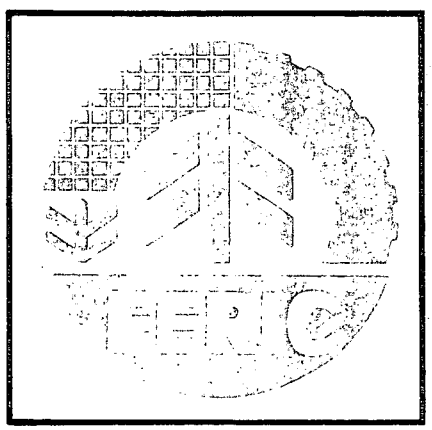
SR126

USING HARVEST SYSTEMS TO ACHIEVE PRODUCTIVITY, COST AND SITE IMPACT OBJECTIVES ON STEEP SLOPES

Proceedings of FERIC's Steep Slope Harvesting Seminar



USING HARVEST SYSTEMS TO ACHIEVE PRODUCTIVITY, COST AND SITE IMPACT OBJECTIVES ON STEEP SLOPES

Proceedings of FERIC's Steep Slope Harvesting Seminar

Held at Kamloops, B.C.
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Abstract

The Forest Engineering Research Institute of Canada (FERIC) held a seminar in October 1997 in Kamloops, British Columbia to address issues related to harvesting on steep slopes in interior B.C. These Proceedings contain eleven presentations by FERIC, forest industry and forest ministry personnel from British Columbia and Alberta.

Acknowledgements

FERIC expresses its appreciation for the time and effort spent by the speakers in preparing and delivering their contributions. Thanks also to International Forest Products Limited's Adams Lake Division for hosting the field trip. Funding assistance for the seminar and proceedings was provided by Industry Canada.

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Session I: Matching the harvest system to the site

(What tools are available and where do we use them?)

Harvesting Systems Handbook

Jack MacDonald, Senior Researcher
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Introduction

When this project was first proposed in 1995, the industry members of our advisory committee were reluctant for FERIC to participate. The green Forest Practices Code guidebooks were just coming out and there was a fear that this handbook would be misconstrued as another guidebook. The project wasn't approved when it was first proposed, as there was concern about a cookbook approach. More discussions between the BCMOF, FERIC , and industry members took place, and in the spring of 1996, the project was approved under the clear understanding that the handbook would not be one of the green guidebooks.

I am guided by a steering committee of 12 members, made up of industry and BCMOF people, from the coast and interior. The objective of the handbook is to provide a resource to help people make better decisions about putting the right equipment on the right site. Many people aren't aware of what equipment is available and this handbook was proposed as a tool to help fill that information gap. Also, we see the handbook as a long-term education resource that could be used in courses and training.

The target audience for the handbook is two fold: first, people who have little or no background in harvesting equipment; second and equally important, people such as you, with a good understanding of the equipment used in their area but unfamiliar with what is used in other areas.

Handbook Organization

When I started work on the handbook, I had a wide open field. There was a lot of information to organize and I looked at several options. One idea was to list equipment saying "This type of machine is used here and for such and such purposes." Although it initially looked good, it is hard to make a list that is comprehensive and covers all types of equipment. The list also would not provide a decision making framework so we decided against that approach.

I looked at a matrix of equipment and sites. That becomes unwieldy pretty fast. I looked at a hierarchy approach or decision trees where if you have this condition you use this equipment. That approach broke down quickly and was rejected because there is always exceptions to rules. We also talked about using a computer program but if you can't define the organization with any of these methods it is really hard to put it into a computer program; and that approach was rejected as well.

I ended up with a discussion by components. The handbook describes the characteristics of different equipment, the characteristics that define a site, the characteristics of how you are using a machine, and external requirements such as the silvicultural system. The characteristics of the components, what makes them alike, what makes them different, and the impact that a characteristic has on the success of using that equipment, were considered. By characteristics I mean, for example, things like rigid tracks versus rubber tires versus flexible tracks. This approach is comprehensive without getting into particular manufacturers, and it enables the handbook to explain why certain characteristics are important. This approach makes it is fairly easy to talk about different combinations of equipment without getting duplication.

One of the handbook's design criteria was to use lots of photographs. The handbook includes pictures of equipment working in a wide range of situations.

So how did we conduct this project and build the information bank? A consultant and I conducted interviews around the province, typically spending one to two hours on each site. We talked to woods foremen, logging superintendents, and operators. We asked them questions like "What kind of equipment are you using?", "Why does it work for you?", "What doesn't work?", "Can you tell us about your successes and failures?". We took this information, summarized it, organized it, and wrote it up in the handbook. Now the handbook is being reviewed.

Reference Section

What will you see in the handbook? The bulk of it is a reference section which discusses equipment by harvesting phase: falling phase, primary transport or the extraction phase, processing phase, and loading phase. A separate section covers operating techniques, site characteristics and external requirements.

The primary transport phase section discusses ground-based systems' issues like tractive ability and log grappling method. It covers cable systems with discussions on deflection and yarding distance, and their impact on productivity and site. An aerial systems section discusses helicopters and balloons.

There is a full section on falling; mechanical falling and manual falling are covered, and sites where you might use different machines are considered. Other topics include types of felling heads, feller processors, feller bunchers, or feller directors. Zero clearance tail swings and other similar issues are discussed.

There is a section on processing: dangle-head versus stroke-delimbers, pull-through delimbers, and manual processing.

Then there is a section on loading. We arbitrarily said, "Hauling will not be considered in the handbook." The handbook covers everything from falling to loading.

In the operating techniques section, the discussion is by phase. For example, in extraction: roadside versus landing: "What would be the differences in productivity and impacts?" In operating techniques there is a fairly thorough discussion on combined systems. What you do in falling can affect what you do in extraction and extraction can affect processing productivity and success.

There is a big section on site characteristics where the handbook discusses things like the implications of slope, ground roughness, and gullies on productivity. These discussions are divided into two sides: the effects of these characteristics on productivity called operational results; and the environmental effects such as impacts on water quality, soil disturbance, regeneration, or the residual stand in a partial cut.

The external requirements section discusses silvicultural systems, utilization standards, and soil disturbance guidelines. These are operating conditions that you cannot go out and measure as they are a product of the human mind. They are things that can be changed by political will or by corporate policy. Included are operating season and mill requirements and how these effect your harvest equipment selection.

Using the Handbook

The handbook is quite large at about 160 pages. The reference section is about 130 pages. One of the reviewer's comments was: "Gee, that is a lot of information Jack, but I don't think I am going to sit down and read it cover to cover. I need a tool to find stuff in there," so there is another part to the handbook. It is actually the first part, although today I am discussing it second. This section is a guide on how to find material in the handbook and a discussion of how you might use the handbook to select the equipment for a particular site. However, I want to emphasize, there is no workbook or worksheet function. Again, one of the original design criteria was to avoid the cookbook approach. While this section discusses how you might use the handbook, it never says this is "the" method.

This first section discusses equipment selection in the context of costs, general characteristics of harvesting systems and equipment, and risk levels. Then the user is advised to find additional information either in the reference section or in other publications.

The "equipment selection in context" section is only two pages long. This section gives, to a person with no experience in matching equipment to a site, the important issues to consider. Things like: Why is it important to get the right equipment on the right site? What issues are involved? Who makes those decisions and when? What are the important factors to consider? Both short-term and long-term equipment selection are important and they are different issues.

Costs

Costs are handled with a general procedure. The handbook identifies four cost categories - low, medium, high and very high. It says operating costs are different than capital costs and there are different cost issues for different companies. You may choose to do your evaluation based on operating costs or capital costs, depending upon your situation. It also makes the statement that cost is really the foundation of your equipment selection. As a company, the bottom line is making a profit on your operations. Cost is one thing that has been missing in the whole discussion in the Forest Practices Code.

Tables

There is series of tables in the book that have equipment types across the top and characteristics down the side. At each intersection, it says high, medium, low, or some numerical value. For example under layout a typical maximum yarding distance for yarding equipment or a typical maximum skidding distance for ground based equipment is identified. This gives you a quick indication of the equipment that might be suitable for the site you are considering.

Risk Levels

The handbook goes from the tables to a risk level analysis. This was designed as a way to focus people on the right information in the handbook and, again, it is not a cookbook approach. If you are using equipment under the right conditions, your financial and environmental risk is minimized. Once you start using it outside of its natural operating environment, risks increase. Now that is a decision that you make yourself. You may choose to accept higher risks and use operating techniques to ameliorate those risks, but nevertheless, the risks are there and they are stated up front.

The risk level scale ranges from level 1 to level 5. "Minimal risk, normal operating conditions" is level 1. Level 5 is "Highly risky, exceptional circumstances required to use under these conditions."

The risk levels are defined and then used in flow charts. An example is the chart for wheeled skidders (Figure 1). At "soil texture," you have two choices: "fine textured soil" or "coarse soil". Fine textured soil with a high soil moisture content is a high risk category. However, if you have a dry, frozen, or snow packed condition than you have less risk and you can look at other factors such as slope. Slope is divided into five categories from over 10% adverse to over 50% favourable. In the mid range, 0 to 35% favourable, the chart indicates to look at terrain. "Is it uniform or broken?" Uniform terrain gives a level 1 which is a minimal risk, broken terrain gives a level 2 which is slightly higher.

You can see that the handbook never says what equipment to use. It just says "these are the kinds of risks you'll be looking at." There are flow charts like this one for each type of equipment in the handbook.

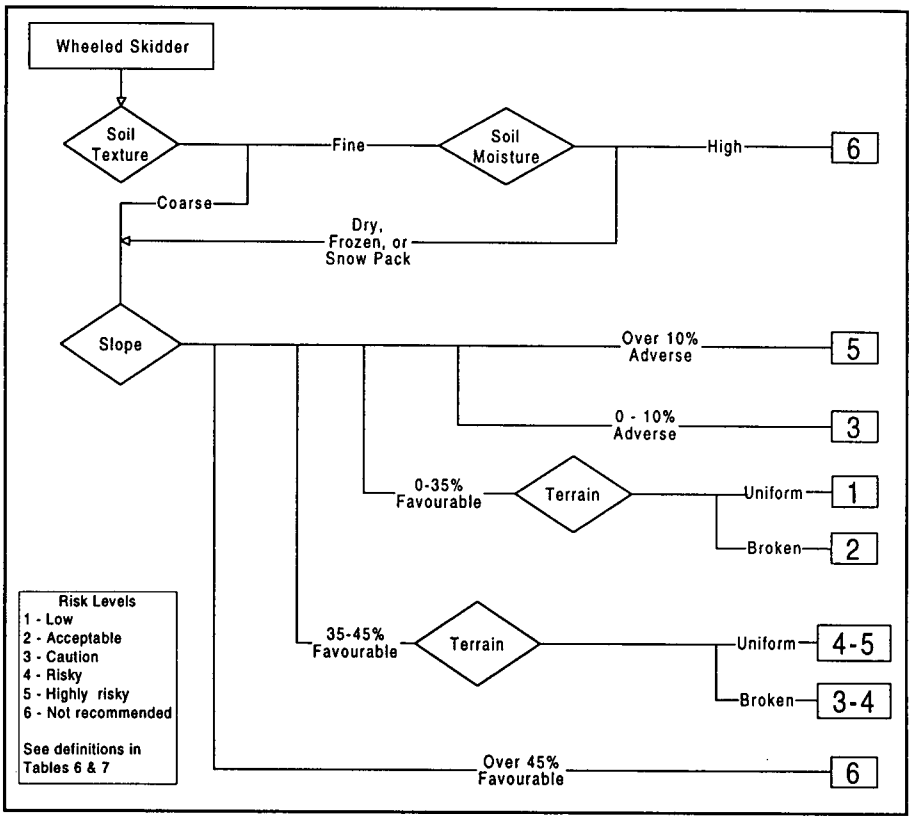

Figure 1. Chart for wheeled skidders.

Current Status

We are planning on publishing the handbook in spring of 1998. If you are interested in reviewing the draft talk to me later. I am certainly open to suggestions if people want to take the time to review the book and see if it matches their situation.

Questions

Q. Are the yarders divided into different types?

A. Yes. I talk about large highlead, small highlead, large skyline, small skyline, dropline with a swing yarder, and grapple with a swing yarder. There are numbers for each one of those. In the body of the handbook it talks about swing yarders versus towers, for example. It treats a lot of information pretty generically. It will never say, this is the right equipment for that particular site. But I think it covers the overall subject pretty thoroughly. Size is one of the things I talk about. Yarder size and yarding distance are often related and I raise these points.

Q. How does a longline system like a Wyssen fit in?

A. Very specifically in the handbook I talk about it under single-spans. It fits into multispan too. It also talks about the Wyssen under the kind of carrier that is used. Jargon is a funny thing when you write about something everybody knows about. It is tough to put things in categories without offending anyone. I talk about machine mobility. I talk about towers and I talk about yarding cranes or swing yarders and I talk about sled mounted yarders. That is one place the Wyssen is mentioned but it's also mentioned under yarding distance and size.

Q. Was Workers' Compensation Board involved in any of this?

A. Only very peripherally.

Q. We've had some issues with Workers Compensation Board that is having a high impact on system selection in the east Kootenays. I don't know about other areas.

A. I don't know if you are aware that there are new regulations? They've just came out and they became effective April 15,1998. I shouldn't quote things because I don't know if I have it 100% correct, but basically it says you can apply equipment to the manufacturers' specifications, otherwise I think you have to have an engineer look at it. That is about as deep as I get with the WCB aspect.

Q. I'm specifically talking about landing size and yarders, downhill yarding and swing yarding. These things are coming to the forefront now. In the past we thought we could use a certain system in an area but now we are in negotiations to determine if WCB considers it acceptable or not.

A. Again, I talk about a lot of things on a fairly broad basis and I do talk a lot about landing size issues and safety. Safety is paramount through the handbook: for example, getting the machine positioned properly on the landing so that you create safe working conditions; i.e., downhill yarding and logs sliding into the landing. The issue is raised to make sure people know it is important but it is up to them to use their professional judgement and discussions to get to the final answer.

System Selection and Application

John Hatalcik, Harvesting Supervisor
Crestbrook Forest Industries Ltd., Canal Flats, BC

Introduction

Crestbrook's operations are in the Nelson Forest Region, in the Rocky Mountain trench. The terrain is mountainous, and the operating area has average slopes of 50–80%, or even steeper. We classify our areas as:

- Slopes <30% are easy.
- Slopes 30–45% are moderate.
- Slopes >45% are steep.

With the implementation of the Forest Practices Code, logging costs are increasing, and selecting the most cost-effective harvesting system is important. Crestbrook considers many factors in selecting the system, and these are discussed in the following presentation.

Terrain

The main point here is varied terrain with a range of harvesting systems. We use 45% ground-based and 45% cable, with the remaining 10% other, which includes helicopter yarding. In some cases, in very steep terrain, the road building costs do not justify using cable systems, and if the wood is large enough, we will go with an aerial system. The K-MAX is our helicopter of choice, although we have had learning pains with the system. The machine has good lifting capacity, about 6000 lb., and is capable of producing 400 m^3/day. The landing area can be filled very quickly, so it must be large enough to handle the volume being produced.

Operating Constraints

We are using longer cable systems now than in the past, for example, up to 550 m. The average skyline system length is about 300 m, and going to longer distances reduces the road construction and decreases the cost of harvest. Intermediate supports are often required, and 90% of our cable contractors use intermediates. They are labour-intensive to rig, although single spar intermediate supports can be guyed back with one or two guylines and are easier to rig than the double spar intermediates. We don't often use double spars now, but in some cases they are necessary. About 30% of our ground is suitable for rubber-tired skidders. We used to be strong advocates of crawler tractors as a less expensive alternative to cable systems. Now, we use cable on much of the 40–60% ground. The Forest District managers have had an impact on what is considered appropriate in terms of terrain and equipment mix. We went from 1 cable machine in 1991, to 9 in my operating area, and 19 company-wide, today.

