HARVESTING TECHNICAL NOTE

HTN06-05
2013

Steep Slope Harvesting in Coastal British Columbia

Summary

Steep slope harvesting operations in the coastal region of British Columbia, Canada (BC) were observed in November 2012 by Keith Raymond, FFR Harvesting Theme Leader, as part of the FFR steepland harvesting research programme. The objective of the visit was to review the state of steep slope harvesting operations on Vancouver Island, especially grapple yarding operations, and to update on current research projects being undertaken in this area by FPInnovations FERIC. Tower yarding to large landings on mountainous terrain has almost disappeared in BC coastal operations due to increasing cost pressures as timberlands owners try to improve their international competitiveness. The development of steep slope felling machines has improved the productivity of grapple swing yarders and opened up opportunities for widespread shovel logging (or "hoe chucking" as it is known in BC). These systems allow operation from roadside with the separation of the operational phases of the harvesting operation resulting in additional productivity gains. The recommendation is that the New Zealand logging industry extends the use of ground-based machinery onto steeper terrain, specifically in shovel logging. A continuum of steep country logging systems is proposed according to slope and roughness of terrain from skidder logging on easy country, to shovel logging (without traction winch) on even terrain of slopes less than 45%, to shovel logging (with traction winch) on even terrain up to 70% slopes, and to grapple yarding on the steepest slopes.

Keith Raymond, Future Forests Research Limited

INTRODUCTION

In the coastal forests of British Columbia, Canada (BC) the shift from old growth (first rotation) logging to harvesting second growth and plantations with reduced tree size on more favourable terrain that has already been roaded has allowed a major shift to mechanised operations. Steep slope felling, bunching and extraction machinery (feller bunchers and "hoe chuckers") are capable of working on slopes up to 60% (Olund 2001, Sutherland, 2012).

Tower yarding on mountain terrain has come under increasing cost pressure from timber owners as forest companies try to compete in the global market place. The development of steep slope felling machines has improved the productivity of grapple swing yarders, and has opened up the opportunity for shovel logging on steep terrain (known as "hoe chucking" in BC). Many machines available today can safely exceed the slope limits established in approved codes of practice (such as the WorkSafe BC limit of 40% slope for tracked machines). An example of this kind of equipment is the ClimbMAX traction winch-assisted feller buncher. Traction winches are synchronized with the machine drive motors to improve machine mobility and reduce track slippage (loss of traction) on steep terrain and loose or wet soils.

Development of the ClimbMAX Steep Slope Harvester in New Zealand, through the funding assistance of FFR and the Primary Growth Partnership, opens up a new opportunity for loggers in coastal BC operations where mechanised felling, bunching and "hoe chucking" is common.

Early in 2012 a Memorandum of Understanding was signed between Future Forests Research (FFR) and FPInnovations FERIC in Vancouver aimed at improving cooperation between the two research organisations and fostering collaboration in research areas of mutual interest. One of the key areas for cooperation identified was in the area of steep slope harvesting operations.

In September 2012, a visit to FFR was made by Mr Jack MacDonald, Harvesting Group Research Leader with FPInnovations. FFR Harvesting Theme Leader, Keith Raymond, conducted a reciprocal research visit to FPInnovations from 21-28 November 2012, including field visits to operations on Vancouver Island. This report summarises the operations visited on Vancouver Island (Figure 1) and current research projects being undertaken in this area by FPInnovations FERIC.

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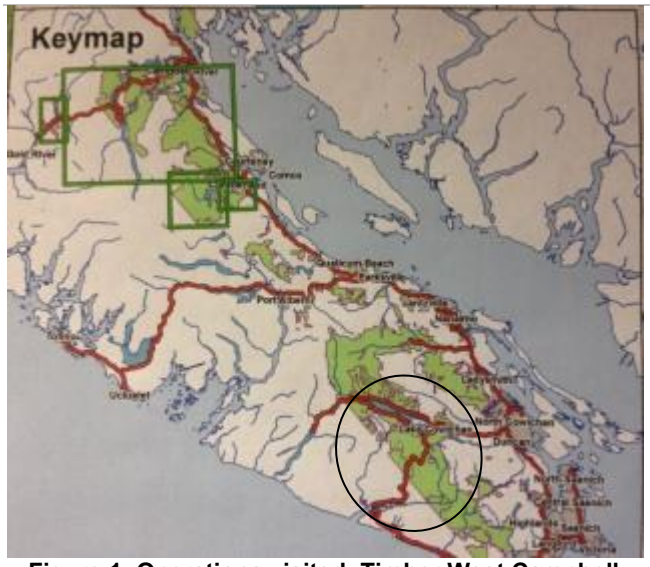

Figure 1: Operations visited: Timber West Campbell River (boxed area) and Island Timberlands, Nanoose Bay (circled area).

