Stand Density Management

Operational Experience and Harvesting Technology: Issues, Costs and Opportunities

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Introduction

I will focus my presentation on our experiences with three elements of the operational aspects of commercial stand density management: the issues, the costs, and the opportunities.

Timberjack's worldwide sales and after-sales support network includes some 80 independent dealers and 250 outlets. In Finland, Sweden, Norway and Brazil, retail sales are handled by Timberjack's own retail companies (Figure 1).

Worldwide, there is a tremendous focus in forestry because the strong demand for wood products combined with preservationist pressures have created regional fiber shortages. Commercial stand density management or thinning is seen as a way to reduce the shortfalls in fiber supply. We are proud to have a very dedicated Timberjack dealer network worldwide focused to support loggers in these efforts.

Locally, we are pleased to be supported by Coneco Equipment here in Alberta, and by Terratech Equipment in Saskatchewan and B.C.

Commercial thinning activity in North America

Since the "discovery" of the spotted owl in the Pacific Northwest, commercial thinning activity in second growth has intensified due to the reduction in clearcut harvests. There are many active and progressive commercial thinning operations and programs in Washington, Oregon, and California. In Texas and the southern U.S.A., there are many commercial thinning operations in pine plantations, while in the Lake States there is a strong push to "thinning or selective logging."

In Canada, there have been commercial thinning

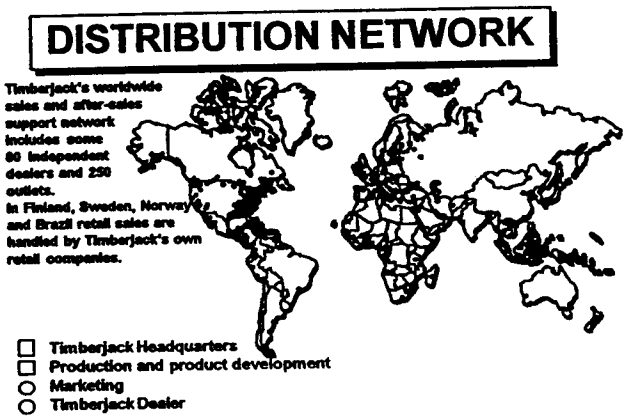

Figure 1.
Timberjack Group's distribution network

operations for many years. In British Columbia on Vancouver Island, there have been commercial cut-to-length logging operations since 1992, and there has been extensive activity in the Thunder Bay, Ontario, region to thin the mixed wood boreal forest. Northwest Quebec has done studies for the past four years. In the Atlantic region, J.D. Irving has been focused on commercial thinning for many years. Here in Alberta there have been many experiments with thinning for several years.

Trees, machines and people

Successful logging or stand density management combines the right mix of three things: trees, machines, and people.

A. Trees

The predominant forest type in Alberta is the Boreal Plains, dominated by trembling aspen, white spruce, and lodgepole pine, and mixtures of these species.

The forest machines of today can physically handle the species, tree sizes, and most of the operating conditions found in the commercial forest areas of Alberta.

B. Machines

At Timberjack we are confident that we have the right machines available for most professional harvesting applications for both the full tree and cut-to-length (CTL) logging methods with two CTL harvesters, five feller bunchers, four forwarders, ten sizes of skidders and four log loaders (Figure 2).

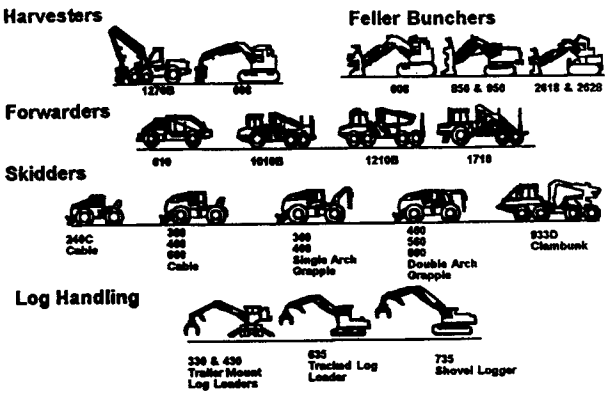

Figure 2.
Timberjack product range

At Timberjack, we recognize that although our full tree product line of machines is very productive, the machines and the full tree logging method are not appropriate to commercial thinning or stand density management treatments except in special circumstances. Therefore the focus of my discussions will be on the Timberjack cut-to-length product line of harvesters and forwarders (Figure 3).