Safety

Safety is clearly an important issue on steep terrain and we have been learning to operate as safely as possible. The Workers Compensation Board has standards for harvesting on steep ground. For example, if you are square lead yarding (yarding straight down towards the machine), WCB requires that at least two-thirds of the log must be on the landing. In steep terrain landing construction is costly as drilling, blasting and endhauling are often necessary. To build a two-thirds landing can cost $10–20 000. To reduce hazard while maintaining smaller landings, we have been yarding on a skew. As well we have been trying some of the highlead systems that have been used on the coast. However, square lead yarding is the most effective technique operationally.

Obtaining adequate tailholds at guyline stumps is another problem. In one case, inadequate guyline stump rigging techniques and stumps with poor root systems resulted in an accident, which fortunately did not cause injuries. When the breakout forces were exerted on the turn, the back guyline stumps pulled out and the yarder rolled 800 feet down the hill. We have used rock anchoring with good success. We drill a six-foot hole, build a loop with one-inch non-swaged skyline, and anchor the yarder guylines to that.

Jerry Okonski has done tensiometer tests on guylines and skylines, and has found a wide range of tensions exerted by the different yarders we use. Therefore, when we are operating in areas with smaller stumps, we'll use a yarder with lower tensions. For example, the Thunderbird TSY-55 has high tensions, and requires good stumps, frozen ground or rock anchoring.

Roads

The cost of roadbuilding in the east Kootenays was $10 000/km, but our average is now $30 000. The increased cost is largely due to the blasting and endhauling that are required on steep slopes. Although the appraisal system is supposed to reflect this increased cost, that isn't always the case. When determining the harvesting system to use, it is important to run the analysis including roads, and determine the relative costs for different systems. For example, a grapple yarding system with 300 m road spacing may be justifiable on 40–50% slopes if endhauling is not required. In other terrain, this system may not be cost-effective.

With helicopters, the road construction cost may not be incurred, but the yarding cost is high, from $40 to $60/$m^3$. The timber must be large, and the layout and cycle time appropriate in order for the harvesting cost to be justifiable.

Wood Size

When Crestbrook has a pulp program, we harvested very small diameter wood. On the other end of the spectrum, we harvest large diameter logs using costly harvesting systems such as helicopter logging. Obviously, the value of the timber will determine which harvesting system is justifiable economically.

Wildlife Management

The Kootenays have populations of elk, mountain goats, caribou, and mule deer, and there are wildlife concerns for these as well as other species. The non-timber resources help to determine what system to use. For example, in elk winter range, snow interception is important and this can be achieved by retaining the large Douglas-fir trees. If the operating area is 50% slope, a slackpulling carriage will be necessary so that line can be pulled. Requirements for other mammal species and fish will influence harvesting system choice.

Visual Quality Objectives

Mountainous terrain is highly visible, and achieving visual quality objectives becomes a large part of planning and system selection. In some cases, mimicking a natural disturbance, for example, an avalanche track, will meet the desired objective. The harvesting system selected must be able to meet the requirements of the prescription; in the case of the slide path, a Wyssen system was used to yard 900 m effectively.

Access Management

In some areas, access is limited by agencies such as the Ministry of Environment. For example, in part of the White Swan River drainage, the MOE has many wildlife concerns and restricted crossing the river and road access on the other side. A temporary bridge was allowed for ambulance access, but the timber was harvested aerially. In these situations, non-timber resources and access restrictions determine the harvesting system.

Conclusion

There are three key considerations when making harvesting system decisions. Harvesting must be done safely, efficiently, and profitably. It is difficult to have these things together these days, but if one is missing, the company will not be operating long.

Questions

Q. Are your cable systems choker or grapple based?

A. We tried grapples but they were too big and we had a lot of breakage. A smaller grapple may work if one was available. All of our cable yarding uses chokers.

Q. You spoke of frozen anchors, frozen wood, and frozen roots. Is choker yarding a problem in deep snow at high elevations.

A. If trees are felled too early, a snow fall and several freeze/thaw cycles can result in very high breakout forces. We fall with yarding and have only two or three days of wood down.

Q. Do you do avalanche planning?

A. We have an extensive avalanche program. Avalanche tracks are classified and we have systems associated with them. Our yarder operators and truckers have beacons. We operate all year in avalanche terrain. Usually twice a year in late winter when the level of danger reaches a certain level, we do avalanche control with blasts.

Q. Do you modify your engineering to avoid creating avalanche tracks on steep slopes?

A. That is a good point. We have created some avalanche hazards, with the Wyssen operation for instance. At this point we haven't modified our planning. In some locations we have avalanches coming onto the roads and snow removal is expensive. We're looking at leaving a buffer to see if it will mitigate the hazard.

Q. What are your cable costs?

A. Depending on wood size, accessibility, and landing availability, our costs average in the low $\$30s/m^3$ for falling and yarding.

Q. What are the costs with aerial?

A. Around $\$50/m^3$ for falling and yarding.

Steep Slope Challenges from a Ministry of Forests Perspective

Doug Nicol, Regional Geotechnical Engineer
British Columbia Ministry of Forests, Nelson BC

Introduction

In this presentation, I will concentrate on some of the risks and consequences associated with landslides and sediment delivery.

Forest Practices Code

The Forest Practices Code contains several sections within the Regulations that pertain specifically to the issues of landslides and sedimentation.

Identification of Unstable Terrain

In the Operational Planning Regulations, Section 25 specifies that a forest development plan must identify areas of unstable or potentially unstable terrain, i.e., having a moderate or high likelihood of landslide. There are three options, depending upon the information currently available:

- Information from detailed mapping of terrain stability should be used if available.
- Reconnaissance level terrain maps should be used if no detailed work has been conducted.
- If neither of those sources of information are available, then areas with slopes over 60% slope must be assumed to be potentially unstable or unstable for identification purposes.

Under Section 30, terrain stability field assessments must be done if harvesting is proposed in areas identified as having:

- a moderate to high likelihood of landslides
- unstable or potentially unstable terrain
- slopes greater than 60%
- indicators of slope instability, or
- been identified by the district manager as requiring a terrain stability field assessment.

However, if all three of the following conditions are met, the assessment is not required:

- The landslide likelihood is moderate.
- The area is in the Interior of British Columbia.
- Harvesting will be cable or aerial method.

Under Section 49, excavated or bladed trails cannot be proposed in areas subject to moderate or high likelihood of landslides until an assessment indicates that building the trail will not cause the terrain to become unstable.

Community Watersheds

Some districts within the Nelson Forest Region contain 40 to 60 community watersheds. Activity in these watersheds is highly contentious. Surface soil erosion hazards and the risk of sediment delivery into streams are key considerations in determining where soil disturbance hazard assessments are required. Again, these assessments do not apply if the harvesting method is cable or aerial. (However, they may apply for road developments.)

Roads

Sections 3(5) and 3(6) (detailed terrain stability assessments) of the Forest Road Regulations apply to road construction. Harvesting method cannot be separated from road location and construction. Before any road can be constructed, modified or deactivated, indicators of slope stability must be considered and a field assessment must be conducted to determine what the impact will be. Section 6 also says measures to maintain slope stability must be part of the road design. Community watersheds are again a consideration, and road design must be compatible with preserving water quality.

Roads in the Nelson Forest Region are an important contributing factor when determining the causes of harvesting-related landslides and erosion events. Table 1 summarizes the road-related landslides and erosion events in 1996.

Table 1. 1996 Landslides and Erosion—Reported Events - Nelson Forest Region

- 58 forestry development related slides and erosion events were considered to be significant.
- 54 were road related (93%).

Cause	
Concentrated water/diverted water	52.0%
Undercut by river erosion/lake drawdowns	21.0%
Oversteepened fill	9.5%
Cut bank failures	9.5%
Inadequate culvert protection	8.0%

Note that 93% of the slides in 1996 were road related. We anticipate that in 1997 we will have greater than 150 slides. The increase is due to the high snowpack and severe rain events in March and April.

When comparing the proportion of slides/erosion events by district, terrain and rainfall/snowpack are the primary difference. Concentrated or diverted water caused 52% of the events. Generally this resulted when a culvert was located in the wrong place, the culvert capacity was inadequate, or cutslope failures diverted water to unstable ground. Overall, 80% of the events were related to water.

Risk Assessment

We have been using risk assessments as a tool to assess development in high risk areas. In these areas, we identify the event(s) that we are trying to prevent. This may lead to identifying a harvesting system that addresses the concern, or it may tell us what the risk is, and knowing the costs, accept or reject the activity. The Forest Practices Code does not, however, state an acceptable level of risk; these judgments must be made by the people concerned.

In the example, Table 2, the likelihood of a landslide is identified, and the consequences to visual, fish, water and property/life values are assessed. The hazard likelihood multiplied by the consequences gives a risk for each value. Mitigation measures can then be applied to reduce or manage that risk.

Determining the likelihood of a landslide is very difficult, but some variables can be quantified (Figure 1). Terrain, soil type, amount of water, and length of road are all factors. With 93% of landslides road-related, clearly choosing a harvesting method that reduces the amount of road required will go a long way towards reducing landslide risk.

Table 2. Steep Hill Creek Branch 100 Risk Assessment, October 22, 1997

Component	Assesment	Failure mode	Probable cause	Effects	Hazard/ likelihood	Consequences				Risk				Mitigation (required or proposed)	Final risk	Additional info/comments
						V	F	W	P	V	F	W	P			
Road 100 segment 0–1+540 Start to Steep Creek Crossing	mapping, joint field review	Landslide	fills or cuts too steep, wet/weak soil, diverted/ concentrated water, poor maintenance	slumps, debris flow, or debris slide; potential impact on fish, water quality, life, property, forest production, visuals	L	H	L	H	L	M	L	M	L		L–M	
		Surface soil erosion	erodible soils, steep road grades	sediment delivery to fish streams or water source												
Road 100 segment 1+540 to 1+560	mapping, joint field review	Crossing fails and fill in the crossing is transported downstream	debris originating up-slope	incremental sediment added by crossing has a potential impact on water quality	M	L	H	M	L	L	H	M	L	dip road, fill with rock; install trash rack	M	Engineer to complete assessment of return period and design crossing. If risk is unacceptable, can install bridge.
		Soil surface erosion	erodible soils, steep road grades	sediment delivery to fish streams or water source												

V = Visual, F = Fish, W = Water, P = Property/Life

Landslide likelihood combines the influences of terrain (including soil type & hydrology), road design (including drainage system), construction quality and maintenance. The terrain hazards should be determined first and then modified depending on the above additional factors. The hazard could be raised by one or more classes if 2 or more of the design, construction, or maintenance variables are substandard. The hazard could be lowered one class if all 3 variables (design, construction, and maintenance) are expected to be of high quality.

Resulting landslide likelihood categories are as follows:

Low = less than 0.0005/km/year (or 0.01/km for 20 year road)
Moderate = between 0.0005 and 0.005/km/year (or between 0.01/km and 0.1/km for 20 year road)
High = between 0.005 to 0.05/km/year (or between 0.1/km and 1.0/km for 20 year road)
Very High = greater than 0.05/km/year (or greater than 1.0/km for 20 year road)

Debris flow likelihood for crossings are as follows:

Low = return period of greater than 200 years
Moderate = return period of 50 to 200 years
High = return period of 10 to 50 years
Very High = return period of 0 to 10 years

Figure 1. Landslide likelihood and debris flow likelihood.

I've defined a very high likelihood of landslide, arbitrarily, as a situation where there is more than one slide per kilometre of road, on a road that has been in place for twenty years. A moderate likelihood is 0.01 to 0.1 slides per kilometre over twenty years. These numbers help to put a perspective on the risk level. A very high debris flow likelihood is at least one occurrence every ten years, while a moderate likelihood has a 50 to 200 year return period.

On the other side of the equation is consequence (Figure 2). In this matrix table, the severity of consequence for visual impact is identified for the degree of impact and the size of the landslide. The consequences for other values are also listed. For example, if a slide hits an S1 to S4 stream, it automatically becomes a high consequence, but if it hits an S5 or S6 stream, the consequence level depends on how close the slide is to an S1 to S4 stream. Water supply consequences depend upon whether there are water users and what type of users. With life, property and utilities values, the question is primarily presence.

When hazard and consequences are combined, the result is a measure of risk (Figure 3). When we arrive at a high or very high risk, we ask questions about cost and mitigation: what is the cost of being in a high risk area; is there an additional cost that would reduce risk from high to moderate; is it reasonable to spend the extra money? In some areas the decision is to live with the risk, but sometimes there are ways to modify the harvesting system, layout or road construction to bring the risk down. The objective is to end up with a residual risk that we are comfortable with, at a cost that is appropriate.

Once a landslide has initiated, estimate the likely travel distance and the visual and social impact to determine the consequences as indicated below (assuming an average road induced landslide width of 25 m).

Size	Visual Impact		
	Low	Moderate	High
Low (0–10 m long)	low	moderate	moderate
Moderate (10 to 100 m long)	moderate	moderate	high
High (>100 m long)	moderate	high	high

Fish Habitat

Low	Hits low fish value stream (S5 or S6), and will have a low impact on an S1 to S4 streams
Moderate	Hits low fish value stream (S5 or S6), and may have some impact on an S1 to S4 stream
High	Directly hits an S1 to S4 stream

Water Supply

Low	Non-water use, watershed
Moderate	Individual domestic, commerical irrigation
High	All community watersheds, or moderate to heavy domestic watersheds (15 or more license)

Life, Property, Utilities

Low	No private property or utilities
Moderate	Private property - no dwellings
High	Life, utilities, highways, rail, houses, etc.

Figure 2. Landslide consequence.

Consequences	Hazard			
	L	M	H	VH
L	L	L	M	H
M	L	M	H	VH
H	M	H	VH	VH

Figure 3. Landslide risk.

Questions

Q. When you say a slide is going to hit a creek, do you mean all of the debris lands in the creek? Or can a slide stop before entering the creek but the siltation will affect the creek.

A. In the case of narrow valleys with minimal flood plains (as is typical in the Nelson Region), the slides often flow directly into the creek, however, there are cases where the slide stops short of the creek and indirect siltation results. You can consider both alternatives.

Q. With your 1996 data, how many of the road-related failures were on old roads and how many on brand new roads built to code?

A. I haven't the numbers with me. We did look at the proportion of old to new and didn't see a difference. This may be because many slides happen shortly after the road is built. Within 2 or 3 years we see whether the drainage structures were placed in the right locations, and cut banks are usually most active then too. Presumably with well-constructed and maintained roads, the slide rate should decline over time.

Q. How long have you been using this process of rating?

A. This year we have done risk assessments in our highly contentious areas, usually community and domestic watersheds. It is useful to have conducted a formal assessment and to be able to identify the level of risk. I would like to see the code change a bit to acknowledge the risk. The purpose of the risk assessment is to identify the level of risk so that we can live with it or mitigate it.

Q. Do you know your success level yet?

A. We have some idea because we have had some problems even with the areas where we have conducted the assessments. We had a slide in a contentious area for reasons we did not identify in the assessment. Risk assessments have been used for 30 years in other industries and they have proven their worth.

Session 2: Using the selected system to maximize results

(How do we use the tools efficiently and safely?)

Efficient Layout from a Contractor's Viewpoint

Jerry Okonski, Logging Contractor and Consultant
Timber Tec, Montana, U.S.A.

Introduction

We've been involved in skyline operations for 23 years, primarily in the interior and the inter-mountain region and we've seen many changes. But certain things don't seem to change as well. The technical principles are still the same. During the last nine years we've worked with Crestbrook Forest Industries, and it has been a re-engineering process, from management, to supervisors, planners, contractors and all of the loggers. The ground-based contractors were given the opportunity to transfer to skyline systems and we worked to select systems and machinery to create a good mix of operations. We now have about 19 yarders working and a really good mix of capabilities.

Building a Logger

When we talk about building a logger or a woods worker we think about safety, productivity, and environmental stewardship. Those three things make the total logger and are all inter-related. You can't have one without the others.

The Yarder Cycle

Efficient layout implies a process, and I'll discuss it from a contractor's point of view: how I see the process, and what I think is important to achieving and maintaining productivity. Good layout is necessary for good productivity. The three activities I call a yarder cycle must be considered: between jobs; between sets or corridors; and between turns. You are trying to minimize the time within each of these activities: minimize the move-in and move-out time; minimize the road change time between settings or corridors; and minimize the yarding cycle time. Good productivity is always a process of minimizing time spent in each stage. For example, during stage one, between jobs, you must plan ahead. During stage two you must plan ahead but you should also rig ahead. And stage three, I say plan ahead, rig ahead, and choke ahead. All of this is aiming towards minimizing time.

