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EVALUATION OF THE WASHINGTON 118 YARDER

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FOREWORD

FERIC is indebted to the Seattle Forest Engineering Research Center of the Pacific Northwest Forest and Range Experiment Station for suggesting this study, making the necessary arrangements, and providing field assistance. We are also very grateful for the cooperation of Hermann Bros. Logging Co., Port Angeles, Washington, owners and operators of the machine studied.

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SUMMARY

The Washington 118 is capable of high speed performance over long yarding distances; during this study it demonstrated versatility under a range of conditions. FERIC found its higher capital cost justified by higher production rates.

The main opportunities for successful application of the Washington 118 occur when road spacing can be planned to take full advantage of the machine's 1500-foot span (approximately twice that of most highlead yarders).

The choice between long-reach and highlead yarding should be based on local conditions. Yarding distances should be long enough to result in reduced road density. Timber size and volume per acre should be large enough to warrant the use of heavy equipment.

The machine is a mobile three-drum crane-type yarder. It was monitored on three clearcut operations on the Olympic Peninsula in Washington during 1977. The stands cut were mainly good quality Western hemlock and silver (amabilis) fir. Particulars of the operation and production data are summarized in the following table.

TABLE S-1. Summary of Operation and Production Data

	Area 1	Area 2	Area 3
Ground slope	Level	15 - 65%	30%
Gross volume per acre, cunits (m^3/ha)	78 (546)	132 (924)	132 (924)
Landings/yarding roads	Multiple/parallel	Single/radiating	Single/radiating
Maximum yarding distance, ft (m)	600 (180)	1400 (430)	600 (180)
Hookup method	Preset & Non-preset chokers	Non-preset (35%) Preset (50%) Tongs (15%)	Non-preset chokers (100%)
Av. time per turn, min			
Productive	3.33	4.90	2.91
Delay	.21	.32	.26
Total	3.54	5.22	3.17
Av. pieces per turn	1.9	2.0	2.0
Av. volume per piece, ft^3 (m^3)	73 (2.1)	87 (2.5)	87 (2.5)
Volume per shift, cunits (m^3)			
Based on time studies and 384 productive minutes per 8-hours shift.*	150 (424)	128 (365)	211 (598)
Based on production records, 27 shifts.	Not available	127 (360)	Not available

*Average turn times and production per shift derived from average turn times include prorated allowances for yarding-road changes, and identified delays less than 10 minutes.

INTRODUCTION

In coastal British Columbia current interest is focused on yarders capable of high-speed performance over long yarding distances as an alternative to shorter-reach yarders which require more dense road spacing. The Washington 118 was one of the machines used in a theoretical comparison of various logging systems made on a coastal area by Sauder and Nagy (1977). This study was carried out to supplement these theoretical results and to provide practical operating information.

The machine was studied on the Olympic Peninsula in Washington, the second of six built at the time of writing. To date, none of these machines is operating in British Columbia.

The field study covered the period from January to July, 1977. The information collected consisted of company information and periodic detailed timing and work sampling during the logging of 275 acres (111 ha) in three separate areas.

MACHINE DESCRIPTION

Table 1 describes the features of the machine studied.