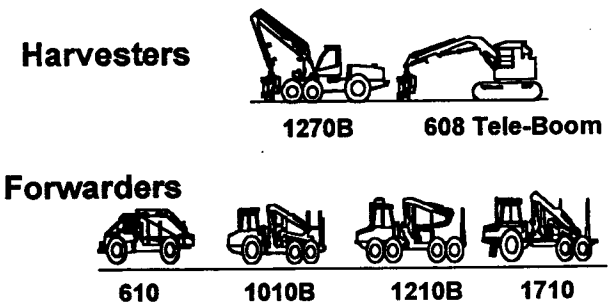

Figure 3.
Timberjack cut-to-length logging product range

The Timberjack 1270B rubber-tired harvester and 608 Tele-Boom tracked harvester are very well received by loggers in North America. Timberjack forwarders range from the four-wheel-drive 610 at 4.5 cord capacity up to the new 1710 forwarder, our largest at 7.4 cords, just introduced to North America.

Issues

Stand density management or thinning is a silvicultural prescription: the way you thin today determines the future of the next stand. Thinning is a serious commercial intervention on the forest stand, and it must be done right to avoid serious consequences.

Concept issues

Let's first look at the issues involved with stand density management, starting with the concept issues that affect the decision to treat the stand or not:

1. Fiber cost impacts
   - Stumpage, "harvesting mortality"
   - Administrative, planning time
   - Handling smaller fiber at the mill
   - Harvesting cost: "20% higher than clearcutting" (Alberta)
2. People issues:
   - Availability of contractors
3. Public perception:
   - Public and media relations

There are two distinct chapters in the book of logging worldwide: BC and AC, and that's not

British Columbia and Alberta Central, but logging Before CNN and After CNN. The point is, forestry and timber harvesting is under tremendous public scrutiny everywhere. The good news is that forest harvesting philosophies are evolving. Forestry used to be "easy" in the 1980s: "Clearcut ... at least cost" or as we knew it, "Wood the Mill." But this all changed in the 90s to: "Minimum impact to the site and maximum return from each tree harvested."

Operational issues

Operational issues or concerns involved in stand density management for the forest owner or manager can be summarized under seven headings:

1. Tree selection by the machine operator
   The risks:
   - Reducing the future value of the stand by taking the wrong trees
   - Effective tree selection at night

   The solutions:
   - Operator training and education in thinning prescriptions and proper tree selection is required
   - Superior lighting on the harvester, tree marking, and the use of a single or split-shifting system where most of the work is done in daylight will help.

2. Thinning intensity
   The risk:
   - Reducing the future value of the stand by the operator taking too many or not enough trees in the thinning

   The solutions:
   - State the thinning objective based on the number of residual trees per hectare
   - Use a stand density management thinning intensity "multiplier."

If you have a cut-to-length harvester, you have a built-in hydraulic tape measure with tremendous reach. By extending the harvester boom to its maximum reach on both sides of the machine and counting the merchantable trees in that circle, you essentially have a sample plot. For example, on the Timberjack 608 Tele-Boom harvester with its 9.4 m boom reach, the operator would multiply the number of residual trees in his "sample plot" by 36 to determine the residual trees per hectare. On the Timberjack 1270B harvester, the multiplier is 46 times for the standard 8.6 m reach crane or 32 times for the 10.3 m thinning crane. (Figure 4.) This is a good, quick, and easy way for the harvester operator to monitor his performance toward the stand density target as he works.

3. Site impact

   a. Soil compaction from harvesting
   There is a risk of creating significant site impact during harvest; also, thinning basically removes only 30% of the trees or basal area of the stand. By using a big, stable harvester with a long reach, 10 m (33 ft) crane, you can create a thick brush mat of discarded branches and tops for the forwarder to travel on.

   b. Soil compaction from forwarding.
   Ground pressure and frequency of travel vs. machine width: consider that big, high-capacity forwarders are less than three meters (10 ft) wide, and generate a static ground pressure of only 10.5 psi, loaded. Also, high-capacity forwarders require fewer trips across the site to remove the wood from the forest.