We always talk about pre-planning, pre-rigging, and pre-setting. I'm a believer in those three activities, especially in the smaller wood we have in the interior region. As John Hatalcik pointed out, the slope characteristics are similar to the coast but we have the disadvantage of low volumes per hectare. That is a significant disadvantage. We have to plan the operation as tightly as we can and train the crews to operate as efficiently as possible.

Efficiency centers around the yarding cycle and I view the yarding cycle as four elements: outhaul, hookup, inhaul, and unhook. I equate it to a conveyer belt. We want to keep that conveyer belt going. Sometimes it has to move a little slower, sometimes it has to move a little faster, but we don't want it to stop and start and stop and start. The conveyor belt concept has worked for us in trying to minimize turn times.

Percent Deflection

To minimize turn time, three things are most important on a logging show: the percent deflection, the rigging plan and the landing. The most important in my opinion is percent deflection. We can talk about payload analysis but I think it all centers around percent deflection.

Percent deflection is a term understood by the manager and the chokerman. A show with 6% deflection or a skyline at 6% means something to the manager, to the supervisor, to the contractor, and to the chokerman. Figure 1 shows that percent slope and percent deflection affect the upper end tension of your skyline system. If we are in a 1% situation, we know we are using all our tension just to hold the line up and keep the system on the road. But if we are at 5, 8, and higher percent deflection, our upper end tension is reduced and we have more capacity to carry a payload. Percent slope has some effect but it is not as significant as percent deflection.

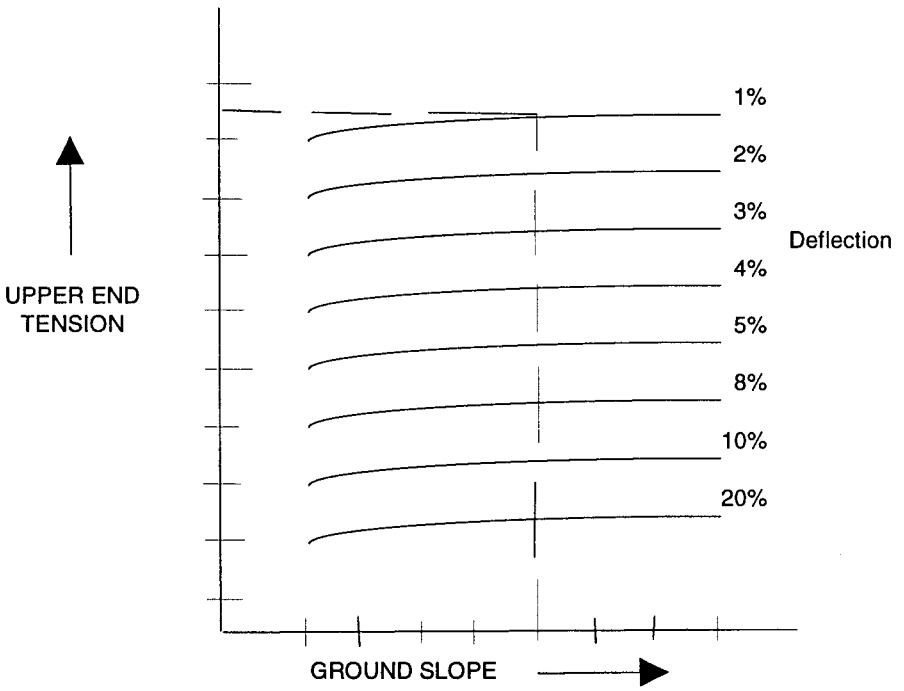

Figure 1. Influence of deflection and slope on upper end tension of skyline.

We like to operate within an optimal range of deflection (Figure 2). If your skyline road is around 5% that could be marginal. The tensions will be fairly high (Figure 1) and if the operation is partial cutting, you will have more hang-ups and it will be harder to control the flow of the log to the landing. A higher safety risk is also associated with it. Therefore, we like to operate at 5% or better.

At the other end of the spectrum, "a little deflection is good or improving deflection is good, therefore a lot more is better." I don't necessarily agree. It is better to have more deflection than less but if you have too much, it will take longer to deliver the choker to the chokerman and a lot longer to bring the payload into the skyline. A high percent deflection is usually obtained in a canyon situation. The skyline has a big belly in it and bringing the turn up to the skyline and taking it to the landing are slow. I prefer 5 to 15% because I like to maintain the line at a fairly constant height above the terrain. It is then easy for the chokermen to grasp the chokers quickly but the deflection is adequate to carry a sufficient payload to the landing.

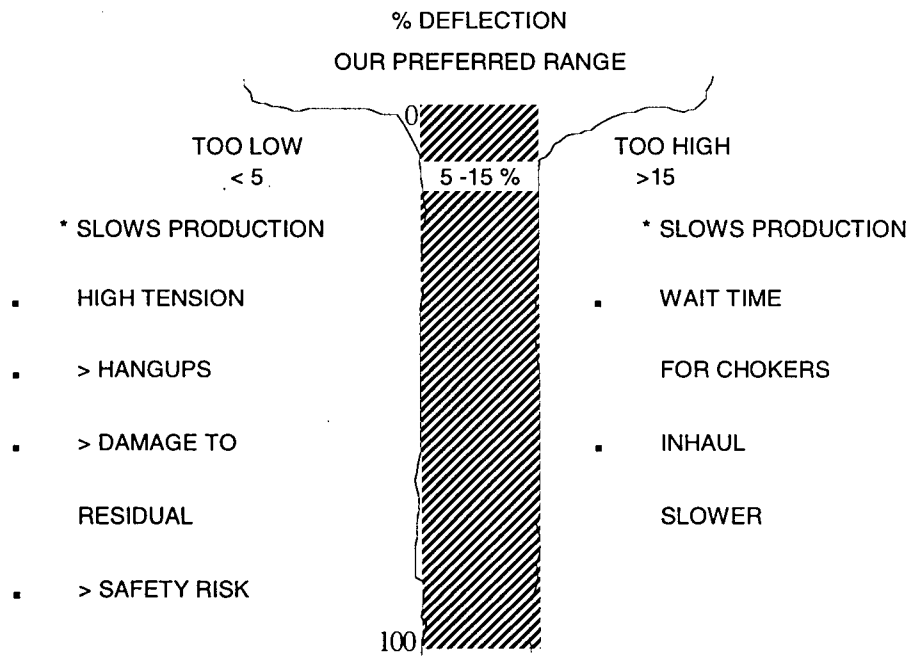

Figure 2. Preferred % deflection range.

Rigging

The rigging plan includes guyline anchoring, tail tree or tailholds, and intermediate supports. Are these structures available prior to cutting or must alternatives be identified?

We have many small stumps in our operating area and these can give us rigging problems. If the structures on the site are not adequate, you can use mechanical supports, multiple stump anchors or rock bolt anchoring. Some options are more expensive than others but they're all effective.

The Landing

The third requirement is a decent landing. That doesn't mean a constructed landing is necessary. The landing may be roadside and in fact, most of our yarding in Montana has been to roadside for seventeen years. Probably 95% of our harvesting in Montana is commercial thinning, overstorey removal, and other types of partial cutting. It is minimum impact harvesting and we cannot construct landings. I prefer a natural landing utilizing the features of the terrain to land my wood. As an alternative we will use a road turnout. Typically we place a brow log below the landing in the chute, arranged to hold three or four turns. Normally a loader pulls the logs away hot. This system has worked quite well for us over the years.

Other operators in the Cranbrook region have developed mechanical means for securing tree-lengths or log-lengths, using some unique ideas.

In summary, three items are necessary to have an efficient layout. Number one, above all others, is percent deflection. If you don't have decent deflection you're going to hurt your production. You may need to use intermediate supports to get both spans better than 5%. A rigging plan and a landing are also necessary.

Planning

Next, we plan ahead. This is the shared responsibility of the company and the contractor. The company normally locates the road and decides which system to employ. Road location is very important, not simply grade but using the natural features and natural breaks. By using the terrain features, the amount of road construction is reduced and the stability of the road is increased. Overall, it aids the harvesting efficiency. I always like to look for tractor ground above, cable ground below. Many roads cut across the steep terrain with a break 50 feet above. I believe the grade should roll to catch the bench and preserve good tractor logging above and keep the cable yarding below where it should be, on the steeper ground.

I also believe the company people should run profiles or deflection lines. These lines are necessary to determine which system to use. Are you going to use intermediate supports? Are they necessary? Can you get around it? Can you use a single span? Do you have to yard downhill? Do you have enough runout for downhill? So many questions can be answered by running a profile and doing a simple graphical analysis to determine percent deflection. Do a simple graphical analysis and do a payload analysis, for example, with LoggerPC.

The company people should also consider all of the anchoring possibilities. At Crestbrook the planners have checklists that walk them through the percent deflection analysis and all of the other variables such as anchors and tailholds. The result is a carefully planned and reasonable harvesting show.

The company does not need to locate tailholds and intermediate support trees. If the contractor is given a boundary and a cut block that has been reasonably planned, he needs to do the remaining 50%. He needs to go into the block and walk it. He needs to run some profiles for his own benefit and do his own deflection analysis and payload analysis. Using his own analysis, it's the contractor's responsibility to locate his tail trees and intermediate supports, and, if the harvest is a partial cut, to locate his corridors. These are for cutting control, and in partial cuts in particular, you have to have good cutting control for directional falling and processing of the logs. When the wood is laid out well, with preset chokers good production and a good residual stand with little damage follows.

Conclusion

Cooperation on the planning between the company and the contractor is necessary. In summary, I believe in efficient layout. Percent deflection, rigging considerations, and the landing are the keys.

Questions

Q. What creative systems are being used in Montana in steep chutes where the log runs back down?

A. Normally we buck log-length and set a brow log down there at a natural break. By presetting we can move a lot of wood quickly. We aim for 30 to 90 seconds for hook-up, and 30 to 90 seconds for unhook. We use pulp logs or snags for the brow log; this has worked well.

Q. You buck and then yard?

A. We buck in the woods, yes. The loader picks the logs out of the chute and keeps it clean. The loading is fast. We've even sorted 3 or 4 sorts in the landing with a 5 metre wide road.

Q. Jerry, please describe your brow log process.

A. (Figure 3) When we locate corridors, guyline positions and tailtrees, we ribbon the trees that are close to the road. Then we high stump them and set a brow log. A boulder, a stump or a natural ledge can also be used to set the brow log or these features may mean a brow log isn't necessary. When the turn comes in, the end of the log hits the brow log and chokers are positioned for the chaser to unhook, normally about his waist level, and he doesn't have to climb down to unhook his turn.

Some of the Crestbrook operators have mechanical devices that they've developed. Also, Skylead has developed a portable device; a series of disks holds small trees with limbs.

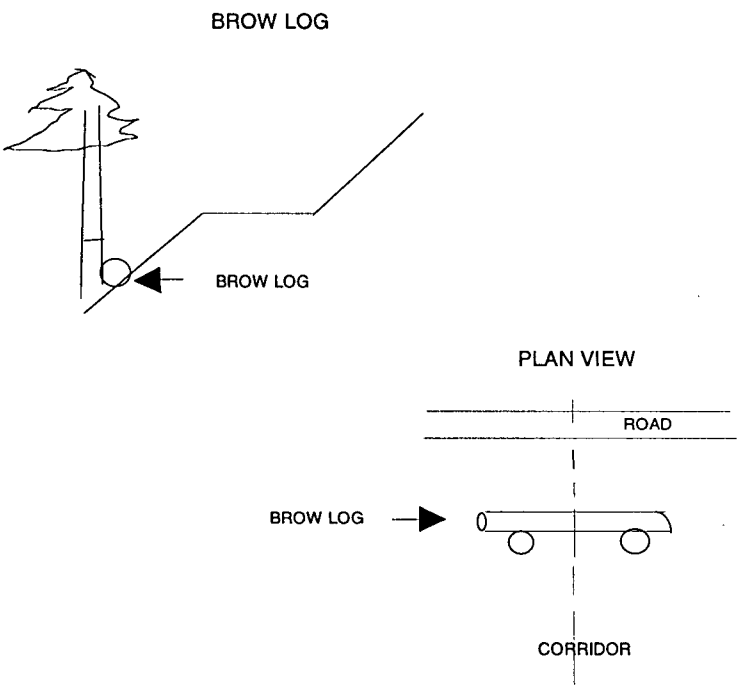

Figure 3. Use of brow log.

Q. So bucking in the woods is necessary?

A. No it is not necessary, but we have found it to be an effective way to move wood off of steep sites.

Q. It's imperative that you use heel-boom loaders in that case, is it not?

A. No, any below-grade reach loader will work. We've used hydraulic excavators, long-boom cranes, and heel-boom cranes, as well.

Q. Do you preset all your cutblocks?

A. Normally.

Q. How far do you usually stay ahead of the yarder?

A. In a corridor, we'll probably hook hot for the first 50 m. Then we might go to three preset chokers for the next 30 m. Then we go to four, then to five; sometimes up to six or seven chokers. It depends on how far out and what kind of payload. I don't have to run but I do a lot of walking because

you walk back to the line twice. It's a nice way to develop a good payload and snake the wood out in a planned manner. Too many times when you're hooking hot you make bad decisions and get a lot more hang-ups. You may have picked a huge tree-length or three big logs and then your next turn is three little ones. With presetting you can pick that little one and maybe two of those big ones and spread the load out better. We usually work with one man on each side of the line. They're always in communication and each man has his own signaling system or tooters. They work as a team.

Q. Do you use the ring & toggle system for attaching preset chokers?

A. Yes, we use the rings. Many times we'll put two chokers on the same ring. That works quite well because it reduces the weight. There are different set-ups. Everyone makes his own T.

Q. Most cable operations in the interior have been tree-length. Your feeling is that bucking in the woods increases yarding efficiency so much that it makes up for the additional falling costs?

A. For us it has. Now we are logging as cheap or cheaper than \$32/ m^3, considering the exchange rate. We have good fallers and they are used to operating with bucking at the stump. In the winter we switch to a tree-length operation. Then we stagger our falling, moving between units to provide fresh logs.

Q. Is there a piece size where you might go to tree-length?

A. Yes, sometimes we've made pieces too small in 30 cm diameter and smaller wood. Then we prefer to yard bunches. That works well in small wood. We've tried yarding short logs and long logs, bunching the top log to the first log. We created a bonus and increased our payload. In a Douglas-fir stand with small trees, marginally commercial, we yarded 400 pieces by noon. The landing was swamped because the bottleneck was handling so many pieces during loading. When we tried cutting all short logs, we wound up in a difficult yarding situation, and produced six short-log loads a day which was only three long-log loads, about 100 m^3 /day.

Q. What about safety concerns bucking on sidehills?

A. In all the time I've been doing this, and in some difficult operations, we've never had anyone hurt by that.

Q. Even in the winter?

A. Even in the winter. We had a faller hurt last week. We had a windstorm with a lot of blowdown and we have a small project to clean up some private land. It was a hazardous situation, and the tree was in a bind. It's unpredictable. The faller is about 50 years old and had never had a falling accident before. But, as far as bucking, we have some very good fallers who have been with us for a long time and know exactly what to do.

Q. What are your additional falling costs when you buck?

A. Our falling cost will range from \$3.50 to \$5.00/m^3.

Q. Jerry, does bucking in the woods cause you to shorten-up, or narrow your corridor spacing?

A. No. Often we'll use a radio-controlled, slackpulling carriage, and we'll go 30, 40 metres or more. Standard operating procedure for us is 40 metres but we'll go 50 or 60 metres to take out a long corner.

Q. Is that because of the carriage you're using? Does tree-length versus log-length have an effect on corridor spacing? Are you saying that your carriage means log length is not important?