Shovel Logging – Background

In the mid-1970s the shovel logging technique was developed on the Olympic Peninsula of Washington State, USA. It was a natural outgrowth of the increased use of hydraulic excavators in road construction. As excavators (shovels) proved their effectiveness in road construction, loggers adapted "dead thumbs" in order to assist in the movement of road lining timber. When the "dead thumb" was replaced by the "live thumb", it soon became apparent that handling of the road line timber was no longer a problem. The legend goes that a logger who was tracking cost closely, realized that this road line wood was the lowest cost timber he was producing. So he thought "What if I place my shovel outside the "right of way" and set the timber back into the "right of way?". The rest is history. Hydraulic excavators were modified for shovel logging much as they were for log loading, with a logging boom, grapple, and cab riser.

By the early 1980s shovel logging was recognized as an effective logging system on gentle slopes of the Pacific Northwest, or PNW (Balcom, 1985; Fisher, 1986; Hemphill, 1986). The high productivity and small crew size made shovel logging a very cost effective system relative to other ground-based systems. Shovel logging is increasingly being utilised on settings with more difficult terrain, previously considered "cable ground". Simply, the cost effectiveness of shovel logging is pushing its application to more difficult terrain. The common view is that shovel logging cannot be beaten for low yarding costs and low environmental impact. On the right ground and in the right conditions, shovel logging is undoubtedly the lowest cost, least impacting logging system.

Certainly there are sites that will never be considered appropriate for ground-based systems. There are sites however that, although they present a challenge to experienced ground-based operators, can be effectively and safely logged with a shovel logger at a much lower cost than cable yarding.

Like any specialised logging system, planning is required in order to maximise the system application. Shovel logging remains productive out to a distance of 5 - 6 shovel swings. The shovel has an effective reach of 45 feet (13.5 m), meaning that in timber of 18-20 m length (60 to 70 feet) shovel logging has an effective range of about 500-600 feet (160-190 m). Traction of the shovel on steep slopes is assisted by using the live heel as a foot to shove the machine into niches of more gentle ground.

The steepest ground on which the shovel operates in the PNW is 55 per cent, with 45-50 per cent common. Shovel logging is very productive; the production of a typical operation averages 6-8 loads/day with one machine and a two-man crew.

Table 1: Typical BC harvesting costs in CAD (quoted from a number of sources)

Phase of Operation	Grapple Yarding	"Hoe Chucking"
Felling	$2.00-3.00	$2.00-3.00
Yarding	$12.00 – 14.00	$5.00 – 7.00
Processing	$6.00 – 7.00	$6.00 – 7.00
Loading	$2.00	$2.00
Total Cost	$22.00 – 26.00	$15.00 – 19.00

The actual unit cost experienced for shovel logging has been quoted at 30% lower than that for cable logging alternatives such as grapple yarding. Extraction costs of $5-7 per cubic metre were quoted for shovel logging versus $12-14 per cubic metre for grapple yarding extraction (Table 1). This is due to the operating costs per hour of the shovel logger being 40-50% of those for a swing yarder.

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HARVESTING TECHNICAL NOTE

HTN06-05
2013

HARVESTING OPERATIONS VISITED

TimberWest, Campbell River, British Columbia

TimberWest operations in the northern part of Vancouver Island involve harvesting around 600,000 cubic metres per year from private forest lands and 700,000 cubic metres p.a. from Crown lands. Added to approximately 1.3 million cubic metres p.a. harvested in the south part of the Island, this gives a total annual harvest volume of 2.6 million cubic metres. Species harvested include yellow cedar, western red cedar, balsam fir, hemlock and Douglas fir.

Four contractors are engaged to harvest the private lands in the North Island operations (each harvesting between 150,000 and 175,000 cubic metres p.a.).

Current regulations in British Columbia (e.g. WorkSafeBC OH&S Regulation 26.16) restrict the use of ground-based logging equipment to slopes not exceeding 35-40% (35% for wheeled machines and 40% for tracked machines) without obtaining specific approval due to machine stability and operator safety concerns.

