.6	0.10	1.3	10.0	11.3	0.13
	large (22")	1.3	20.0	21.3	0.07	1.3	13.3	14.6	0.10	1.3	10.0	11.3	0.13

*1,000 cubic feet = one 48' trailer load of logs, pulpwood, firewood or any combination of these products;
= conditions under which productivity potential is less than one load per 10 PMH day

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Tree-Length PMH/Load

Tree-Length Felling & Skidding PMH/load for Hardwood Stands in the Northeast*

Cycle Time (min)	10 hitches/load	6-7 hitches/load	5 hitches/load
	total PMH	total PMH	total PMH
15'	3.9	3.0	2.6
30'	6.4	4.6	3.8
45'	8.9	6.3	5.1
60'	11.4	8.0	6.3
75'	13.9	9.6	7.6
90'	16.4	11.3	8.8
105'	18.9	13.0	10.1
120'	21.4	14.6	11.3

*1,000 cubic feet = one 48' trailer load of logs, pulpwood, firewood or any combination of these products;
= conditions under which productivity potential is less than one load per 10 PMH day

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Tree-Length Felling & Skidding PMH/load for Hardwood Stands in the Northeast*

Cycle Time (min)	10 hitches/load	6-7 hitches/load	5 hitches/load
	total PMH	total PMH	total PMH
15'	3.9	3.0	2.6
30'	6.4	4.6	3.8
45'	8.9	6.3	5.1
60'	11.4	8.0	6.3
75'	13.9	9.6	7.6
90'	16.4	11.3	8.8
105'	18.9	13.0	10.1
120'	21.4	14.6	11.3

*1,000 cubic feet = one 48' trailer load of logs, pulpwood, firewood or any combination of these products;
= conditions under which productivity potential is less than one load per 10 PMH day

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Financial Implications of Lower Productivity in Tree-Length Systems

- Example – 1 person system, producing 5 loads per week (2 sawlogs; 3 pulpwood);
- ROI is 15%; a living wage and an acceptable return on the investment
- Production drops to 4 loads per week;
- ROI is -108%; loss of equipment equity and a good reason to look for another job;
- What is the implication for silvicultural treatments?

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Cut-to-Length Systems



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Two Parts

MAFES Miscellaneous Publication 762

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Harvester Productivity (tons/PMH)

(merchantable volume, top = 3 inches)

DBH (in)	SW (tons/PMH)	HW (tons/PMH)	DBH (in)	SW (tons/PMH)	HW (tons/PMH)
4.0	4.7	3.4	11.0	40.5	29.5
4.5	5.4	4.0	11.5*	47.3	34.4
5.0	6.3	4.6	12.0*	55.1	40.2
5.5	7.4	5.4	12.5*	64.4	46.9
6.0	8.6	6.3	13.0*	75.1	54.7
6.5	10.1	7.3	13.5*	87.7	63.8
7.0	11.8	8.6	14.0*	102.3	74.5
7.5	13.7	10.0	14.5*	119.4	87.0
8.0	16.0	11.7	15.0*	139.4	101.5
8.5	18.7	13.6	15.5*	162.6	118.5
9.0	21.8	15.9	16.0*	189.8	138.2
9.5	25.5	18.6	16.5*	221.5	161.3
10.0	29.7	21.6	17.0*	258.5	188.3
10.5	34.7	25.3			

Softwood = balsam fir, and spruce
Hardwood = paper birch, quaking aspen

*Productivity information for dbh greater than 11 inches is extrapolated since information was only collected for dbh up to 11 inches.

Nor

MAFES Miscellaneous Publication 762

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Forwarder Productivity (tons/PMH)

(merchantable volume) 150 logs per load

Distance (ft)	Log weight (tons)				
	0.05	0.06	0.07	0.08	0.09
400	15.0	14.6	18.1	19.7	21.3
500	14.6	14.2	17.7	19.3	20.9
600	14.2	13.8	17.3	18.9	20.5
700	13.8	13.4	16.9	18.5	20.1
800	13.4	13.0	16.5	18.1	19.7
900	13.0	12.6	16.1	17.7	19.3
1000	12.6	12.2	15.7	17.3	18.9
1100	12.2	11.8	15.3	16.9	18.5
1200	11.8	11.4	14.9	16.5	18.1
1300	11.4	11.0	14.5	16.1	17.7
1400	11.0	10.6	14.1	15.7	17.3
1500	10.6	10.2	13.7	15.3	16.9
1600	10.2	9.8	13.3	14.9	16.5
1700	9.8	9.4	12.9	14.5	16.1
1800	9.4	9.0	12.5	14.1	15.7
1900	9.0	8.6	12.1	13.7	15.3
2000	8.6	8.2	11.7	13.3	14.9
2100	8.2	7.8	11.3	12.9	14.5

A log with 0.05 tons weight is 14 ft long and has a diameter of 5 in.
A log with 0.06 tons weight is 14 ft long and has a diameter of 6 in.
A log with 0.07 tons weight is 14 ft long and has a diameter of 7 in.
A log with 0.08 tons weight is 12 ft long and has a diameter of 7 in.
A log with 0.09 tons weight is 14 ft long and has a diameter of 7 in.

CTL is limited by distance



Northeast

CTL

- Ideal in the right situations
- Unprofitable in the wrong situations



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Summary

- Discounted cash flow methods help compare alternatives;
- Grow good timber – it's a scarce resource;
- Strong markets allow full utilization; poor markets skew utilization downward;
- Match harvesting systems to prescriptions; and
- Actions that lower harvesting productivity cost more; optimal results require adjustments

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Full Presentation Here:

<http://bit.ly/BickMay2017>



Northeast Forests, LLC

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