A. The slackpulling carriage has really helped us do a better job. We used the old Christie carriage for many years but when we converted over to the newer radio-controlled carriages, we found our production increased by half of a load to a load per day. We were able to minimize damage to the residual stand because you aren't locked into that stop's position on the skyline. Also, the carriage works well in a canyon situation. With a radio-controlled carriage you can leave your mainline out and reduce the tension on the system until you bring the turn up the skyline for a distance. Then you can stop, pull your mainline in, and get the turn up to its normal position.

Total Chance Planning

Grant Sime, Senior Planner
Silvatech Consulting Ltd., Salmon Arm, BC

What is Total Chance Harvest Planning?

Total chance harvest planning is the access and harvest design of an operating area for the full rotation. This phase of the development process can provide a solid foundation for all the activities that come after. Total chance harvest planning allows the licensee to make good management decisions, and provides for an assessment of impacts and compromises to logging efficiency that may result from accommodating non-timber resource values or the salvage of catastrophic events (e.g., insect infestation). Because these plans provide a development plan for the whole rotation, the long term impacts of any change to the harvest design can be assessed in terms of logistics and log costs.

After 15 years of working in the tough terrain of the Interior Wet Belt, I have developed an appreciation for the value of good landscape level planning. My experiences have taught me the value of looking at the whole picture; at what the ground will offer, to avoid backing the company into a corner (high log costs) later on.

Over the last few years, forestry in British Columbia has been directed by the Forest Practices Code, which has turned out to be an opportunity from a planning perspective. The code provides a directory of the fundamental elements of planning, that we can be reasonably confident, will remain consistent over time. Combining the use of FPC Guidebooks and licensee planning guidelines (e.g., road grade limits, harvesting systems profile, etc.) with good mapping and resource inventory data, the planner has the necessary background to develop a sound multi-pass harvest plan. It follows that a good total chance plan should produce a robust, but flexible harvest plan that will form the backbone to development activities through-out the rotation.

You have probably all seen the results of piece meal planning; the old methodology of laying out first pass logging without adequate consideration to future development and harvest. The result is all to often, high road and logging costs because previous development is in the wrong spot to effectively service the rest of the area. Further, it often becomes difficult (expensive) and sometimes risky (disturbance) to modify existing development to hit the relief breaks necessary to realize the benefits of total chance for the remainder of the rotation. However, this situation usually increases the value of a plan that will provide a strategy to remedy these problems and get the development back on track.

Total chance planning or total chance harvest planning becomes even more important on steep ground, where the impacts of poor initial planning are often painful. On tougher terrain, the planner will have few development options, which must each be assessed for strengths and weaknesses (e.g., slope instability, road cost, etc.). Careful consideration of these important variables will help solidify the companies economic position over the long term, and assist in the decision making process. It follows, that by not providing a flexible long term plan, the area may become economically non-viable at some point in the rotation, which may also result in timber supply impacts down the road.

I will try to describe the various stages that I go through in developing a total chance harvesting plan for an area, and try to further illustrate the advantages of the these plans and how they provide an important first step to Integrated Resource Management Planning. As an initial step to multi-resource planning, the total chance harvest plan provides a means to determine the best (i.e. stable) access and harvesting strategy. This will later allow the planner to assess the costs associated with measures related to the protection of other forest resource values. In this way, the decisions you make now are founded on a knowledge of long term forest management objectives, as well as short term.

Before You Start!

Develop an outline of your total chance planning process, then describe the individual phases and management objectives. I suggest that you search out FERIC's Total Chance Handbook written by Robert Breadon back in 1983. I have found the concepts and procedures of great value.

Find an overview map (e.g., NTS) where the boundary of your interest area can be delineated. The size of the interest area might vary from 500 to 50,000 hectares, but the important thing is to determine a logical boundary for the plan. Consider where the wood is going (i.e. manufacturing facilities, existing haul roads, sort yards, dump-sites, etc.) while you are determining the size and configuration of your planning unit. It may make more sense to split a large area up into smaller, more operational units.

Getting good quality contour and planimetric mapping is critical to developing a sound plan, especially in steep, complex terrain. The BC Ministry of Environment, Lands and Parks, 20 meter contour mapping (TRIM) will work in the easier terrain. However, in steep or broken ground, 5 or 10 meter contours on a 1:5000 or 1:10,000 scale base will help the planner to identify important slope breaks (landing and road locations), stream crossing locations, and planimetric features (i.e. openings, rock outcroppings, etc.).

Find a variety of air photo scales that cover the area of interest. Scales of 1:40,000 and 1:60,000 will give the planner a good overview (i.e. timber types, operability line, existing and potential main haul road options and other landscape features) of the interest area. To zoom in, 1:15,000 scale coverage allows the planner to pick up on specific ground features like rock, instability, timber type and subtle terrain features. The bulk of the Total Chance Harvesting Plan should be developed from this low level photography. Access all available Terrain Stability Assessments done for the area. If available, these assessments and recommendations should become an integral part of the Total Chance Harvesting Plan.

Search out all available information on identified timber (e.g., Forest Cover) and non-timber (e.g., visuals) resources. If possible, convert this information to folio overlays to match the scale of your base contour/planimetric map. Although the main focus of a total chance harvesting plan is to utilize the terrain to minimize impacts on the environment and control log costs, non-timber resource information can be used as a guide to direct your design decisions through-out the planning process to ultimately achieve all resource management objectives through the rotation. With this approach, the integration of non-timber and timber resource values is being given consideration through-out. However, toward the end of the planning process, the harvesting plan will require careful scrutiny, to ensure that all identified resource values have been accommodated. By starting with a sound operational harvesting plan, that makes the best use of the terrain, the planner can easily

identify and quantify compromises to optimal efficiency as measures to manage other resources are applied. It becomes a logical progression to move from a total chance harvesting plan to an integrated total resource design.

Planning: What to look for?

Now that you have a good contour/planimetric base map, timber/non-timber inventory information and terrain stability data, identify and evaluate any prior development (i.e. harvesting, roads, trails, etc.). If there has been development, was it based on total chance or has it created any stability problems to date? The answers to these questions will allow the planner to decide whether or not to build on previous development strategies.

Next, review the base map to identify what the terrain will offer for road network and landing options. Note the slope breaks, and look for good stream crossings, as these will likely become important control points later in the process. Scribble all over the map, to get your thoughts and possible options down on paper. This draft will be a valuable field tool as you later tie down control points and assess alternatives in the field.

Harvesting Equipment

Before you go any further, get a good feel for the harvesting equipment profile that is currently available. The reality, is that this profile is what you maybe limited to in the first pass. Therefore, the planner should understand the operating limits of each piece of equipment, in order to design for optimum efficiency. In the second, third and fourth passes (even-aged systems) the planner might insert harvesting systems and equipment, not currently in the companies contractor profile, which might better suit the terrain (e.g., longer yarding distances, grapple opportunities, helicopter, etc.).

If machine type and configuration are predetermined, this will control road density and landing placement. Obviously, when-ever possible, select the machine/systems profile that best fits the terrain features and will result in the lowest <u>overall</u> log cost and protection of the environment.

Identify Control Points and Main Branch Road Options

Now that the planner has the necessary pieces of information to complete a total chance harvest paper plan, control points need to be identified and marked. This is especially important on steep terrain, where good creek crossings, switch-back and landing locations are limited. It also helps to identify inoperable sections of ground (i.e. potentially unstable ground, brush openings, rock outcroppings, swamps, etc.) in order to refine the amount of operable forest within the interest area. These areas may later provide opportunities for valuable wildlife-tree patches, FENS, old growth reserves, etc.

With consideration to the control points established, identify alternatives for the main and/or branch road network, working within the acceptable range of road grades specified in the company' standard operating procedures.

Total Chance Landing and Spur-road Design

At this point the planner has selected from the paper plan, the most promising main haulroad option. Ultimately, field truthing will either confirm this choice or result in change to a more feasible alternative. The planner should ask; which route best catches the terrain breaks? which option will result in the best grade control? which route will service the area best over the rotation?

Now the planner must look at a landing and spur road design (tributary to the selected main access route) that will best service the area, minimizing logging costs and ground disturbance. In conjunction with the landing selections, the harvest setting boundaries should be roughed out. The planner

should identify the skidding or yarding direction to help determine each setting. To identify optimal yarding distance for tough cable settings, I have been using a payload analysis program, developed by Oregon State University, called LOGGERPC. Utilizing available stand information, and contour mapping (profile), representative and critical settings can be assessed for optimal yarder type and yarding distance to ensure an acceptable payload. A rough idea of available deflection can also be checked by assessing the profile generated from the contours. While the accuracy of this exercise is only as good as the quality of the contour information, it will give the planner some confidence that the landing positions and setting boundaries will work.

At this landscape level, it is important not to get hung up on unit planning issues (e.g., exact tailhold and intermediate support locations). The focus should be on sound operational logistics and developing confidence that more site specific unit planning will simply build on the landscape level total chance harvesting plan. The utility of the landscape level plan in later unit planning exercises, will depend on how well the planner read the ground (i.e. landing locations) and how much flexibility was built into the design, to accommodate fine-tuning.

Field Reconnaissance and Ground Truthing

A paper plan is only as good as the tools and information used. Hopefully, when you get to the field, you will find that the planimetric and contour map information is of good quality. Testing should be carried out to ensure that this is the case (e.g., field profile).

The field reconnaissance phase of the plan is critical, as it provides an opportunity to verify critical control points (i.e. landings, stream crossings, switch-backs, operability, etc.) identified in the paper plan. This ground truthing of the paper plan will identify any potential problems with the design and facilitate adjustments.

At this phase of the landscape level planning exercise, the planner should, in addition to confirming operational control points, assess the accuracy of the timber typing. This will be important information later on, when determining the harvesting schedule and the economic contribution of the interest area (e.g., product/log value - log and milling costs). In addition, the planner should be identifying existing and potential insect, disease, and mechanical (e.g., windthrow) damage, as this may have a bearing on the management of the interest area (e.g., block configuration, scheduling, etc.).

During the field assessment of the plan, the planner should also be considering the stand characteristics (i.e. stand conditions and structure, aspect, elevation, soils, etc.) to identify potential silviculture systems options.

Harvest Polygons and Pass Schedule

Setting harvest boundaries for the total chance harvesting plan will largely be determined by landing and road placement. However, the planner should also look at planimetric features (rock outcroppings, unstable terrain, swamp complexes, and inoperable terrain, etc.) to identify and map potential wildlife tree patches and movement corridors. Also, identify and map stream, wetland and lake reserve zones based on Forest Practices Code default classification criteria (unless better information is available). The proposed block can then be constructed around these features as combinations of individual landing settings.

The planners knowledge of the identified non-timber resource values within the interest area will also play an important role in the development of block

design and scheduling over the rotation (e.g., achieving visual landscape objectives). Assess your compliance with non-timber management objectives and regulation and modify the design accordingly to accommodate these resources over the entire rotation (all passes/entries). Because you are working from a sound total chance development plan, potential landing setting (polygon) combinations (block configurations) are limited only by logistics, economic viability and forest policy. The block scheduling will also be determined by these factors, in addition to age class.

Finally assign block numbers that reflect the pass schedule and suggested silviculture system or harvesting method (e.g., 2901 ..... 2 = second pass, 9 = seed-tree with reserves, 01 = polygon or block number).

Final Total Chance Harvest Plan

The final stage of this process is simply the culmination of the previous steps, resulting in a brief description of management options, a volume/area pass and systems summary, and a final Total Chance Harvesting Plan Map.

Conclusion

Total Chance Harvest plans will assist company and Ministry planners in completing annual updates to Forest Development Plans and provide a useful platform for discussions with resource agencies, licensed users and the public. These plans are also a great field tool, as they save valuable time by identifying opportunities and issues early in the development process.

From a managers perspective, sound total chance harvest planning over a rotation, provides for an inventory of blocks that fit specific equipment profiles (optimum productivity). As it is often difficult to establish new logging contractors, without a volume commitment, a number of these plans will fuel an inventory of blocks that will help to secure good, long term contractors in the community.

Questions:

Q. Have you done a total chance plan on an area that had already been planned by a company or licensee and showed them how much money they could save on their road building and logging costs doing it your way versus doing it theirs?

A. No. Where licensees are currently doing total chance planning, there is little demand to review existing plans.

Q. Licensees using Total Chance Plans are good ones to ask about resulting efficiencies and savings in dollars, especially those who are sold on it. (Terry Smith, Silvatech Consulting Ltd.)

A. Yes, in my experience, the plans have improved recovery and reduced costs and certainly layout costs. The tougher the ground the greater the advantage.

Session 3: What we have learned: what works, what doesn't

(Practical experiences with systems in use)

Sensitive Site Harvest Systems

Dennis Young, Weyerhaeuser Canada Ltd.
Jack Thompson, South Cariboo Enterprises
Grande Prairie, AB

Introduction

In this presentation we will share the results of three years of harvesting steep and sensitive sites by South Cariboo Enterprises in Weyerhaeuser's Grande Prairie-Grande Cache operations. We'll talk about the original system we envisioned, what's worked for us, what didn't work, and what the system has evolved to today. To conclude our presentation we'll tell you what we believe are the main factors that have helped us to be successful, and what the future opportunities are for improvement.

Background Information

Weyerhaeuser's Forest Management Area (FMA) (similar to a Tree Farm Licence (TFL) in the BC) straddles the Alberta/BC border up near Dawson Creek in the north, and stretches south and west from Grande Prairie along the Rocky Mountain foothills. The allowable annual cut of 1,574,000 m^3 of conifer supplies a sawmill in Grande Cache and a pulp mill and a sawmill in Grande Prairie.

The zone <100 km from Grande Prairie is lower elevation with flat to gentle rolling terrain, boreal forest, and mixedwood forest heavy to hardwoods. Moving south, the elevation increases. The camp-based contractor operations (>100 km from Grande Prairie) are in the higher elevation foothills area where the ground becomes more broken and difficult. The wood here is primarily lodgepole pine and white spruce. The topography includes deep river valleys with flat terrain moving away from the rivers.

Our area includes Two Lakes, prime recreational sites for the people in the region. Our intention is to preserve the wilderness experience where people feel they're getting away from it all even though it's a commercial forest area. Reducing visual impact was identified as a key objective. Numerous meetings were held with various interest groups prior to and during the development of the harvest system and design plans for the area.

In 1993 we examined where logging would be done in the Grande Prairie area and saw that we were looking at steep ground. We determined that 7 to 10% of our total logging area is greater than 35% slope. In our camp-based contractor operations, 30 to 40 % of the logging is on over 35 to 40% slope.

An objective was to log the steep ground safely. As we pushed the envelope for rubber-tired skidders, we wanted to prevent accidents, not just react. We were also looking for a logging system that would require fewer roads with less visual impacts from the roads and would also give us longer seasons for harvesting. Many of our activities are focused on winter operations and we wanted to extend both the summer logging and the summer haul season.

We wanted low ground pressure equipment, hot logging, and a haul system that would support steep ground and limited decking areas. Developing a stable skilled group of employees to operate the equipment was recognized as critical to fulfilling our objectives. One of the keys to running specialized equipment and getting predictable results is the operator.

In 1994 we advertised in BC, Alberta, and Saskatchewan for proposals from contractors to help build and manage a sensitive site harvest and off highway haul system. We went through a lengthy application process. Based on previous experience and discussions with candidates, we felt that South Cariboo Enterprises and Jack Thompson had the mix of skills and attitude that we needed.

1994-95 Start-up System

We started by purchasing a Timbco 445 buncher with an Ultimate 5300 saw head and a TransGesco TG80 clambunk skidder. During the winter, operators were trained on the feller-buncher and skidder and we tested the equipment on steep ground in various sizes of wood. We began working in the Red Rock area southwest of Grande Prairie. During the first winter we felled and merchandised at the stump with the Ultimate, cutting the prime wood out and sorting the pulp in the bush. We used the clambunk to skid the wood to roadside.

We had a fleet of picker trucks hauling. They sorted the wood at roadside and transported the prime logs, leaving the pulp behind. The plan was to eliminate the need for a delimber and quality sort at roadside to reduce costs. We also wanted to reduce roading and eliminate the need for burning limb piles at roadside.