The Steep Slope Hazard Assessment Tool (Part 1 of the BC Forest Safety Council Steep Slope Resource Package) must be used for all operations where the slopes and ground roughness exceed these limits. Steeper slopes require alternative harvesting systems such as cable yarding, hand falling and helicopter operations. As these operations are more hazardous and costly, there is a lot of interest in ways of avoiding these options through the use of tethered harvesting machines to improve machine stability and extend the range of ground-based equipment (Sutherland, 2012).

Grapple Yarding - Fall River Logging Ltd

The harvesting area visited was Harvest block BR210 off Browns Main Road above Browns River managed by Timber West, Campbell River, British Columbia.

Adam Wonderlick and Kevin Playfair, the owners of Fall River Logging Limited, operated a Madill 124 swing yarder (Figure 2), with a mobile tail hold, a Madill 3800C feller buncher (also used as a “hoe chucker”), a Waratah 624 processor on a John Deere base, and other related loading equipment (Load and Haul operation).

Figure 2: Madill 124 swing grapple yarding to roadside

In the steepest areas of the block felled wood was grapple yarded to roadside (Figure 3).

Figure 3: Grapple yarding feller-bunched wood

At the roadside a Waratah Harvester processed the stems into logs (Figure 4).

Processed logs were then piled at roadside for later load out. Where the road was narrow and the terrain was steeper, the processed logs were retained by high stumps cut on the downhill side of the road (Figure 5).

On the flatter ground (slopes up to 40%) the Madill 3800C “hoe chucker” worked straight up or down the hill, swinging or sliding logs on a bed of stems towards the road (Figure 6).

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HARVESTING TECHNICAL NOTE

HTN06-05
2013

Figure 4: Mechanical processing of decked wood at roadside

Figure 5: Processed logs piled at roadside retained by high stumps

Figure 6: Area shovel logged uphill to road

Shovel Logging – Wolf Lake Logging Limited

This was a large scale ground-based operation using a Tigercat feller buncher (Figure 7), two Madill 3800C "hoe chuckers", two skidders (Cat 535 &Cat 545), two Waratah processors, one Madill 2850 ButtNTop loader and four trucks, producing 14 loads (range 12-15 loads per day) or 450 tonnes per day.

Figure 7: Tigercat feller buncher with disk saw and accumulator

Another one of TimberWest's B.C. coastal operations where shovel logging was observed on slopes of 40-45% is shown in Figure 8.

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HARVESTING TECHNICAL NOTE

HTN06-05
2013

Figure 8: Harvest area of 45% slope that had been "hoe chucked"

Island Timberlands Limited operations

Island Timberlands Limited is a private timberlands business focused on the sustainable management of high quality timber and other forest products from coastal British Columbia. Their operations are in the southern part of Vancouver Island around Nanoose Bay (north of Nanaimo). The quality of the timberland holdings is a result of being the successor to one of Canada's foremost forest products companies, MacMillan Bloedel Limited.

In 1999, MacMillan Bloedel Limited was purchased by Weyerhaeuser Company, which then in May 2005 sold all of their BC coastal assets and Island Timberlands was formed as a result of the purchase of the BC coastal private timberlands. Island Timberlands, owned by Brookfield Asset Management, a Canadian real estate and infrastructure company with global holdings, comprises an area of approximately 258,000 hectares of private managed forest land on Vancouver Island, the mainland coast and the Queen Charlotte Islands.

Harvesting volume comprises approximately 1.2–1.3 million cubic metres p.a. from the private forest lands. Species harvested include Douglas fir, hemlock, western red cedar, balsam fir, and in lesser volumes yellow cedar and Sitka spruce.

About 35% of the harvesting is a unionised company operation. The operations are not "stump-to-dump" but are separated by the phases of the harvesting operation (felling, yarding, processing and loading). There are three contract processors, one "phase" grapple yarder and two hoe chucking operations to produce 430,000 cubic metres p.a. A fleet of fifteen trucks (13 company and two contract trucks) are used for hauling.

Island Timberlands have been logging second growth since the 1980s, but In the next three years the old growth forest will be exhausted and there will be a move onto the steeper second growth forests (so called "guts and feathers" as one of the older loggers described it). In order to control harvesting costs, helicopter logging has been phased out and hoe chucking has become the dominant logging system (Figure 9).

Figure 9: "Hoe chucking" operation at Island Timberlands Ltd on 40% slope.