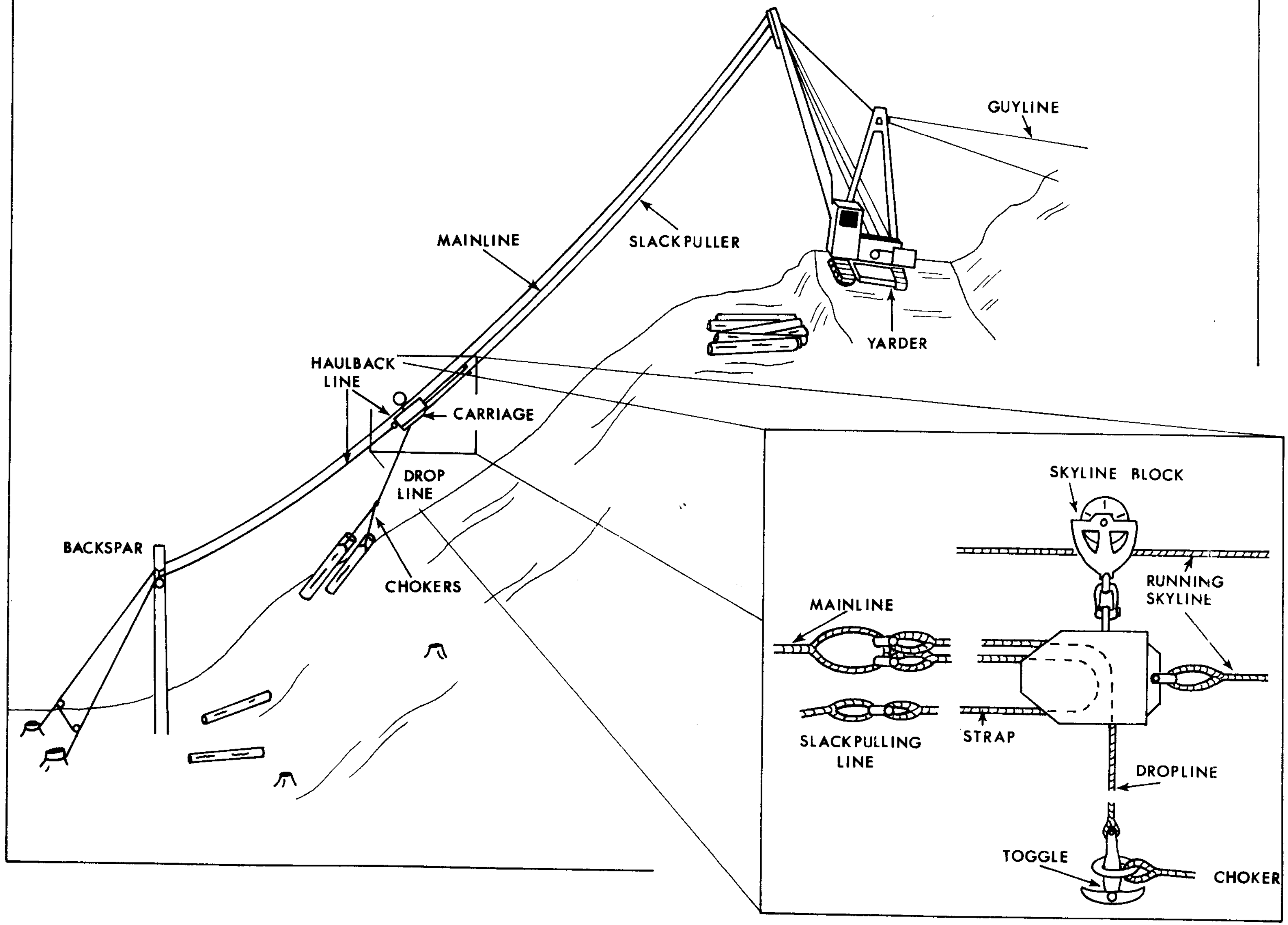
The boom and A-frame gantry are hydraulically lowered and raised during moves. During yarding three 7/8-inch (22-mm) guylines support the gantry and are tensioned by hydraulically-driven drums. For added purchase, each guyline is led over the gantry, through a block at the anchor stump, and back through the gantry to the drum (two-part system).

The Washington 118 is designed to be used in the running-skyline configuration with the carriage running on the haulback as shown in Figure A. This yarder features a closed-loop hydraulic interlock (Vari-lock) between the haulback and the mainline drums. The hydraulic interlock maintains correct line tension by varying the speed of the haulback drum in relation to the mainline and slackpulling drums. This compensates for the changes in effective diameter of the drums as cable is wound on or off, and allows for deflection adjustment to suit the operating requirements. The mainline drum drives the slackpulling drum.