Sometimes bigger is better. The static ground pressure of a machine alone is not the best measure of site impact. Let's look at a site impact comparison between horse logging and logging with a forwarder (Table 1). Unless the ground is frozen, horse logging is anything but forest friendly!

4. Residual tree damage
   The risk:
   - Exposing the residual trees to infection through scars inflicted during harvesting and forwarding.

   The solution:
   - Excellent operator visibility, long reach cranes and superb crane control, which minimizes contact with the residual trees.

- The superior lighting on the harvester and forwarder and daylight operations on a single or split-shifting system will help.

"How Do We Behave in Our Thinning Operations?" a study by Anders Froding for the Swedish National Board of Forestry, 1980 and 1989, says: "During the rapid expansion of mechanical thinning of the 80s is an almost 50% reduction in the frequency of damage to the residual trees." "Damages," which are stem scars in excess of 15 cm^2 (2.3 in^2) or matchbox size, are declining. In the 1980 study, the average damage frequency was 7.8% of the residual trees. The average of the 1989 study was only 3.3% of the trees.

5. Root rot
   The risk:
   - Infecting the residual trees by introducing root rot fungus through stem scars, root crushing, or fresh stumps.

   The solutions:
   - Building big brush mats to protect the tree roots
   - Focusing the thinning activity during the coolest time of the year so that the roots are protected by frost or snow, and
   - Timberjack harvester heads are available with automatic stump spraying of urea to kill the stump.

6. Compensating the machine owner
   The risks:
   - Paying more money for a poorer, less valuable product
   - Using an unfair pay rate that puts the contractor out of business

   The solutions:
   - A production or volume pay rate based on the average tree size can be established using the on-board harvester computer
   - Quality incentive factors can be based on stand treatment objectives.

7. Product sorts
   The risk:
   - Poor optimization of each tree and sorting the products for optimum quality and value

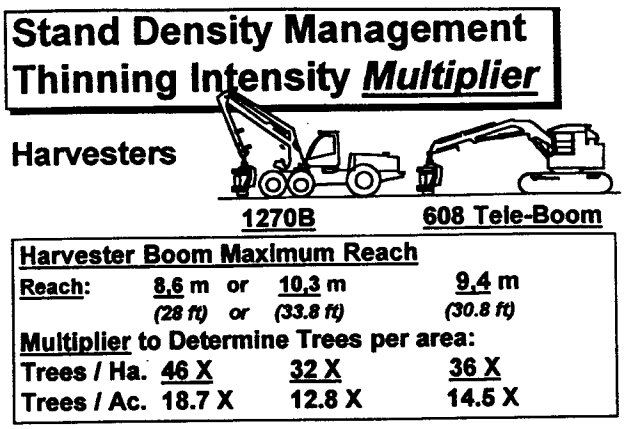

Figure 4.
Stand density management thinning intensity multiplier

Table 1.
Site impact comparison between horse logging and logging with a forwarder

Item	Horse	1210B Forwarder
Weight	2000 lb.	33,000 lb.
Footprint	4 /3 hooves	8 wide tires
Payload	1 ton	15 tons
Ground pressure	7.3 psi/hoof	10.5 psi loaded
Trips/15 tons	15 trips*	1 trip

*Empty and loaded!

The solutions:
- The on-board harvester computer, which is designed to extract and record the highest value product from each tree
- Timberjack 762C and 746C harvester heads are available with paint marking for effective sorting of sawlogs and pulp at the stump and roadside.

Costs

The cost of something is the fuel that drives the engine of change. Since we are discussing the

operational cost of stand density management, let's look at a recent study done in Sweden, "New Opportunities in Thinning" (Sonstrup Study, Sweden 1985-93, SkogForsk News, Vol. 2 1993). In the search for maximum growth from the forest and minimal site impact, the conventional thinning practices in Sweden dictated 25 m (80 ft) between the machine strip roads, assisted by manual or small machine felling in the "middle zone" beyond the 8 m (25 ft) reach of the CTL harvester booms.

Experiments were conducted in 1985 with the conventional 25 m (80 ft) and with 15 meter (50 ft) and 10 meter (33 ft) strip road spacing; a follow-up thinning was completed in 1993:

"All study plots were thinned down to the same basal area, including the strip roads. On the 25 m and 15 m trail spacing plots, there was selective thinning between the strip roads to achieve the basal area target. On the 10 m spacing option, the system of line thinning was used, whereby the entire thinning cut was from the strip roads."