In Island Timberlands forests the logging systems on easier slopes are predominantly hoe chucking out to 600-700 feet (180-200 m) and grapple skidding to 1000 feet haul distance (300 m). On steeper ground they will use feller bunchers and hoe chucking to 40-45%, then grapple yarding on steeper slopes beyond that. Loads for yarding are oriented with tree butts towards the road (Figure 10).

"Hoe chuckers" are commonly 30 tonne excavators such as the Cat 330B with high and wide chassis giving 900 m (3 foot) ground clearance, a high cab (cab riser) and an extended boom and arm giving a 14 m reach. On the steepest hoe chucking sites they tend to use a smaller excavator such as the Cat 200B.

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Figure 10: "Hoe chucker" operator (Island Timberlands company crew) explains "hoe chucking" work method.

Hoe chucking feller-bunched wood is twice as productive as hoe chucking hand-felled wood (ranging between +35% and 100% more productive depending on conditions). Productivity rates for hoe chucking range from 250 tonnes per 10-hour day in hand-felled wood to up to 400 tonnes per day in feller-bunched wood.

Island Timberlands are committed to using feller bunchers rather than hand felling due to the safety factor, increased productivity, reduced breakage, and benefits it gives to the extraction phase (hoe chucking or grapple yarding). The Logging Manager stressed the advantages of bunched wood for grapple yarding, commenting that "it comes in like a trained pig!"

Average costs for hoe chucking in average tree size of 60-75 cm butt diameter were quoted as between $5.00-6.00 per cubic metre. This is based on daily costs of around $2000 per 10-hour day and production of 330-400 tonnes per day for a hoe chucker working in bunched wood. Where a hoe chucker is tied to a grapple yarding operation, production may be lower at 240-320 m3 per day (6-8 loads per day) and costs rise to $6.00 – 7.00 per cubic metre. This compares to quoted grapple yarding costs of $12.00 – 14.00 per cubic metre (yarding phase only).

A common felling head is the Quadco intermittent swing saw with 360^0 rotation (Figure 11). Feller bunchers in coastal BC are achieving 650 tonnes per 9-hour day (72 tonnes per hour) on a single shift. This equates to an annual volume of 150,000 cubic metres per year.

Figure 11: Timber King self-levelling feller buncher operating on steep slope.

The most common processor observed was the Waratah grapple processor (such as the Waratah 624) mounted on a Madill HT2250B loader or a Cat 330D. Processing productivity is commonly 50 tonnes per hour which means the processor operators are commonly working 12-13 hour days to balance production.

CONCLUSION

Summary of Observations

1. Use of tower yarders has almost completely been eliminated in Coastal BC operations because they were too slow to set up, required too much labour and were not very productive. Most tower yarders logged less than 60,000 tonnes per year (250 tonnes per day) with a large 8-9 man crew. Good cable loggers were getting more difficult to source and train. Tower yarders also restricted the productivity of downstream loaders, processors and trucks (due to interference on the landing) and had a

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HARVESTING TECHNICAL NOTE

very poor safety record. Logging contractors that stayed with these legacy yarding systems have simply gone out of business during the last decade.

2. To improve the productivity of skyline logging systems, the gathering function in smaller second growth timber (bunching) needed to be improved to reduce cost through shorter cycle times and optimum haul size. Now that most of the harvesting is in second growth, steep terrain felling machines are the optimum way to fell, bunch and orient hauls with tree butts to the road for yarding on slopes up to 60%.

3. Feller bunching is particularly advantageous where swing grapple yarders are employed, and raises yarder productivity into the 100 tonne per hour range at distances up to 350 m (1200 feet). Using a two-man yarding crew (one yarder operator and one mobile tail hold operator) not only is labour cost cut by 75%, there are also huge benefits in faller and yarding crew safety. Swing yarders such as the Madill 124 can produce 140,000 tonnes per year (650 tonnes per day) in good conditions.

4. Shovel logging provides a low cost alternative on downhill slopes to 40% and distances to 200 metres (650 feet) from the road. Shovel logger productivity can run to 60,000 tonnes per year (250 tonnes per day) in coastal timber with a single operator in a fully guarded cab (ROPS, OPS, FOPS certified). Where large piece size trees and steep terrain or rock outcrops dictate felling by hand, the shovel logger is sometimes used to bunch the manually felled wood to make optimum yarder turns. Swing grapple yarder cycles are about 60-80 seconds, and productivity is usually much higher than for the shovel logger. Shovel logging in a yarder setting can help to pull away from sensitive riparian zones or to clean off areas where cable deflection is poor. Thus shovel logging to a yarder helps to maintain high yarder production.