Table 1. Specifications of Machine Studied

Machine Type	3-drum mobile crane type yarder (see Figure B)
Boom Height	54 ft (16 m)
Engine Size	318 hp (236 kw)
Number of Winch Drums	4 (mainline, haulback, slack-puller, strawline)
Maximum Line Capacity	Mainline: 2,070 ft of 7/8 in. (631 m of 22 mm) wire rope Slackpulling: 2,070 ft of 7/8 in. (631 m of 22 mm) wire rope Haulback: 3,800 ft of 7/8 in. (1,158 m of 22 mm) wire rope
Rigging Configuration	Running skyline with slack-puller
Length of Dropline	Approximately 100 ft (30 m)
Type of Undercarriage	Track
Type of Carriage	Young YCC-13 (see Figure C). A grapple carriage can be substituted.
Year of Manufacture	1976
Manufacturer	Washington Iron Works, Seattle, Washington
Price--Basic f.o.b. Vancouver ($ Canadian)	Approximately $502,000 (1977 estimate, Sauder and Nagy)
Canadian Distributor	Washington Logging Equipment Ltd., Vancouver, B. C.

FIGURE A. DIAGRAM OF RUNNING SKYLINE SYSTEM



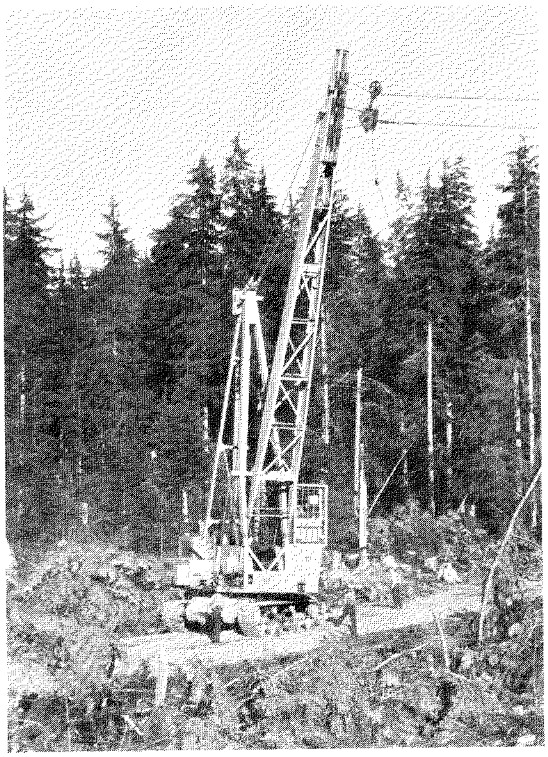
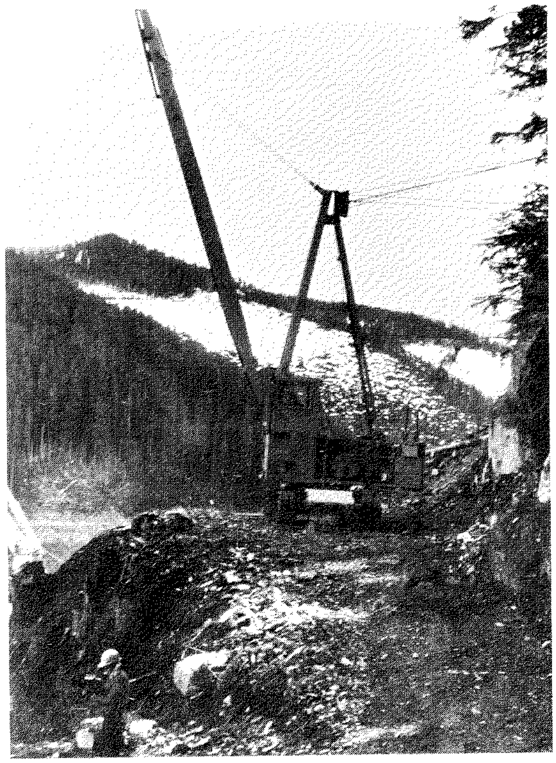



FIGURE B. WASHINGTON 118 SET UP IN AREA 1 (LEFT) AND AREA 2 (RIGHT)

FIGURE C. YOUNG YCC-13 CARRIAGE WITH TURN

The mainline is overwound and the slackpulling line is underwound, and during the outhaul or inhaul cycle the mainline and slackpuller drums are geared together for identical rotation. When used to lower the dropline (pull slack) or raise it (take up a turn or commence the outhaul) these two drums are chain-driven at equal speeds. The drums are mechanically interconnected at all times.