1994 Findings

A problem developed because we weren't clearing the pulpwood, and the clambunk was driving over it. Finally, the picker trucks moved the wood to high ground and the haulers took it to the mill.

The clambunk was two to three times as productive as the Timbco when the Timbco used the Ultimate head to delimb in the block. The clambunk and the buncher could safely handle slopes up to 60-65%, but this was the upper limit. The clambunk had 36 inch wide tracks on the front and 42 inch wide tracks on the rear. These tracks helped with stability (it was able to skid across 30% slopes), but they limited travel on adverse slopes in the winter. Road location was critical because the clambunk had difficulty driving out from under the load on decking areas with slope greater than 10%. The sort by the picker trucks met the sawmill quality requirements, however, the loading and hauling of the pulpwood was slow and costly. By working into March and April on the frost and using the low ground pressure clambunk, we were able to extend the harvest season and skid wood for the summer log haul.

1995-96 Experience

In 1995-96, we continued to work in the Red Rock area. Five off highway picker trucks equipped with central tire inflation (CTI) systems were hauling. We acquired an older model stroke delimber to free the Ultimate up for straight cutting and delimbing at the stump and this helped increase our production. The picker trucks were able to operate in the soft ground where the conventional haulers could not. With CTI air system we began moving wood in the summer season on a regular basis.

Our goal was to head for the Sherman Meadows area close to the Two Lakes recreation area. We tried some logging designs that would be acceptable to the public and still meet Weyerhaeuser's needs for volume. We harvested a small designed block out in the Red Rock area first in order to demonstrate the system that would be used in Sherman. Several groups came to look at it including the forest ministry, environmental groups, and any others interested. As well, the testing of the CTI picker truck was completed during the summer harvest in Red Rock.

In the designed block we tried to mimic the meadows that were in the Sherman area. We used tree retention, leaving islands of trees in the middle. We feathered the edges by thinning or selectively logging a buffer to give it a natural look similar to a mountain where you have open areas or slides.

It was quite successful. Based on the public input we received on the Red Rock block and Weyerhaeuser's 3-D design software, we developed a logging plan design for the Sherman Meadows. The cutblock size and skid distance was less than our original estimate, and the clambunk was under-utilized. During the harvest, it worked occasionally in other harvest areas to assist in skidding steep ground.

Harvesting began in Sherman in late October 1996 with delimbing at the stump and limited in-block roads. The stroke delimber processed defect and sorted the sawlogs and the pulp in order to increase buncher productivity and ensure progressive hauling of the pulp by the picker trucks.

1996-97 Experience

During the first year we found the TransGesco had a traction problem climbing steep ground. It could skid down 30% slopes but it had trouble getting back up. With the wider tracks, it didn't have enough traction.

In the fall of 1996, we purchased a pair of 28 inch single grouser tracks and used 2-3/8 inch grouser bars, 3 to 4 inches long. The narrow tracks increased the productivity of the clambunk during the winter and allowed it to skid up to 40% adverse grades. We used similar tracks on the Timbco and we found it very safe on the hills.

We purchased a second delimber and contracted additional feller-bunchers and skidders. But we still weren't getting the production we wanted with the Ultimate. When we brought on the additional buncher, it was not feasible to skid the closer wood with the expensive clambunk. So we used a grapple skidder for the close wood and kept the clambunk for long skids (>300 m) and rough ground.

During the summer we do silviculture work with the clambunk, scarification by chain dragging and barrel dragging. It is cost effective even though its hourly rate is higher than other equipment. The clambunk could handle an additional chain (four sets of chain on a big spreader bar) and obtains better ground coverage. We now do up to 700 hectares of silviculture work during the summer.

To produce more volume at lower costs, we bought a hot saw for the feller-buncher. The Ultimate productivity was 18 to 25 m^3/h, delimbing at the stump while the clambunk was averaging 40 to 45 m^3/h. Now the Ultimate is limited to cutting road right-of-ways, building bridges, selective harvesting, and delimbing on soft ground in the summer.

Due to smaller cutblocks in Sherman, the roads and associated debris piles were not visible. Data showed limited recreational use in the late fall as camping was finished and snowmobiling and ice fishing started in December. We therefore decided to delimb at roadside and burn in early November.

Our CTI picker trucks were capable of hauling on the soft, wet roads during the summer and fall and increased the number of haul days. Payloads averaged 40 tonne in the summer and 50 tonne in the winter, and the trucks are able to handle 14 -16% adverse grades without using a tow vehicle.

The progressive hauling of pulp was still an issue because we only had one suitable truck. It can haul logs up to a maximum of 12.3 m long on the back bunks on the trailer, on off-highway hauls. For the front bunks on the tractor, the logs are no longer than 6.7 m. This truck is working well.

For CTI systems, some of the trucks have the Redline air system while others have the Eaton system. Weyerhaeuser thought the CTI equipped trucks could get 3000 h/y/truck. We've increased that now and have more than doubled the annual hours on the trucks, compared to our conventional log trucks.

As a result of these changes, Weyerhaeuser has increased our volume to 150 to 170,000 m^3/y in order to utilize the clambunk efficiently. Using the skidder freed up the clambunk for use in other areas helping other contractors with their steep ground. This brought up issues such as timing and falling pattern. Falling from the bottom prevented tops from covering the butts and aided skidding with the clambunk.

Several South Cariboo employees were hired and trained by Weyerhaeuser to assist in block layout and road design. Smaller block shapes hid the roads and the feathered edges and tree retention patches created the impression of natural meadows in the Sherman landscape. Silviculture crews found the amount of debris from some spruce and pine stands was a hindrance to planting.

1997-98 System Changes and Plans

In 1997 we purchased two additional CTI picker trucks bringing our fleet up to seven. We also bought two more excavators for a total of three. Excavators do all our roadbuilding and piling of tops now. We purchased a used John Deere 748 skidder to continue work with the contract buncher.

Our plans for 1997-98 are to stay in the Nose Mountain area to finish the remaining 25 blocks; 17 are clambunk blocks. The clambunk areas are fairly steep. We can build a road to the bottom or there will be some uphill skidding that can't be done with a regular skidder.

We continue to look for contract feller-bunchers because we don't have enough summer ground to keep all our equipment running and we rely on some contract bunching help in the winter. On this steep ground, work tends to slow down a bit.

Jack and I have talked about replacing the Timbco or looking at other equipment on the market as the Timbco will soon have 14,000 hours. This year we're testing an excavator for decking wood or perhaps loader-forwarding.

We will be road building in the Sherman area this year, five or six kilometres to access future harvesting. We have worked slowly in this area to give the public opportunity to give us feedback. Next year we'll take out twice the volume, 75-80,000 m^3.

One of our other contractors has bought a D5H high drive with a swing-grapple and we want to test it on some of the steep pitches to complement the grapple skidding.

Summary

Generally we have been able to harvest and haul ten months of the year although in the summer we do slow down. Starting November 1st when the frost hits, we have a seven day/week operation.

Regarding road construction, we've moved away from using one cat and one hoe to a lot more hoe work. The hoes are working eleven months/year between deactivation, road work, piling brush and assisting the summer log haul.

Worker skill development is another area we're doing things differently. During the first and second years of this program, we identified four key employees in Jack's operation. We brought them into Weyerhaeuser to help with block layout and planning. Jack's operators now help us do some of the detailed harvest plans and this has developed their aerial photography reading skills and other block planning skills.

To better utilize harvesting equipment during the summer slowdown period we use it for drag scarification, with 500 to 600 hours/year .

Jack's crew is multi-skilled; many can drive truck, run hoe, conduct harvesting and scarification operations, do block planning, and build roads. This has allowed us to keep them working and retain key employees. Having operators capable of driving trucks and running equipment within a day or two, depending on the weather and business needs, helps the operation be cost-effective.

As Jack mentioned, equipment utilization has met or exceeded our targets. The log trucks average 4500 h/y, the Timbco averages 5000 h/y and the TransGesco averages about 4000 h/y.

During planning we schedule spring harvesting for blocks where the wood can be forwarded to a road or area suitable for summer hauls. In the past we stopped logging about March 15th. With Jack working at higher elevation camp-based operations we've said "Keep logging as long as the frost is in the ground" and we've gone as late as the end of April. We stage that wood onto summer ground or to roads suitable for summer hauling. Using this approach, marginal summer ground can be hauled in the summer, especially with the central tire inflation trucks.

CTI has been a definite help to us in the summer and we have been able to haul without the roads breaking up. By hauling part loads, especially using the picker trucks, we pack the road. The low tire pressures can heal the road or pack a winter-built road. I've seen places where a pick-up can't go, but a CTI truck can go in, pick up half a load of wood and return. Then, in several days you can drive in with your pick-up. CTI has made the difference during the summer by achieving payload targets and traction on steep ground.

The picker trucks were a good choice for the steep ground and limited decking areas because they are flexible. The main log haul areas usually have a very large volume and a loader and 12 or 14 trucks are suitable. But the picker trucks work well under the conditions I've described.

The last factor in the operation's success is Jack and Jack's employees. Their positive attitude and ability to work together with us as a team, discussing changes and developing the next solution, has been a real asset. I want to thank Jack and his employees for all the public relations work that they do.

Questions

Q. What do you consider to be the maximum slope for your skidders? Where's the break off between skidders and forwarders or clambunks? Is that legislated by the WCB in your province?

A. As far as I know, we don't have a WCB regulation. We tend to use 30 to 40% slope but it depends how long the slope is and how broken up it is.

We can't leave logs because it freezes and thaws and the logs freeze in tight. We've been encouraging each contractor on steeper ground to have equipment in his fleet that can work there safely.

Q. Could you share with us the rate on the TransGesco based on your hours?

A. Generally we work on $160/h. If he's far away, isolated, or in a camp then there's some discussions on camp costs, maintenance, and travel costs.

Q. Do the CTI rigs come equipped straight from the factory or do you retro-fit them?

A. We have them done at McCoy's in Edmonton. We don't have them done at the factory because we don't get Eaton axles. We've been staying with Rockwell and Eaton won't do the system on a Rockwell axles. McCoy Brothers in Edmonton have gone to Redline or Altech and we're installing that now.

Q. Is that on all wheels or just the drivers.

A. Everything, the trailers and the truck.

Q. What is the typical conversion cost?

A. About $28,000.

Q. How does that affect your hourly rate?

A. We try to use $5/h for CTI. FERIC is doing a study of the costs, and has been studying our equipment for three years. There are some tricks because rear-ends can be damaged and some components can be over-loaded and over-stressed. During the first year we were overloading because we had terrific traction. We learned quickly to reduce the loads: move a half load out and deck it, then go back into soft ground for another part of a load, come out, top the load off and go to town with 40 or 45 tonnes. You're still getting your payload to town but you're doing it without wrecking the truck.

Skidding on Steep Ground

Deric Manning
Weyerhaeuser Canada Limited, Okanagan Falls, BC

Introduction

In my 24 years with Weyerhaeuser, I've seen the company expand in British Columbia, Saskatchewan and Alberta. I've had an opportunity to visit operations in the three provinces and hear people speak about how they operate in the different locations. Although it is all one company, many things are different, but we have interesting similarities to the Alberta operations.

Our operations in Okanagan Falls have primarily off-highway hauls and central tire inflation has been standard equipment for the last three years. We're doing studies similar to those described by Dennis Young and Jack Thompson, and have had similar results. It was nice to hear that they pay the same prices as we do.

I came here today to talk about something that we're all faced with here in BC. We have a lot of rules, the Forest Practices Code, and many different levels of planning, and we need to be able to adjust. When we see an opportunity to do something differently that will achieve as good or better results, we need the flexibility to do that.

We had an opportunity to do just that in the last couple of months and I want to share the experience with you. The opportunity may not present itself often but when we operate on steeper ground, we need the ability to do things a little differently.

Okanagan Falls

Okanagan Falls is a small community located in the southern Okanagan valley, near Penticton. The sawmill has operated since 1971. Our harvest volume is 450,000 m^3 /year, primarily from the upper plateau of the Okanagan highlands. About 80% is mechanical harvesting, feller-buncher and grapple-skidder. But 10 to 20%, increasing up to 30%, is harvested by other systems. This change in harvesting system is driven in part the Forest Practices Code but also by our mountain pine beetle history. We had a huge infestation for 10 years and we harvested much of our mid-elevation ground. Now we're entering the higher and lower elevation areas and different harvesting systems are appropriate here. For example, we operate near the Apex ski hill. An area around a small lake, Nickleplate Lake, had no road access for a number of years and had a big beetle problem. We applied for a large cutting permit to salvage dead trees; up to 40% of the trees were dead. We have a chipping operation that handles all dead wood.

The area was designated as a community watershed but then it was delisted. However we still had plans in place as though it was a community watershed.

Company Safety Policy

Our company promotes safety as top priority. We have strict rules about operating equipment on specific slopes. For example, the rule now is that slopes over 35% for more than a 30 m distance, cannot be logged with a rubber-tired skidder unless the contractor/operator has a detailed plan. The steep slope addendum is two pages long and the contractor must sign it for each harvest block. The contractor must complete a lot of pre-work before he can start logging. Within an area, a variety of methods of harvesting may be necessary.

The Steep Block Trial

One of our contractors has a Caterpillar, a brand new Timberking, which is the new Caterpillar version of a Timbco, as well as Caterpillar loaders, crawlers and other equipment. Because he is a good customer, Caterpillar brought him the new Caterpillar 527 crawler tractor to test. This is Caterpillar's version of the D5 high-track that Finning has been building for a few years. It just happened that both a Timbco and the Caterpillar 527 were close to the study block at the same time.

The trial area was a small patch of mature timber surrounded by immature, and had very difficult access. The bottom portion of the block was to be cable logged and we were allowed to build a bladed excavated trail to the top. Since we only do 5 to 10% cable yarding in our operating area, we only have one cable operator. He yards with a small excavator with winches and a boom attachment that makes a 6 m tower. He does not have downhill yarding capability so we had to address the upper part of the block in another way.

A Timbco 400-C Series Hydro-Buncher felled for the yarding show and we wanted to take the opportunity to test the equipment on steep ground. The upper part of the block ranged up to 55%. We went through safety issues before starting. The specifications on the Timbco say it will level to 51%. We asked the operator "How confident are you? What can you do?" and he said " I can easily go to 55%". So we said "OK, let's take a whirl at it" and he did. We used a Caterpillar 527 grapple crawler-tractor for the skidding. When it came to the operation, an operator was not provided and one of the contractor's operators with 25 years experience operated the machine. He thinks the machine is a smooth operating thing, but at $420,000 it's an expensive investment. As with our other operations, safety was a primary concern.

On other areas we use a Caterpillar D5 grapple crawler-tractor from Finning and without the wide pads.

If we had harvested the block according to the logging plan, a trail would have been built up to the block and the stand would have been hand-felled and skidded with a lot of difficulty. By running straight up and down with those two pieces of equipment, we achieved a better result.

Results

The top part of the block had scattered boulders, 0.25 to 0.75 m^3 in size. Those rocks were a major problem. When the Timbco operator was on a 47% slope near the top of the block, he came up to the boulders and decided he could not go any further safely. A corner was left unfelled and we still need to determine how to deal with it.

Ministry of Forests personnel visited the area and were pleased with the result. However, it was a one-time operation because we don't have enough steep ground for the contractor to justify buying a machine for $420,000.

Conclusion

I wanted you to think about opportunities that are available and what we can change in our operations. We may not have been able to do harvesting with this equipment in the winter but it did produce a result that people liked. We liked the result because we did not have to reclaim a trail!

Questions

Q. What was the forest floor displacement? When we cat skid on ground that steep, especially on shallow soils, we worry about site degradation.

A. The displacement wasn't high but you have to have the right operating conditions.

Q. At 55 % slope, did you encounter any difficulties with the Caterpillar 527? Did you make any changes in the way you operated? Turned around? Did you back up the slope? Drive up the slope?

A. We could do anything we wanted. Not right at 55%, but up to 45% the operator felt like he was on flat ground.

Q. Did he get any production along the backline?

A. Yes, we were skidding down to the bottom of the steep slope and then the rubber-tired skidder took the wood the rest of the way. Production was about 130 m^3 /day.