When strip road spacing was reduced from the conventional 25 m (80 ft) down to 15 m (50 ft) spacing, they experienced slightly lower logging costs in both the first and second thinning; but when strip road spacing was reduced from the conventional 25 m down to 10 m (33 ft) spacing, they found 25% lower logging costs in the first thinning, but 16% *higher* costs in the second thinning.

As a result of this 1993 study, the major forest owners of Sweden started to refocus their efforts to reduce the cost of thinning. As a result of this decision, Timberjack canceled production of our small in-stand CTL harvester, the 570, and we focused efforts on our professional thinning harvesters, the 1270B and 608 Tele-Boom; our CTL heads and computers; and on our effective long reach telescopic and parallel motion thinning cranes (Table 2).

Productivity

Factors affecting the productivity of harvesters are listed from the most to the least critical:

Tree size	Volume, length, branches, form
Prescription	Final Harvest vs. thinning
Stand density	Merchantable and unmerchantable
Log lengths	Random, 16 ft (6 m) vs. 8 ft (2.5 m)
Operators	Skill, training and motivation
Product sorts	Species and product
Terrain	Slope, ground roughness, snow

Table 2.
Timberjack CTL Harvesters

	Timberjack 1270B	608 Tele-Boom
Power	204 hp	167 hp
Reach	8.6 m or 10.3 m (28 ft) or (33.8 ft)	9.4 m (30.8 ft)
Head	762C or 746C	762C
Capacity	65 cm 50 cm (25 in) (20 in)	65 cm (25 in)
Feed Speed	14.7 ft/s 15 ft/s	14.7 ft/s
Computer	Timberjack 3000 Measuring and Control Computer	

1. Harvester productivity

I've chosen three "forests" or forest types to illustrate the impact of the harvest prescription on harvester productivity (Table 3). Note: The productivity estimates are based on observations and some time, motion, and effort studies:

A harvester working in a "cleaned" pure stand cutting random length 5.5 m logs with no sorting would get 100% of the potential productivity in the machine. If the machine moved to a pure natural stand, productivity would be expected to drop to 90% because of the unmerchantable trees in the forest.

If the harvester clearcutting the "cleaned" pure stand is now asked to do 3 product sorts, productivity would drop to 90%. And if the machine were asked to thin that stand, productivity would be expected to drop to 70%.

The main advantages of big CTL harvesters in stand density management is their lower cost per volume of wood produced. This is achieved by:

- Productivity = power, feed speed, TMC
- Capability = built tough, industrial
- Flexibility = thinning and clearcuts
- Stability = Long reach cranes, tree size
- Terrainability = Hydrostatic, tires/ tracks
- Computer = Accuracy, volume record, upgradable to paint marking and urea

2. Forwarder Productivity

Factors affecting the productivity of forwarders are listed from the most to the least critical:

- Distance = Actual distance to the unloading site
- Payload = Volume carried each trip
- Log lengths = Random, 16 ft. (5 m) vs. 8 ft. (2.5 m)
- Operator = Skill, training and motivation
- Prescription = Final harvest vs. thinning
- Product sorts = Species and product sorts required
- Loader capacity = Lift, swing, and grapple size
- Terrain = Slope, etc., affecting travel speed

Impacts on productivity of the forwarder of log lengths, sorts, and distance

A forwarder working in random length 5.5 m logs at 1-150 m distance with no sorting would get 100% of the potential productivity in the machine. If the operator were asked to sort for species, productivity would be expected to drop to 90% because of the extra time in log handling.

If the operator were now asked to forward from up to twice the maximum distance, productivity would be expected to drop another 10% because of the extra travel distance.

The key advantage of big CTL forwarders is definitely the lower cost per volume of wood produced, achieved by:

- Productivity = payload, speed, TMC
- Reliability = built tough, industrial

Table 3.
Impact of harvest prescription on harvester productivity

Harvest Prescription	Forest type		
	Cleaned Pure Stand	Pure Natural Stand	Mixed Natural Stand
Clearcut - random	100%	90%	80%
Clearcut - 3 sorts	90%	80%	70%
Selective (patch) cut	80%	70%	60%
Thinning - random	70%	60%	50%
Thinning - 3 sorts	60%	50%	40%

- Flexibility = thinning and harvesting
- Stability = wide tires, tracks
- Terrainability = Hydrostatic transmission, balanced bogie axles, and good ground clearance
- Impact = fewer passes over the site

Opportunities

Let's start with a realization that thinning a natural stand is the same as planting 30- to 40-year-old-plus trees.