The free ends of the main, slackpulling, and haulback lines were eye-spliced. An 80-foot, 7/8-inch strap (24 m, 22 mm) with eye splices at each end was shackled between the main and slackpulling lines and run through the carriage along with the dropline. The dropline was attached at the shackle connecting the mainline and the strap. At completion of the inhaul the shackle travelled through the boom fairlead and was wound onto the mainline drum.

AREA DESCRIPTION

During the study the Washington 118 worked in three cut blocks in stands of Western hemlock and silver (amabilis) fir. The three areas are described in Table 2 (see also Figures D, E and F).

OPERATION

The Washington 118 yarder was backed up full-time by a Caterpillar 245 hydraulic loader equipped with a Young log grapple. In Area 1 the loader worked from log decks behind the yarder and was occasionally used to yard logs close to the road. The loader worked next to the yarder on more confined landings in Areas 2 and 3 and at times was required to hold incoming logs in Area 2. Sawlogs and pulp logs were segregated and loaded separately.

Average loading and hauling production (based on information from Area 1) was 18 highway loads per shift. Loading did not limit the rate of yarding production during the study.

In Area 1 (level ground) yarding roads were generally parallel and were perpendicular to the haul road, spaced about 150 feet (45 m) apart. Use of the dropline permitted hookup of logs within 100 feet (30 m) on either side of the skyline. In Areas 2 and 3 (steep ground) yarding was uphill on yarding roads radiating from central landings.

Table 2. Cutting Areas

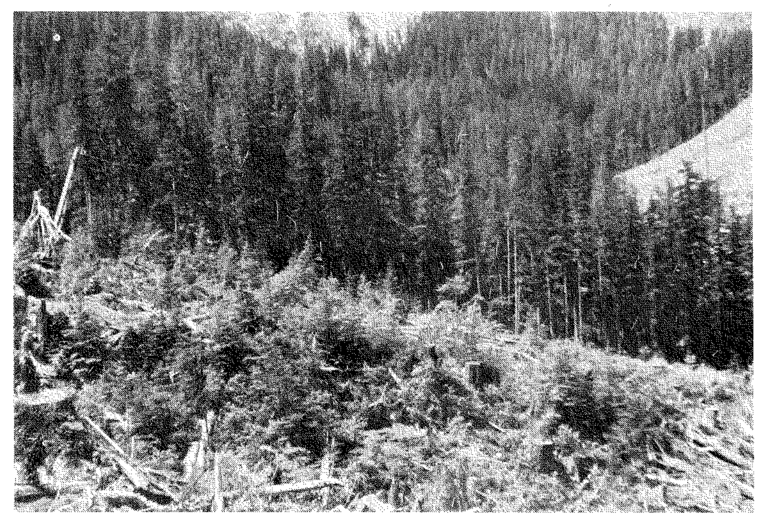
	Area 1	Area 2	Area 3
Acres (Hectares)	199 (81)	48 (19)	28 (11)
Slope, percent	0	15-65	30
Maximum yarding distance, ft (m)	600 (180)	1,400 (430)	600 (180)
Estimated gross volume:			
Cunits per acre	78	132	132
(m^3 per ha)	(546)	(924)	(924)
Total cunits	15,490	6,334	3,695
(Total m^3)	(43,863)	(17,936)	(10,463)
Local net factor (net vol/gross vol, percent)	89	89	89
Average gross vol per log ft^3 (m^3)	73 (2.1)	87 (2.5)	87 (2.5)

Source of Volume Estimates: U. S. Forest Service cruise data for Area 1. Since Areas 2 and 3 contained windfall, volumes were extrapolated from cruises of adjacent areas.

FIGURE D. ARROW ABOVE BACKSPAR IN AREA 1.

FIGURE E. ARROW INDICATES YARDER IN AREA 2.

FIGURE F. YARDER FAR LEFT IN AREA 3.



Pre-rigged backspars were used in all areas for increased deflection. These were unguyed and not always topped. The running skyline was led through one block about 40 feet (12 m) high on the backspar, then through two separate tail-blocks hung on stumps behind, and then back through a second block on the backspar (see Figure A). There were no standing guylines.