Q. At what distance?

A. The crawler skidded 250 m down the slope.

Q. What were the costs?

A. The cost for falling and skidding was about \$18/m^3. Caterpillar gave the contractor the machine to use and he supplied the operator but the cost would have been \$18/m^3. Also, if those two pieces of machinery weren't used full time, it would be much more expensive.

Q. Did you try any adverse skidding?

A. Yes, on some other ground that was 30 to 40% and we went right up to 30% adverse.

Q. Did it affect productivity?

A. No, productivity was virtually the same going uphill or downhill. The only thing that stopped the machine was the operator. When he felt uncomfortable with the slope, he stopped and we supported his decision.

Q. From a safety perspective, at what slope would you be comfortable with this crawler? Does WCB have any regulations?

A. No, there are no WCB regulations. That's why our company is developing our own. We're guessing the company will say 45%. We did go a bit beyond that figure in the trial.

Q. With Weyerhaeuser having so many divisions in the Interior, have you looked at sharing a contractor so a machine like that is available? Our company has five divisions and we don't do that but I was wondering if yours would have enough work.

A. The only thing we've traded or shared that I know of is cable. We haven't a lot of this ground but it would be nice to have a machine available. It's a good idea.

Using a Long-line Cable System in Interior Conditions

Murray and Shawn Sanders
Long-line Industries Limited, Revelstoke, BC

Introduction

We designed our long line cable system totally from scratch, and have been operating it for 10 years. We've worked with it seasonally, off and on, and have logged approximately 32,000 m^3 on five different blocks. Now for the first time, I'm logging in one block and I have another job ready when I'm finished. The industry is beginning to recognize that it needs some long-line logging systems.

Our system is unique compared to other skyline systems. It is a small skyline system with the capabilities of a large one. We have no maximum distance other than the maximum cable length and the acceptable logging cost. Our current system, the original one that we built, has a 10,000 lb (4545 kg) lift capacity. It's designed for downhill logging, best suited to cross-valley situations, and it's very effective when used to cross riparian zones.

We're working on a long narrow cut block, extending up the hill from the creek with a riparian leave strip along the creek banks. With this system we don't pre-fall the whole block. We cut the corridor up to our anchors and anchor the line. Then we fall, buck, and yard the logs out progressively. In our current block, the corridor goes right across the river. The cutblock starts at about 350 m on the other side of the river. We have just enough clearance to handle the maximum load capacity of 10,000 lb and the carriage weight of 3,500 lb.

How the System Works

The system has an endless running line and is driven differently than most systems. The carriage travels on two skylines and the smaller endless running line runs below the skylines. The endless running line passes through the carriage, runs parallel underneath the skylines to the back-end, across the block into the next corridor, and back down to the yarding machine, or as we call it, the traction winch. Inside the carriage is an aluminum-lined drivewheel with grooves in it. When the skycar is not clamped to the skyline, the running line pulls the carriage up the hill. When the carriage gets to its destination, the skyline clamp is locked by radio control and, at the same time, a brake band releases freeing a drum inside the carriage. The endless running line is powered with the traction winch, and in turn powers a winch inside the carriage, lowering the dropline to the ground.

The hooker hooks the log and it is lifted up to the carriage when the yarder operator powers the dropline winch in the other direction with the endless running line. Another radio command signals the skyline clamp to let go and the brake band on the dropline drum is simultaneously locked. The log is then brought down the hill. We always pull the log up the hill towards the carriage when breaking the turn out before yarding downhill.

It's important to fully suspend the log before starting to yard down the hill, and the point at which the log is choked will vary with the terrain and log in order to achieve full suspension. In some cases, a spur road may be constructed to position the traction winch more effectively to increase deflection. We can yard tree-lengths as well, and that way, a lot of limbs and debris go to the landing.

The Traction Winch

The traction winch drives the system. On one side of the winch, the 9/16 " endless running line runs to the back of the cutblock and back down to the carriage. From the other side of the winch, the line is blocked over, goes through a tightening system, and then runs parallel to the skyline up to the carriage.

The two big wheels in the traction winch are similar to the system inside the carriage. The aluminum-lined wheels have a series of grooves on the outside; the 9/16 " line wraps around the wheels, producing the traction necessary to drive the line. The only spool of cable in the whole system is the self-contained dropline in the carriage. The carriage can hold up to 520 feet of dropline.

At the top of the hill, the skylines are attached to crotch lines and anchored to four or eight stumps. At the bottom, the skylines are anchored to a deadman in the ground. We bury a 30 ft log about six feet deep.

Logging Costs

Logging costs vary. In some situations we can log for $\$35/m^3$ while in others, the cost may be as high as $\$135/m^3$. As an example, on our current block we have a 1200 m span from anchor to anchor and 500 m of dead ground. We yarded 4000 m^3 from the first yarding road. On the second road, we will yard 4500 m^3. It costs approximately $\$350/h$ to run the yarding crew and all the equipment including the loader and we have $\$2/m^3$ cable cost to cover the running line, skylines, dropline, and chokers. We also have a set-up cost. The set-up cost depends how many m^3 will be yarded, how much helicopter time is necessary, and where the cutblock is located. We fly the strawline out using a helicopter. We're logging this block for $\$55/m^3$. That includes the layout and building the landing and spur road.

Questions

Q. What is your average production?

A. We produce about 10 m^3/h in this example. We've logged areas where we've been out up to 1500 m, with 700 m of dead ground and a low volume underneath the lines and the production is less. We are still experiencing design problems. We have had down time on the carriage with bearings going and the carriage is the bottleneck to improving the system. We need to build a carriage that can lift more, travel faster, and have less downtime. The system is very simple and the ownership and operating costs will be very low. There's no motorized carriage, just a few turning sheaves inside the carriage.

New hydraulics have become available since we built the traction winch 10 years ago. A two-speed hydraulic motor is now available that will bolt into place. With this system, the low gear could be used for lifting the log loads when power is needed, and high gear could be used for speed when coming in loaded and going out empty. This would increase the carriage travel speed and production.

Q. There must be a tremendous amount of sag in your skyline.

A. In the example, we're running the line as tight as we can, at about 7.5%. We can carry a 15,000 lb load, including the logs and carriage. It's not a system suited to convex terrain. A heavy concave slope is needed to operate with a large percentage of deflection in the line.

Q. Do your fallers walk in?

A. Yes. When we first built the system we were close to town and two guys could have been landed on the hill with a helicopter for $140 per trip. But we were still in the learning stage and we might yard two logs and then fix things for two days. If a helicopter was close by, we might use it. We use a cable crossing with a safety belt and a pulley to cross the river.

Q. Are you bucking the cull in the bush or do you bring it to the landing?

A. We don't limb anything in the bush, we only buck to weight in the bush. About 75% of the limbs go in to the landing. As far as cull wood, we take good pulp but we leave the large woody debris, as required by the client.

Q. Your cull pile doesn't become too big with tops and limbs?

A. Our brush pile does grow big and we need to have room for the limbs and tops that come in. We hook many of the tops that break off. It hasn't been necessary to slash burn anywhere we're logged so far. We feel that will be a real advantage of the longline because you can leave the ground cleaner than with helicopter logging.

Q. Are there any problems with aviation when your lines are strung across the valley?

A. Yes, we had a close call about two months ago. A helicopter came within 20 ft of the line. He knew it was there; it was the same machine that flew our strawline for us but a different pilot. I have a marker line about 700 ft from the skyline and the pilot admitted it was a big mistake for him to be there. He said he saw the marker line but he didn't expect the skyline to be that close. I said "Well, you were flying right over a cut-block. I had to have a skyline there to get the wood out." That's one big concern and we've talked with Transport Canada and Workers' Compensation Board. Transport Canada says you need to have an Air Notum but nobody reads Air Notums. Several years ago a skyline on the coast did get a helicopter.

Q. Are they considering letting you log within the reserve or selective log along the creek?

A. No, we're only cutting a corridor through the riparian area. In most areas the timber adjacent to the rivers or creeks was harvested years ago, and we have a plantation to yard over.

Q. How many chokers do you run and what's a typical cycle time?

A. We use a 1/2-in dropline with a bell on the end and we usually have three sliding 3/8-in chokers on it. You might hook several non-merchantable tops with a big cedar butt, for example. When we're cutting a 125 m wide road up the hill, we allow 10 or 12 min for loading the carriage and travel time depends on yarding distance. Our carriage has an average working travel speed of 800 ft /min. The cycle time may be two minutes out, 10 minutes loading the carriage, two minutes in, and then 1 minute unloading.

Q. The big advantage I see for your system over the Wyssen is that the Wyssen is shotgunning using gravity to move the logs. You're not, you can pull your load uphill to your landing. With the Wyssen system, the landing location is limited to where the belly is unless you want to speed the carriage up and try to run it uphill.

A. The Wyssen system takes its power source to the top of the hill and shotguns. We keep our power at the bottom and pull the line up, then pull the carriage up, and hold the carriage back coming down.

Q. You're still using gravity when coming down?

A. Yes.

Q. Then you are limited by where your belly is?

A. No. You could start pulling the load in if you got to the bottom of your belly and the landing was higher up. The Wyssen system can't swing wood across the valley because they can't drop the chokers out of their carriage because the belly of the line will drop rather than the chokers.

Q. With the Wyssen they want at least a 27% chord slope on their skyline but on your system it could be it flat, hypothetically.

A. Yes, because we drive both ways.

Q. Why don't you pre-fall?

A. We've only worked in big cedar and hemlock and we find without pre-falling, we get very little breakage. I've felled for years in big timber on the steep slopes, and I feel bucking is far more dangerous than the falling when you're pre-falling all the wood.

We get a variance from Workers' Compensation Board so we can have two guys together on the hill. We can have the chokerman and the faller working together provided the chokerman is two tree-lengths away when the falling is being done. The faller might fall and buck a half a dozen trees. The chokerman can hook them up and the faller can just move down the hill several tree-lengths and fell and buck another patch; then they hook them out together.

Harvest Systems Design

Cameron Brown, Development Forester
Silvatech Consulting Ltd., Salmon Arm, BC

Designing Harvest Systems For Cable Logging

How do we define harvest system design? I consider it a process of developing a site specific harvesting plan that addresses:

- Worker safety.
- Site impacts and silvicultural objectives.
- Production and efficiency objectives.

A plan may contain a fairly small amount of information or it may be incredibly detailed, depending on what we're trying to accomplish and how complicated the situation is. It will always contain road and landing locations, yarding patterns, and yarding system. In more complicated scenarios like uniform selection cutting and using intermediate supports, it will have well defined corridors. Yarder placements, intermediate supports, and tail trees may need to be located on the ground so they line up in a straight line for every corridor. The yarder will then be able to move in, set-up, and begin without any delays. There is a whole spectrum of detail between a basic clear-cut scenario and a detailed plan for a selection system.

Why Design Harvest Systems?

Spending sufficient time on harvest system design is cost effective. It maximizes the efficiency of the equipment. Hourly costs for layout are considerably less than hourly equipment costs. On steep ground your options are limited and mistakes are costly. A good harvest system design will minimize environmental impacts on soils and creeks and other values and it will ensure a successful yarding operation.

Initial Planning

I approach the design in several ways. The first question is "Are you working with a total chance harvest plan or not?" That has a big impact on what you do, especially in the initial planning phase.

If you have a total chance harvest plan someone else has considered the big picture: general road locations, general block locations and size. Are you isolating timber above or below the block? You potentially know the block shape and access pattern. The surrounding area has been considered and your layout and unit design can begin in the specific area you're concerned with.

If that's not the case, for the result to be good layout, you need to consider these factors on the fly in the field. It generally means more reconnaissance work. You will need to move around the hillside to make sure the block you're laying out today isn't going to negatively impact future development. That means a lot more walking and higher layout costs. The alternative is to place the block where you think it will work and hope it works out for the best. That's not typically what we recommend.

If you have 5 metre contour mapping, you're half-way there even if you don't have a total chance plan. With good contour mapping, even less precise than 5 metre contours, you can do a total chance plan on the fly as you're doing layout. Good mapping speeds layout because you can see your options on paper without covering every inch of the ground on foot.

Block Layout Procedure

For me, block layout or design consists of seven interrelated steps.

If we are using a total chance plan, it has identified critical control points in the field. If not we must find those control points to make sure we're not limiting future development.

Run some grade lines and preliminary deflection lines to determine road options and the general ground shape.

- Analyse deflection and select equipment.
- Finalize the road and landing locations.
- Run more detailed deflection lines.
- Establish harvest boundary locations.
- Then mark in the field any design features you need to implement the plan.

While doing these steps, keep in mind the silviculture objectives and non-timber objectives on the site.

1. Critical Control Points

Critical control points are the main factor especially when you're dealing with cable operations. Slope breaks and benches are where you want your landings to be because they provide the best deflection. Unless the road is a dead-end spur, you need to consider future extensions of the road and ensure that road placement for the current block does not limit future development.

When doing reconnaissance work for control, keep in mind that you need deflection, and an anchor system. If there are no natural anchors you need man-made anchors (deadmen, rockbolts) and these may require heavy equipment access. Deflection and anchors must be considered during road placement, especially in conventional blocks with cable blocks above or below.

Critical control points are key to making sure you don't limit yourself in the future. Always consider future development.

2. Preliminary Deflection Lines

Running preliminary deflection lines and grade lines helps you determine the shape of the slope. Record things like slope breaks and potential intermediate supports and tail trees. If you're not sure if a tree is suitable, consult guidelines such as those published by Oregon State or OHSA on tree size. You can also drill trees to check soundness.

While doing this, think about tradeoffs. With total chance plans many of these have already been considered. Otherwise, consider tradeoffs in the field. Do we use one road up at the top and intermediate supports down below to save ourselves building another road? Maybe we want to split it into two 200 metre yarding distances with two roads. Usually an economic analysis of road building costs and differential production rates on the yarding will tell you which one is better. Future access issues should always be considered in this process.

The objective is to look for deflection and if deflection isn't there, can we create it somehow with the use of intermediate supports and tail trees.

3. Selecting Equipment

After we've run the deflection lines and know the general shape of the ground, we begin thinking about which equipment to use. Considerations are tower height, how far we want to reach out, and wood size. Obviously a small Owren yarder isn't going to pull a tree length 70 cm Douglas-fir. The equipment must be matched to the timber and the site.

If we use intermediate supports, we need an open sided carriage that can pass a jack. The carriage must be matched with the yarder.

Landing types: if we use a big tower we will probably use a central landing with a radial yarding pattern. If a small mobile yarder is used, a parallel or corridor pattern is more likely.

Harvest and SP (silviculture prescription) objectives also come into play. If we're leaving a uniform distribution of trees on the hillside, we need a slackpulling carriage, a rigging system that can run a slackpulling carriage, and a yarder that matches it.

Obviously, the selection is limited to the equipment complement of the licensee or company. Additional equipment may be brought in for a specialized job but basically there is likely to be two or three yarders available. This cuts down your options.

Finally, from an economic viewpoint, we want to pick the most productive yarder relative to its hourly cost.

4. Analyzing Deflection

Once the deflection lines have been run and we have several potential yarders in mind, we can start exploring some scenarios. We can decide on road locations based on the deflection lines. Where are we going to put our roads? What type of yarder are we going to use? Where are we going to have our tailholds? Are we going to rig a tail tree? We can start exploring scenarios to see what's going to be the most effective.

LoggerPC is an excellent tool for analyzing deflection and payload. I believe it provides a more specific measure of payload than simple estimates of the % deflection. Percent deflection is a good indicator of payload capacity, but generally it gives a more conservative estimate.

I see many people using LoggerPC and not necessarily in the right way . Here are several pointers.

Make sure equipment specs are right. If you work with your yarding contractors on a regular basis, you can give them a sheet with the information needed for LoggerPC. Simplify it for them and get them to fill it in so that you can model reality.

The key to LoggerPC is to model what's realistically going to occur in the field. Make sure you get the right tower height, line size and line type. Swaged line is a lot different than IPS line. Make sure you use what is on the yarder.

If they're running a standing skyline or a running skyline in the field, pick the option that's appropriate.