Stand density management opportunities for the forest owner or manager:

Forest health	• Change in the microclimate • Tree vigor improved • Fire proofing the stand
Volume	• Recovery of "islands of wood" using existing roads • Harvesting mortality • Increase in MAI - doubling
Value	• Adjustment of tree species and form for the future
Aesthetics	• Strip roads can be made invisible to the public when the harvester enters the stand at a 45° angle to the road for one machine length, and then turns perpendicular to the road.

Stand density management opportunities for the machine owner with large CTL machines:

Productive work	• Steady employment with private and industrial forest owners • Generally work close to the mill
Flexibility	• Applying the machine and operator capabilities to thinning and clearcuts

Timberjack CTL Product Range

Forwarders				
	610	1010B	1210B	1710
Power:	100 hp SS	110 hp HS	172 hp HS	210 hp HS
Load:	4.5 cd	5.2 cd	6.3 cd	7.4 cd
(Stacked)	16,5 m³	18,7 m³	22,9 m³	26,9 m³
Loader:	22'	23.6'	23.6'	24'

Figure 5.
Timberjack CTL product range — Forwarders

Employees	• Motivation, training, availability
Image	• Public support, professionalism

We feel that the Timberjack 1270B rubber-tired harvester and 608 Tele-Boom tracked harvester are very appropriate machines for logging in the boreal forest. The 1270B has the gentle maneuverability of a hydrostatic transmission and the reach and control of the parallel motion harvesting crane. The 608 offers near zero tail swing, and the durability and stability of a proven track machine along with the long reach "tele-boom." Both machines feature the Timberjack 762C head and 3000 measuring and control computer. The Timberjack forwarders, from the four wheel drive 610 at 4.5 cord capacity up to the new 1710 forwarder, our largest at 7.4 cords, can match the output of most CTL harvesters and handle most logging operations.

C. People

There is an ancient Chinese proverb which says: "If you plan for one year, plant rice. If you plan for ten years, plant trees. If you plan for 100 years, educate your children."

Why do you train people? To convert the experienced forest working into the professional

Table 4.
Forwarder productivity in relation to log lengths, sorts and distance

	Log lengths and sorts required			
	Random lengths	**5-meter lengths**	**5-meter lengths**	**2.5-meter lengths**
Forwarding distance	**No sorts**	**Species sort**	**3 product sorts**	**Species sort**
0-150 m	100%	90%	80%	70%
0-300 m	90%	80%	70%	60%
0-500 m	80%	70%	60%	50%
0-700 m	70%	60%	50%	40%

Note: The productivity estimates are based on observations and some time, motion and effort studies.

forest worker. A good operator will respond to attention and instruction just as a forest responds to thinning or an individual tree responds to fertilization.

Conclusions and recommendations

We feel that big, commercial CTL forest harvesting machines offer the capability to handle the variability of tree size and operating conditions of the boreal forest. They also have the flexibility to handle both the thinning of an immature forest as well as the final harvest of a mature stand.

1. Operational costs — Focus on cost per cubic meter roadside, which is a function of machine productivity. The initial cost of thinning will reduce the cost of the final harvest by increasing the average tree size above what it would be with no intervention.

2. Operational opportunities — Learn from the long experience in boreal forest stand density management planning and techniques from the Nordic countries. Utilize the professional contractors and their productive and capable CTL harvesting machines that are available now in North America.

3. Concept opportunities — Stand treatments can be used to improve forest health and reduce the risk of wildfire. From experience in BC, we know there is the potential to recover 25 to 30% more fiber per hectare with CTL logging.

4. Wildlife habitat opportunities — Stand density management treatments can be used to create and improve wildlife habitat for threatened or desired species.

Points to think about:

- As we practice commercial stand density management, remember: the working forest must still be a good place to play.
- A tree is not immortal, but a forest can be.

This is Timberjack's 50th Anniversary, and forestry is the only business we are in. For more information on Timberjack, our operations, products and services as well as comprehensive contact data to both Timberjack business units and our global dealer network, visit our home page at http://www.timberjack.com