The complete crew consisted of three chokermen, a rigging slinger, yarding engineer, hooktender, landing man and loader operator. The number of men choking logs varied with requirements for changing to new yarding roads.

Up to five chokers were used, each 5/8 inch (16 mm) in diameter and 12 feet (3.7 m) long. Each was fitted with a steel ring through which the dropline could be threaded. At first in Area 1 a T-type pivoting toggle was used on the end of the dropline to hold the choker rings, but the toggle was discarded because the pivot pin tended to seize. Next (Area 2) a choker bell was hooked to a ferrule on the dropline for the same purpose but this occasionally worked free during the outhaul. Finally, an improved T-type toggle was fitted (see inset, Figure A).

In Areas 1 and 3, only non-preset chokers were used. In Area 2, all three methods were used: non-preset and preset chokers, and tongs. The tongs were used for individual large logs lying flat. Moving lines could be kept well clear of the ground. Presetting chokers was possible where long yarding created an advantage and this was done in Area 2. On long yarding roads, the crew first cleared logs close to the centerline (from the machine to the backspar) without presetting chokers. Yarding with preset chokers then proceeded in the reverse direction to the full width possible. As the crew came close to the machine some members started rigging for the next yarding road and the others returned to the non-preset method.

Sampling Method

The timing and production results were obtained at the times and by the methods shown in Table 3.

Table 3. Sampling Dates and Methods

Area	Date Sampled	Method of Sampling
1	January 1977	Detailed timing
2	May 1977	Detailed timing
3	June 1977	Work sampling

"Detailed timing" involves continuous timing of the work cycle segments. The segments timed are outhaul, hookup, inhaul, decking, unhooking, road changes and delays. A detailed definition of each of these seven time categories is given in Appendix I. "Work sampling" involves instantaneous observation of the work cycle at predetermined random intervals to obtain the percentage of time spent in each of the seven categories. Both of these techniques are described in detail by Cottell, et al. (1976) in FERIC TR-8.

RESULTS AND DISCUSSION

PRODUCTION

The results of the timing studies for the three areas (and for the different hooking methods in Area 2) are shown in Table 4. These are some of the main points:

Area 1: In Area 1, the timber was yarded on parallel roads and windrowed before the machine travelled to the next backspar. This area had significantly less volume per acre but production was higher than in Area 2 because of short yarding distance (av. 325 ft or 100 m). Road change time (prorated over the 140 turns) amounted to 0.62 minutes per turn, or 3 times that for Areas 2 and 3.

Area 2: Volume per acre was higher than in Area 1 but the yarding distance averaged 837 ft (255 m) for all turns.

Yarding road changes accounted for only 0.20 minutes per turn since the machine stayed on a single landing throughout. Presetting chokers was used on 50% of all turns and gave the shortest cycle time of all methods, despite the longer average distance (911 ft or 278 m). Volume per turn and per shift was significantly lower, suggesting that preset chokers were generally used on the smaller logs. The number of logs per preset turn averaged 2.2, versus 2.0 logs

Table 4. Results of Detailed Time Studies

(All times in minutes)

Category	Area 1	Area 2					Area 3
	Non-Preset Chokers	Preset Chokers	Non-Preset	All Chokers	Tongs	All Turns	Non-Preset Chokers
Number of turns in sample	140	176 (50%)	125 (35%)	301 (85%)	55 (15%)	356 (100%)	*
Slope	0%	15 to 65%--uphill yarding					30%--uphill
Maximum yarding distance, ft	600					1,400	600
(m)	(183)					(427)	(183)
Average yarding distance, ft	325	911	746	844	799	837	325
(m)	(99)	(278)	(227)	(257)	(244)	(255)	(99)
Outhaul, av. time/turn	.44	.81	.69	.76	.76	.76	.25
Hookup, av. time/turn	1.12	1.53	1.93	1.70	1.70	1.70	1.31
Inhaul, av. time/turn	.67	1.47	1.48	1.48	1.39	1.46	.61
Deck, av. time/turn	.26	.35	.39	.36	.34	.36	.17
Unhook, av. time/turn	.22	.39	.49	.43	.40	.42	.33
Road change, av. time/turn --prorated	.62	.20	.20	.20	.20	.20	.24
Productive time/turn	3.33	4.75	5.18	4.93	4.79	4.90	2.91
Delay, av. time/turn --prorated	.21	.31	.18	.26	.65	.32	.26
Total av. turn time	3.54	5.06	5.36	5.19	5.44	5.22	3.17
Av. pieces/turn	1.9	2.2	2.0	2.1	1.4	2.0	2.0
Av. volume/turn, ft^3	138	124	250	179	152	175	175
(m^3)	(3.9)	(3.5)	(7.1)	(5.1)	(4.3)	(5.0)	(5.0)
Volume/shift, cunits	150	94	179	133	107	128	211
(m^3) --based on 384 min/shift	(424)	(267)	(507)	(376)	(304)	(365)	(598)