Make sure that you have the right yarder and carriage, that the yarder is placed on the profile roughly where it's going to be in the field, and that you use realistic tailhold heights. If you need a 20 metre tailhold to get the payload, you probably won't find that in the field. Some contractors won't even rig tail trees. They will only do stump tailholds. Know your contractor and what he's capable of, and run your analysis accordingly.

5. Establish a Unit Plan

Once we're explored options and we've found one that will work, go out and finalize the road locations in the field. When the roads are in place and a machine is chosen, the rest of the planning is straight forward. We simply need to determine how far the yarder can reach and still get reasonable payloads (deflection).

This will require a few more deflection lines from specific landing locations. Analyse those and you will know how far out the yarder can reach.

If the distance is beyond the capabilities of the yarder, scale them back. At that point record the information that you want to implement in the field and take it out to the field. The operation may be a simple highlead clear-cut, where the only marks in the field are roads, boundaries and some landings, with a generic yarding pattern on the map. Or the operation may be more complex, like a uniform selection system, where yarding corridors, intermediate supports, tail trees, anchors, etc., are marked in the field.

6. Putting the Design in the Field

With the deflection lines for a guide, the boundaries can be hung where LoggerPC says the deflection ends. If it says terrain point six, that's where you cut it off. Walk out, find that terrain point and start hanging boundary from there and connect up the similar points on the remaining deflection lines.

Consider operational factors like guylines and guyline circles out behind the yarder. When you have downhill yarding and a steep slope behind the yarder, Workers' Compensation Board says the guylines can come down at a maximum of 45 degrees. If the slope is 60 or 70%, the anchor location will be a long distance from the yarder.

Conclusion

I've described my approach to layout, but other people have equally good ways of doing things. A few steps are always necessary:

- Find your control points,
- Run your grade lines,
- Run some preliminary deflection lines,
- Figure out what your options are, and
- Then analyze the deflection and select some yarding equipment.

It's an iterative process of trying out scenarios and seeing what works best. Finalize your road and landing locations and figure out what timber you can reach. Hopefully you're not isolating wood. Working with a total chance plan will tell you how the wood above and below the block will come out. If you're not working with a total chance plan, you must consider future operations. Maybe it's necessary to use intermediate supports to get some wood now so it's not isolated in the future. It may be better to take higher yarding costs now rather than isolating wood below or above the cutblock. Mark the boundaries in the field and any detailed information that may be required to make the unit safe and productive.

Questions

Q. Do you do any tricks for cross stream yarding?

A. Make sure the streams are not direct tributaries of fish bearing creeks. The only success we've had so far have been at locations a reasonable distance from a fish bearing creek or if the wood is fully suspended. Those are about the only two options you have. We have one block with an S6 creek that we're yarding across. It feeds into an S4 that feeds into a much larger fish creek. They seem to be reasonable allowing us to do that. There is about

400 metres from where we're yarding to where it feeds into the S4. Have you got a specific scenario?

Q. No. Are you doing anything on the ground to get additional lift to protect the streambanks?

A. Just ensure you have good deflection so you only have the butt end coming through. Many times the creek will be fairly incised so the stream will be protected by the banks. You may scuff up the banks but if it's just butt drag you won't scuff them much more than you would an open slope. No, I don't have any great answers.

Q. Is LoggerPC just a payload analysis program or does it consider deflection? I've used it but it just gave the payload and I was trying to get the deflection.

A. It won't give you percent deflection but it definitely deals with deflection in the sense that payload and deflection are related.

Q. It seems like some guys like deflection and some guys like payload. Did you write the program?

A. No, I wrote a manual for it.

Q. Why couldn't both deflection and payload analysis be incorporated into the program?

A. They certainly could. I plot a picture of the profile with my yarder and tailspar and draw the line and deflection in and just measure it.

Q. We asked the developer at Oregon State to add a percent deflection calculation because it's probably not much programming but it hasn't been done.

A. Yes, it's simple. The developer has left Oregon State. If someone wants percent deflection you can measure it from the plot for them. The payload numbers are sufficient as long as you're getting realistic numbers. A cubic metre weighs about 1000 kg so match it to the yarder and if you need to get 4 m^3/turn to be productive, then you need a 4000 kg payload.

Q. Except that they wouldn't accept a LoggerPC printout. He wanted percent deflection.

A. In those cases what we do is print out the picture and measure it. It only takes a couple of seconds.

Q. With percent deflection a chokerman can analyze a profile with a pencil, a ruler and a scale. He feels accomplished by determining the deflection is 5% or 6% or 7. It's a common language. The payload analysis is fine but the common guy doesn't do it.

A. Yes, percent deflection is something everyone can understand. With payload analysis, you can take a profile, run the analysis, and show that in the first third of the profile you can load the line down to 10 000 kg; the analysis may also show that anything passing through midspan cannot have more than 3 000 kg and the back of the line is limited by that critical point. Your chokerman can adjust the loading relative to where he is on the line, if that information is communicated to him.

Q. I use LoggerPC occasionally but it doesn't do the analysis I need. I do the analysis by hand on graph paper. I need a loaded skyline path to see if I clear my terrain points. If I don't clear a point I've got to go up higher in my spar tree or change something else somewhere. Is there a computer program that will do that analysis?

A. LoggerPC does give you a loaded skyline path but not for your system. You've got a very unique system (endless running line system). LoggerPC has standing skyline, running skyline, and multispan. The physics have been modeled right down to the coefficient of friction on the ground. Your system has two big skylines.

Q. Yes, but they're fixed skylines and they act as one skyline. They're joined together with a large rigging block at the top.

A. OK, then you could use the standing skyline analysis. It's called "Phase 2" and it will show you a loaded path.

Q. We found LoggerPC to be ultra conservative. If the load can't clear two or three terrain points it will shows a payload of zero. By moving laterally to the right or left a little bit we can swing it over if we need to. That's one case where we like percent deflection over payload analysis.

A. Yes. He's saying LoggerPC is conservative because sometimes you can just move over and get off the knob on the deflection line. I would think that percent deflection and LoggerPC would treat the situation the same way if it's the exact same line. Percent deflection would give you a more generic answer I guess.

LoggerPC does have a factor of safety built into it. Any line strengths you input are divided by three because you're not supposed to be working at the line's breaking strength. You should be working below the elastic limit of the line. If you give someone a LoggerPC report and they say "I can get way more payload than that"; yes, they probably can but they're potentially working above the elastic limit of the lines. Once your lines are fatigued, they will wear much quicker and will come down fairly quickly.

You can always get more payload than what LoggerPC tells you, especially on a running skyline. The running skyline scenario is the one I've found really conservative because it's limited by the braking torque the yarder can apply to the haulback line. One line is pulling in and one line is pulling back the other way, and that's how you get your lift. If you're braking on this line and pulling on that one, how much can the brake hold? Which is stronger, the winch or the brake? If you estimate the brake torque too low, you will get low payloads and the analysis may say the design isn't going to work. The yarder crew will say "This is a piece of cake, it's no problem." You need to make sure the braking torque you put into LoggerPC is accurate. The yarding crew may also have cranked up the PSI to get more braking power.

Cut-to-Length Experiences

Russ Ferguson, Forest Technician
Riverside Forest Products Limited, Kelowna, BC

I will describe my experience for the last four years with the short-wood system. I'll start by giving you an overview of our operating area and then discuss why we got into the system, its advantages, disadvantages and where we can use it.

Riverside's Kelowna Division

The Kelowna Division, with an AAC of 430 000 m^3, operates in the Kamloops and Nelson Forest Regions. We share TFL 49 with our northern partner, Armstrong Division, and operate under two Forest Licenses.

Our operations are in the Okanagan Highlands, primarily in the mountain spruce zone. Harvesting has focused on mountain pine beetle for the last 20 years. Our species profile for the mill is 80% lodgepole pine, 10% spruce, 5% balsam, and 5% Douglas-fir. Sixty-seven percent of our operations are in community watersheds. The area has been extensively harvested to salvage the mountain pine beetle damaged wood. This factor, as well as over 50 years of activity mean we are over the 20% harvesting level suggested in the community watershed guidelines.

Why We Use Cut-To-Length

Due to the high equivalent-to-clearcut area values, community watersheds, wildlife, Visual Quality Objectives (VQOs), obligations to control mountain pine beetle, and MOF encouragement to select and beetle-proof stands, we decided to carry out beetle proofing and partial cutting on lodgepole pine stands with lower levels of mountain pine beetle attack.

Initially we resisted selective harvesting in pine stands for several reasons: we were concerned with forest management implications. We have very good reforestation in clearcuts, our pine stands are very susceptible to blowdown, and the majority are overmature. We're also very concerned with logger safety and job quality. However we were soon faced with being unable to access areas due to the constraints mentioned earlier. When we began partial cut operations, our operational concerns were indeed realized.

We tried to beetle proof using hand fall - line skid systems but we were not satisfied with the result. Falling difficulties and hang-ups resulted in too many trees being removed and residual tree and soil damage were also unacceptable. With 33 fallers and buckers killed in the forest industry in the past five years, worker safety was a very real concern. Landings were also required. We had stopped using them quite a few years ago and we were not planning on going back to using landings. Thus we refused to continue with the system. Clearly we had to find a better system.

The System

The cut-to-length system consists of a harvester and a forwarder. There are many machines on the market, and they cost about $1 million for the two machines. The machines in our operations are Timberjacks. The harvester falls the trees and cuts them to length. Our logs are cut into 17 ft 2 in lengths, giving us a two inch tolerance. The machine cuts and processes about 17 m^3/h or 50 trees/h with our piece size in a partial cut. In a clearcut it will cut up to 24 m^3/h or 80 trees/h.

The forwarder comes in, picks up the logs, and hauls them to roadside. Nothing except logs is brought out to the road. Both machines operate on top of the limbs and tops removed by the harvester and very little soil disturbance occurs. Trails are about 5 m wide and 20 m apart.

The prescription called for the remaining stand to consist of roughly 350 trees/ha. To accomplish this the loggers were instructed to cut the trees 6 to 7 m apart. Priorities for cutting were green attack, red attack, gray attack, damaged lodgepole pine trees, spruce trees, and a variety of stem heights. The harvesting is similar to an old sanitation commercial thin. If we have epicenters with heavy blowdown greater than one hectare in size we are instructed to reforest them. With roadsides decks, once the logs are hauled, there are no ditches to clean and no landings to burn. In 15 years, we hope to re-enter the stand and clearcut it.

Where It Works

Where does this system work? It works very well in partial cuts, on wet ground, in riparian areas (because the equipment runs on a brush mat), on steep broken slopes and on adverse slopes up to 30%, and in wood up to 22 inch diameter.

Where It Does Not Work

Where does the system not work? The system will not work when the wood is bigger than 22 inches in diameter. It is possible to cut wood up to 26 inch diameter but the production decreases after 22 inches. A tree bigger than 26 inches must be hand felled, and the first length may need to be manually bucked. Then the harvester can delimb it and finish bucking it.

The system does not work on slopes greater than 40%.

The biggest influences on productivity are stand density, piece size, long forwarding trails, slopes over 30% adverse or favourable, some snow conditions (deep sugary snow), and number of sorts. Generally, the influences on productivity are much the same as those that affect productivity for conventional ground-based systems.

What conditions does the cut-to-length system require to be efficient? Short forwarding distances, 10 to 20 inch wood, and availability of green branches for matting for wet riparian areas all contribute to efficient use of the system.

Advantages

The systems advantages include:

- Effective harvesting in riparian areas
- Decking at roadside on steep ground (does not need much room)
- Longer operating window (10 to 12 months /year)
- Less roads to build (longer forwarding)
- Less ground disturbance (running on brush)
- Working on adverse ground (20 - 30%)
- Can operate in blowdown (block perimeter, no landings, very mobile self contained unit)
- Great feathering ability
- Ability to sort (size, species, grades)
- Less breakage (therefore better recovery)
- Great quality
- Good utilization
- Very flexible
- Suited to the owner-operator

Disadvantages

The systems disadvantages include:

- Higher cost in equipment
- Forwarder can be heavy if no matting on the ground
- Not effective in large wood (>22 inch)
- Higher cost than some other ground based equipment

Load and hauling

- Type of truck and loader
- Good payloads (greater than 50 m^3/load)
- CTI equipped truck allows more hauling days

We use a self-loading truck equipped with CTI. The back set of bunks has a sliding hydraulic ram which brings it to the back of the crane for easy loading. Then the ram pushes it back out so the crane can load the front two sets of bunks.

Advantages at the mill

- Logs are easier to handle
- Less breakage than conventional log lengths
- Less trim allowance required - 25% less in our case (bucking is square to the bole of the log and measured lengths are precise.)
- Easier to deal with sweep wood
- They say that three times as much short wood can be decked in the same space as conventional length logs at the mill.

Layout Concerns

All turnarounds or small loop roads need to be identified. Loop roads are necessary for roads where logs will be decked for loading. If they are included during layout, obtaining permits for building the road will be more efficient. Wider turnarounds or loop roads are necessary because the trailer does not sit on top of the tractor for the return trip as with conventional trucks.

When working in a wet area, room to operate on both sides of wet areas makes the operation easier.

Effective forwarding distance is 150 to 300 metres. We do use the system at 500 metre distances, and we go even farther to remove small beetle attack or blowdown epicenters by running a forwarder trail to the area. However, this can be costly.

The system meets WCB requirements. It's very safe with all workers inside the machines.

Conclusions

In conclusion, no matter what the capabilities of the equipment, it will simply not work unless the people running it want to make it work. There are many people who are negative about the system. We were fortunate to have a contractor that wanted to change, believed in the system, and made it work. The system is not meant to answer all harvesting problems. Conventional clearcuts with feller-bunchers, grapple skidders, processors, and tree length wood have a place in the vast majority of our operations, but the shortwood system is an important harvesting system option for us. We are operating in a period of constantly changing demands and this system gives us a very viable alternate harvesting system where it is required and/or appropriate. It is a safe and efficient way for partial cutting.

Although our costs are higher than our conventional logging costs, when one looks at the bottom line and takes into consideration all the benefits of the cut-to-length system for partial cutting, we find the costs are very acceptable.

Questions

Q. How much more does cut-to-length cost compared to conventional logging?

A. A few dollars more. It varies with the prescription. With cut-to-length you operate in many different situations and the costs vary accordingly. You might have many sorts and that will increase your costs. Longer forwarding, 500, 600, or maybe 1000 metres, will also increase the cost. But it definitely costs a few bucks more than a conventional system.

Q. What percent of logs do you cut to 17 ft 2 in?

A. Pretty close to 100%. If you're working in blowdown the accuracy goes down because the saw must be reset each time the first log is cut. Generally it's very precise. Occasionally there may be a computer problem otherwise accuracy is just great.

Q. Have you kept track of gains in the mill yard with shortwood?

A. The company started but I don't know if the results are all in. For example: conventional log lengths might have around 5% to 6% breakage. Shortwood is now below 1% breakage so you get a big gain there.

Q. Matting can have multiple effects. Do you find piling all the tops and limbs in front of the machines gives you a matting effect?

A. We get a big matting effect which we need for the machines to operate in sensitive areas. Matting isn't a problem for reforestation because we don't replant partial cuts until after the final cut. In a clearcut we bring a site preparation machine and the whole area is prepared.

Heli-logging in the Chilliwack Small Business Program

Murray Sluys, SBFEP Forester
British Columbia Ministry of Forests, Rosedale, BC

Introduction

In this presentation, I will explain our district's involvement in heli-logging in the small business program. We harvest with helicopters for four or five reasons, and I'll describe them. I'll also discuss one example of layout in our type of terrain. Then I'll talk about whether anybody is making money at heli-logging. I have some cost figures from the Forest Service's perspective and some layout costs and will compare these with longline layout.

Then when I'm finished, you may be able to say, "We've got some terrain like that. Possibly we could heli-log it." Or you may say, "I think I'll move to Grande Cache, Alberta!"

Heli-Logging in the Chilliwack Forest District

The Small Business Forest Enterprise Program in the Chilliwack Forest District has an AAC of 300 000 m^3 and in 1994 we were heli-logging a small portion of that (Figure 1). In 1995 and 1996, we harvested over 100,000 m^3 using helicopters. This year, 1997, is the biggest year for heli-logged wood. We're proposing less in the future, and we want to balance at roughly one-third of our volume to be heli-logged, reflecting our longer-term needs.