5. The secondary advantage of swing grapple yarders and shovel logging is their ability to pile at roadside and move along the road thereby eliminating the congestion and unsafe working environment of working on a landing. There is no longer a need to build costly landings that add to site degradation and environmental risk. In viewing operations over two days, no landings were sighted in any operations.

6. Mobility at the back end of the swing yarder operation is provided by a mobile tail hold, usually a 30-tonne excavator with swivelling fairleads on a short tower. Mobile tail holds are quick to move and are safer than using stump anchors and digging dead man anchors. They also provide necessary lift at the back end of the skyline corridor. With a mobile tail hold and mobile guy line anchor for the swing yarder, the whole operation can continuously move along the road.

7. In the operations viewed and in discussions with company logging managers it became apparent that the four phases of harvesting (falling and bunching, yarding, processing and loading) are dephased in time (often by only a day) to eliminate interference and allow each machine to work at 100% of its capacity every day without waiting for wood. De-phasing also reduces the impact of breakdowns since the other phases keep on producing. Each phase of the operation is costed separately and rates are often quoted for each specific phase (not the total logging rate).

8. Decking all wood to roadside allows mechanical processing at roadside. Use of the Waratah grapple processor appears to be universal. No other type or brand of mechanical processor was sighted. Where terrain allowed, the processor worked a track alongside the road, processing and stacking the final log products at the road edge for load out. Mechanical processors have a production rate of about 50 trees per hour (in 1.0 tonne tree size this is 50 tonnes per hour) and usually operate double shift to keep up to a grapple yarder in bunched wood.

9. Due to mechanical processing at roadside there were fewer log sorts processed in BC operations. While this was not the focus of the field visits it was apparent that there were no more than 5-6 log sorts processed. Most of the wood was destined for a dry land sort yard at Campbell River where export and domestic logs were sorted and scaled.

10. Remote pockets of quality old growth timber are now often logged by helicopter at higher cost in order to eliminate environmentally unpopular new road development. These are commonly known as single stem operations as often only specific trees are cut and removed as opposed to large clearfelled areas.

11. A continuum of steep country logging systems is apparent according to slope and roughness of terrain; from skidder logging on easy country to 30%, to shovel logging (without traction winch) on even terrain of slopes less than 45%, with

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a new option of shovel logging using a traction winch-assisted harvester (e.g. ClimbMAX) on even terrain up to 70% slopes, extending grapple yarding to only the steepest slopes (Figure 12).

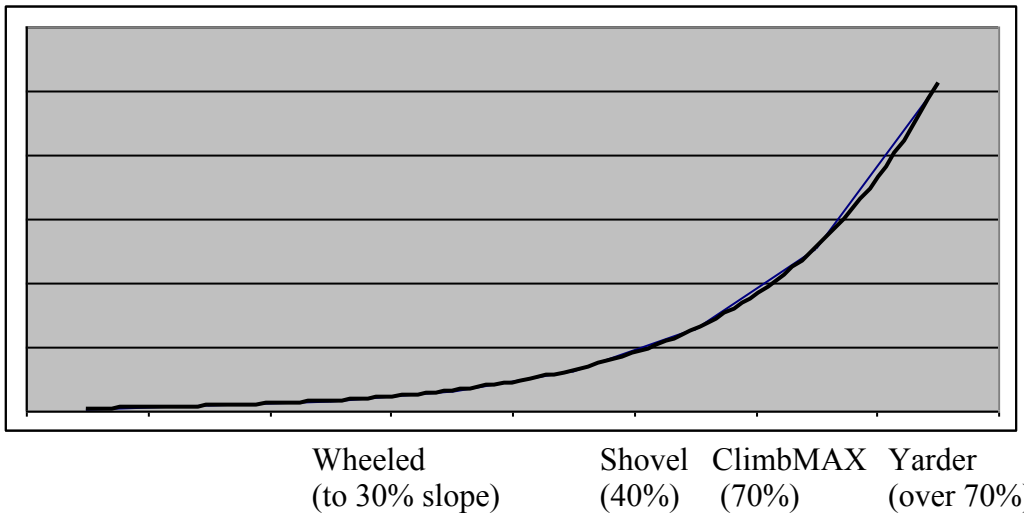

Figure 12: Continuum of logging systems with increasing slope

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