*Cycle time based on 251 work-sample observations.

for non-preset turns. Non-preset chokers were used on 35% of all turns. Cycle times were longer than for preset, largely because hooking time was longer, and shorter average yarding distance did not compensate for this. Volumes produced were higher, however, because the volume per piece was higher.

Tongs were used on 15% of the turns in Area 2. Tongs gave the longest cycle time in Area 2, despite the shorter average distance (799 ft or 244 m). The volume per turn with tongs was lower than for the combined choker turns. Tong turns normally were for single logs (average 1.4 logs per turn) but the logs tended to be large ones. High delay time resulted from the fact that the tongs frequently slipped off logs and required resetting at the point of origin or elsewhere during inhaul. It is probable that the same turns would have taken even longer to handle with chokers.

Area 3: This area combined the advantages of high volume per acre, short yarding, and moderate slope. Yarding cycle times were lowest (3.17 min).

The work-sampling method was used only in Area 3, and results may not be entirely comparable between this area and the others. However, the results demonstrate the capability of the machine for high production under favourable conditions.

The results are based on detailed timing and work-sample studies performed by FERIC. Additional production data covering much of Area 2 were obtained from the company. The volumes, converted from Scribner board-foot scale, are shown in the following table.

Type of Production	Days	Volume/Day		Total Volume	
		Cunits	(m^3)	Cunits	(m^3)
Yarding merchantable logs	27	127	360	3,429	9,710
Yarding unmerchantable material ("YUM" yarding)	14	76	215	1,064	3,013
	41	110	310	4,493	12,723

Excluding "YUM" yarding, sustained production per day was roughly comparable to the yarding rates measured during the short-term FERIC timing studies. The 4,493 cunits (12,723 m^3) logged falls short of the 6,334 cunits (17,936 m^3) cruised, indicating a possible error in the extrapolated cruise volume.

Delays

Individual delays longer than 10 minutes are not considered part of a regular cycle and were excluded from the calculation of average turn times. Delay times (see Table 4) ranged from 0.18 minutes per turn (16 min per 8-hr shift) for non-preset chokers in Area 2 up to 0.65 minutes per turn (57 min per 8-hr shift) for tongs in Area 2.

"Picking up lost logs" was the second most common delay and it occurred in 8% of the total turns in Area 2, with an average delay time per occurrence of 2.1 minutes. Almost half of these delays occurred on the 15% of the turns where tongs were used. In Areas 1 and 3 tongs were not used and the average delay time for picking up lost logs was only 1.7 minutes (an occurrence of less than 1% of the total turns in these areas). Logs lost from choker turns were picked up in subsequent turns without major interruption of the yarding cycles.

The most common delays were those associated with wear in the running lines. These lines were replaced once during the study period, and their life was not more than 5 to 6 months despite frequent lubrication with machine oil. Line life might be extended by using larger sheaves on the backspar and in the carriage but this was not tested. Line wear was noticeably increased during dry weather, probably because of the grinding action of mixed oil and dust in the lines.

The most severe wear occurred in the dropline and the strap connecting the main and slackpulling lines. There is always abrasion when these lines run through the carriage and additional abrasion when the running lines wrap together during the outhaul. The life of the strap and dropline was only about one month.