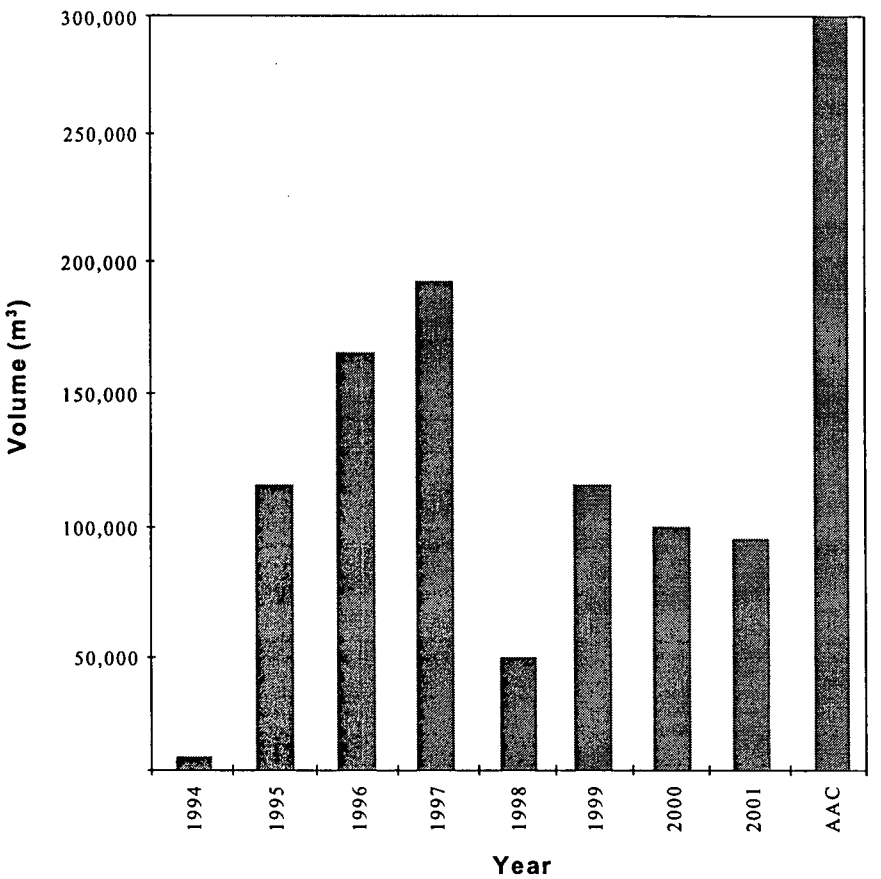

Figure 1. Volume harvested by helicopter-Chilliwack Forest District, Small Business Forest Enterprise Program.

Four Reasons Why We're Heli-logging

In 1990 the spotted owl issue was created in our district. The definition of a spotted owl is anything that locks up about one third of your development plan for about seven years. One of those might be coming to your operating area. We had roads built, bridges built, and blocks laid out, and when the spotted owl issue escalated, all activities came to a grinding halt. I had timber sales that were sold and awarded that were cancelled due to the owl issue. The forest licensees were in the same situation. In fact the road development made it easier for the owl surveyors to get to the areas. We needed to find alternate areas quickly.

When the Forest Practices Code was enacted in 1995, adjacency issues locked up more time.

Our operating areas in the Chilliwack District are usually the top third of the mountain, because of the history of previous logging. Of those areas, about one-third is heli-logging, one-third is longline and the rest is conventional. We have about 10% in the valley bottoms in second growth now and that has been very profitable, from the Ministry of Forests' perspective.

The visual corridors were ignored for years because they were contentious and it was easier to log behind the corridors and out of sight. Eventually, however, operations must occur within these corridors. This is the final factor contributing to heli-logging and longline systems within our district. It is more sensible to begin harvesting these difficult areas now, slowly, rather than further delays and having only these areas to harvest in the future.

For all those reasons, we began looking up at the mountains, the rock bluffs, and the small benches on the rock bluffs for wood to heli-log. Usually the quality of this wood was good and this helped justify the more expensive harvesting method.

Experience with One Block in the Lower Fraser Valley

The block I will discuss is between Hope and Chilliwack, where Highway 7 is on the north side of the Fraser River, and Highway 1 on the south and is visually sensitive. You've probably all driven past it. The terrain is very steep at 70, 80, and 90%. We looked at the benches for timber to harvest. Much of the area is not loggable but we instructed the layout crew to "Get up on a bench and look for some wood on an area that is stable. It has to be plantable and it has to look good so create an irregular shape." They traversed an irregular 7-ha shape on a bench and the computer simulation didn't look too bad.

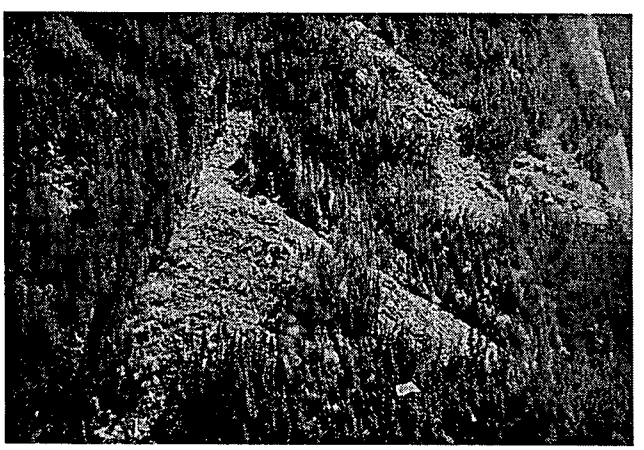

Figure 2. Cutblock on mountainside.

After it was logged the rock bluffs were partially visible, and some deciduous remained on the area, blending well with the landscape (Figures 2). Very few people notice that we had logged up there.

We made a few mistakes on this block. About 0.9 ha was unplantable. I had signed the PHSP off and had been personally on site with a planting shovel looking for plantable spots. This was one of the first blocks we heli-logged and we wanted to make sure it was right. Some of the talus-type slopes are very difficult to plant, and I included some unplantable area (Figure 3). Although there is soil under the boulders, it wasn't possible to put seedlings there!

Figure 3. Unplantable area on a talus slope.

What Terrain is Suitable?

Typical terrain for helicopter logging is very steep and rocky (Figure 4). I must emphasize that helicopter logging is the last resort, when you can't use any other system. No one has bid on our sales with a balloon yet. On the steep rocky terrain and convex slopes, numerous intermediate supports would be needed. It would be very difficult to put a road into many of these areas too. We instruct the layout crew to find a bench with some good wood on a site that is stable enough to log. All of these blocks are walked by our geotech as well.

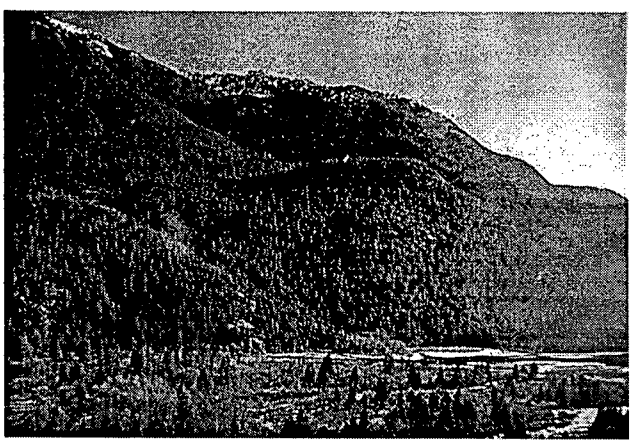

Figure 4. Typical terrain harvested by helicopter.

Other Heli-logging Experiences

We have put numerous areas for helicopter logging on the market to see if they would sell. We have had a few sales turned back where the bid price was high and the market fell, but many of them are proceeding. It is proving to be a valuable harvesting alternative on steep slopes.

We also had the Russian Kamov work on our timber sales. When the chokermen are done for the day, they hook a grapple on the machine and it works for two more hours with no ground crew. We've also done selective logging of beetle kill in Manning Park with a small machine, a Bell 205. The K-MAX also would be suitable for some of our areas.

In the silviculture prescription on some of the high visibility blocks, we require all cedar and balsam trees about 25 cm in diameter to be left. That is possible on fairly gentle benches, but with slopes 60% or greater, it is difficult to leave residual trees. The WCB requires felling of any tree that is brushed. We want to mask some of the rock bluffs with standing timber, and are experimenting with different techniques.

Is Anyone Making Money At This?

In 1995, based on 116 000 m^3 the upset price was \$14/m^3 and the bonus bid was \$38/m^3; the bonus was roughly twice the upset. In 1996, when the market went down, the upset was \$5/m^3 and the bonus was \$12/m^3, based on 165 000 m^3. The same ratio exists with the bonus being roughly twice the upset price.

This year we've only sold one good Douglas-fir stand. It went for a bonus bid of \$30/m^3 and an upset of \$7, a total of \$37/m^3. Here the ratio increases because of the wood quality. For those of you who don't pay a bonus bid, that tells me that there is some profitability in helicopter logging, keeping in mind that the coastal appraisal manual gives roughly a \$65/m^3 allowance for heli-logging.

So, does the government subsidize helicopter logging? I don't know, I'll let you answer that.

We're selling one block just east of the city of Mission where the logical heli-landing requires about \$100,000 reconstruction costs including bridge and road reconstruction. With a 15 or 20 second longer flight time, we can fly over the problem to a landing that is already accessible by road. Our costs are then landing construction and rehabilitation. We avoided the road construction costs. That allowed us to respond quickly to the wood drought we had. As you know, province wide, the small business program has a considerable backlog of unsold wood that we're working on. We were able to avoid any backlog by going to the helicopter-logging profile.

Layout Costs

As far as layout costs are concerned, heli layout costs are roughly \$1.70/m^3 including the flight costs to fly the crews of \$0.60/m^3. Compared to our longline layout costs, which are about \$0.90/m^3 just for layout, helicopter layout costs \$0.20/m^3 more. I was surprised because I thought the heli layout would be cheaper because there are no roads, profiles or plans. We do have to survey all the streams. There may be some unproductive time when the fog comes in and the crew has to fly out or walk out. It is still unclear why the costs are so high for heli layout.

About ten years ago our layout costs for conventional blocks were about \$0.35 to \$0.45/m^3 but with the code they've gone up quite a bit.

Hoechucking On Snow

I want to mention one of our Chilliwack loggers who has a Timber Sale in Lillooet Forest District. He's logging on 50% slopes, hoechucking on a spring snowpack. That's another option for steep slopes: logging on snow. It may be common in the interior but on the coast it's fairly unique. It's totally dependent on the structural strength of the snow. He levels a road and hoechucks the wood to it. It is inexpensive with minimal impact.

Questions

Q. I'm going to bypass your comment about the Ministry of Forests subsidizing anything and go on to safety and the WCB. What's been the WCB reaction to helicopter logging? One WCB person told me not to get used to it because by the time they're finished writing the new regulations, nobody is going to be doing it. Have you had that same message in the Ministry from WCB?

A. We've got some fairly hard-line WCB inspectors in our area and because of their concern we bring them on site before we sell the sale. For the selective thinning in Manning Park, we asked them on site because we wanted their opinion on the snags because Manning Park staff wanted to leave snags standing. We resolve the safety issues and get approval before we sell the sale.

Q. How long ago did you log the Manning sale?

A. Three years ago.

Q. Was it a fairly light select log?

A. Yes, it was only green attack trees and some gray attack trees if they were a hazard.

Q. It's probably not possible anymore, particularly around here. They're really moving away from any selective logging with helicopters.

A. That's good to know.

A. We're (the Ministry of Forests) doing it in Merritt on the other side of Manning Park and we're not having problems right now.

Q. I've heard things about WCB in Vernon stopping all selective logging.

A. Well, that's a heads up on that one.

Q. Murray, what's the average size of a heli-logging sale in the Chilliwack District, volume wise?

A. We put a number of patches together to make a total sale volume of about 10,000 m^3. We have one block that was proposed at 25 hectares on the aerial photographs and the contour maps. It was 44 hectares when it was laid out and we went back and removed 4 hectares. The timber just kept going along the bench.

Q. How many m^3/ha normally?

A. We've sold pulp stands but we don't get much money for them, \$2/m^3. That's only a last resort. Generally we have some good wood, 600-800 m^3/ha, but we've sold 400 m^3/ha as well. It's not the volume per hectare that counts as much as the value of the stems. For example, you can selectively log cypress at high elevations and it's profitable if the logs are high value.

Session 4: Discussion Group Summary

Discussion Group Summary

Workshop participants were divided into groups to discuss current steep slope harvesting issues. The objective was to provide participants with an opportunity to discuss problems and challenges and to develop ideas that were applicable to their situations. The discussions were also meant to define problems where work and information are required before they can be resolved. This will help FERIC plan future research projects.

The steep slope harvesting issues of most concern to workshop participants can be broadly classified into seven categories: safety, workers, planning, site impacts, small wood, roads, and harvesting system knowledge and availability.

Safety

- exposing more workers to risk
- hand falling and bucking on steep slopes
- roadside sorting on steep side slopes
- ground based systems that are pushed to their limits

Workers

- providing consistent employment
- education and certification of workers
- availability of experienced lay-out staff
- skills training for operators
- company commitment to cable logging

Planning

- difficulty in keeping required equipment available for diversity of terrain
- bureaucracy and administrative delays
- dealing with natural events such as blowdown and insect attack without compromising future harvest options
- benefits of having loggers working with the planners

Site Impacts

- road maintenance on steep ground
- slope stability
- site degradation
- road construction

Small Wood

- economics of harvesting low volume stands
- appraisal system considerations
- operating costs
- allowable annual cut concerns
- marginal wood quality

Roads

- high costs of building and rehabilitating roads on steep ground
- temporary versus permanent access
- adequate sorting and decking space

Harvesting System Knowledge and Availability

- information transfer from FERIC to industry
- sharing experiences between areas
- contractor flexibility to log all terrain types
- knowledge of system productivity and costs

Field Trip Summary

Field Trip Summary

On October 23, 1997 workshop participants toured International Forest Products Limited's (Interfor) Adams Lake Division to observe steep slope harvesting in the area. The group visited two sites on the west side of Adams Lake approximately 80 km northeast of Kamloops. The sites are in Interfor's Forest Licence A18693 in the Barriere pass area. Ron Vautour, Woodlands Manger was Interfor's Representative and hosted the tour.

The sites are in the Interior Cedar Hemlock biogeoclimatic zone (ICHmw3) at average elevations of 1300 m and 900 m. The prescribed silviculture system was clearcut with reserves for both sites.

Site One

The first site was a 26 ha block with slopes ranging from 10 to 65%. Two 0.3 ha patches were retained for visual screening, a wildlife tree patch was retained along one boundary, and leave strips were provided as wildlife movement corridors for mule deer. The stand was 87% Douglas-fir and 10% western red cedar and averaged 558 m^3/ha.

The block had been felled using a feller-buncher (40%) and hand falling (60%). A Pierce dangle-head processor processed 50% of the volume while manual delimbing and bucking was used for the remainder. Most of the volume, 75%, was yarded with a Thunderbird TSY-155 swing yarder, a 51 ft tower rigged as a standing skyline with a mechanical slack pulling carriage. A rubber tired skidder with chains and D6 crawler tractor skidded the remaining 25% of the volume. Harvesting productivity for the block ranged from 100 to 350 m^3/day.

Site Two

The second site was an 88 ha block with slopes ranging from 25 to 65%. The block consisted of 14 small openings ranging in size from 0.8 ha to 3.8 ha with reserves between the openings. The prescription provided leave areas for visual screening and wildlife corridors. Helicopter logging eliminated the need for road access. The stand was 65% Douglas-fir, 18% western red cedar, 8% lodgepole pine and 8% spruce and averaged 438 m^3/ha.

Falling and processing was done by hand and a Boeing Vertol helicopter (10,000 lb lift capability) yarded the logs. Productivity was 500 to 1000 m^3/day, depending on weather and yarding time.

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