During 23 days of observation, eye splices in the running lines (see Figures G and H) required replacement once in every three days on the average. Each splice required an average delay of 25 minutes, or about 8 minutes per shift. Improved fittings to connect the lines should help to overcome this problem. The slackpulling line lasts longer than the mainline. Successively resplicing the slackpulling line made it shorter than the mainline. Aside from splicing delays, the changes in relative lengths led to a differential in effective drum diameter between the two connected

FIGURE G. SPLICING NEW EYE

FIGURE H. NOTE DETERIORATION OF CABLE.

drums. The mainline drum was slightly larger in diameter than the slackpuller drum throughout the inhaul. After the dropline was fully taken up into the carriage, further inhaul caused the mainline to take the full line pull and the slackpulling line to sag. When this occurred on long turns the carriage had to be stopped and the dropline lowered to equalize tensions in the two incoming lines, and the inhaul cycle resumed. This type of delay occurred 81 times on 187 turns in Area 2, with an average delay time of 0.15 minutes.

ESTIMATED YARDING COSTS

Sauder and Nagy (1977, TR-19, Appendix III) derived a total owning and operating cost of $189.68 per scheduled machine hour for the Washington 118, based on operation in coastal B. C. This would be equivalent to $1,517 per 8-hour shift. The yarding cost per cunit would thus be $1,517 divided by the shift production in cunits attained for each area. The expected range of yarding cost for clearcut areas in B. C. (based on production rates in Washington), is shown:

Source of Production Data	Production cunits/day	Yarding Cost $/cunit
Area 2, 27-day company records	127	11.94
Area 1, detailed timing	150	10.11
Area 2, detailed timing	128	11.85
Area 2, detailed timing, excluding tongs	133	11.41
Area 3, work sampling	211	7.19

Area 2 (excluding tongs) is probably the most representative of conditions where machines of this type would be favoured over highlead in British Columbia. In Area 2, yarding distances are long enough to result in reduced road density, terrain is steep enough to discourage dense spacing of roads, and timber volume per acre is high enough to warrant the use of heavy equipment. Under these conditions yarding costs would usually exceed those for normal highlead, but these higher yarding costs would often be compensated by lower costs in other phases, particularly in road construction. The choice between long-reach and highlead yarding should be made by local analysis of such factors.

FERIC TR-19 (1978) is an example of an analysis which favours the Washington 118 over highlead because of local opportunities to decrease road development costs through longer yarding.

CONCLUSION

FERIC's study of the Washington 118 yarder with running skyline demonstrated the machine's versatility in a variety of setups. Its capital cost is high but yarding production and derived costs were satisfactory in the three areas of differing volume per acre, piece size, yarding distances, and terrain.

Backspars were required in all three study areas for adequate deflection. The production rates recorded include the time taken in rigging. The slackpulling capability permitted lateral yarding within 100 feet (30 m) of each yarding road, and also permitted presetting of chokers on over half of all choker turns. The use of tongs for yarding caused delays but may have prevented even longer delays had chokers been attempted on the same logs.

We noted heavy wear on running lines and eye splices. This may be inherent to the system.

Production was satisfactory in Area 1, even with short yarding distances and a gross timber volume of 78 cunits per acre (546 m^3/hectare). Productivity and costs would naturally be less favourable where volume per acre is lower. Proponents of this system believe, however, that it would remain competitive with other cable systems wherever long reach and lateral yarding capabilities can be used to advantage.

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APPENDIX I:
Definitions and Study Forms

1) Definition of Time Categories

TIME ELEMENT	BEGINS	ENDS
Outhaul	when the chokers have pulled free from the log deck	when the signal to 'Stop Rigging' is given
Hookup	end of outhaul (for grapple yarding, includes time to position on logs)	when the signal to 'Begin Yarding' is given
Inhaul	end of hookup	when the incoming turn reaches the back end of the log deck
Deck	end of inhaul	when the logs have finally come to rest on the deck
Unhook	end of deck	when the chokers have pulled free from the log deck
Road Change	when crewman signals start of road change	at start of outhaul for first turn on the new yarding road
Delay	when a productive function is interrupted	when the productive function is re-commenced