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Helicopter logging in British Columbia: pole logging with the Kamov KA-32A helicopter

Contents

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Abstract

The Forest Engineering Research Institute of Canada (FERIC) studied a medium-lift Kamov KA-32A helicopter in a pole logging operation in coastal British Columbia. The report presents harvesting productivity and cost, and describes factors affecting the operation.

Keywords

Helicopter logging, Kamov KA-32A, Aerial logging, Coastal British Columbia, Partial cutting, Selective harvesting, Productivity, Costs.

Introduction

Forest engineers and planners recognize that helicopter logging is a highly specialized system with its own unique requirements for safe, cost-effective harvesting operations. However, information about the capabilities and performance of different helicopters in typical British Columbia harvesting situations is scarce, as is information about site, stand, organizational, and operational factors that influence helicopter logging productivity and cost. To provide this information, FERIC has established an ongoing project to study helicopter logging operations in B.C. through a series of short-term case studies.

This report presents the results from a study of a Kamov KA-32A medium-lift helicopter performing a pole-logging operation on the south coast under summer conditions. Cedar poles were selectively harvested (prior to a clearcut operation) on moderately steep slopes using a helicopter to minimize log breakage and damage. FERIC, Canadian Forest Products Ltd. (Canfor), Sechelt Creek Contracting, and VIH Logging Ltd. cooperated in this case study.

Objectives

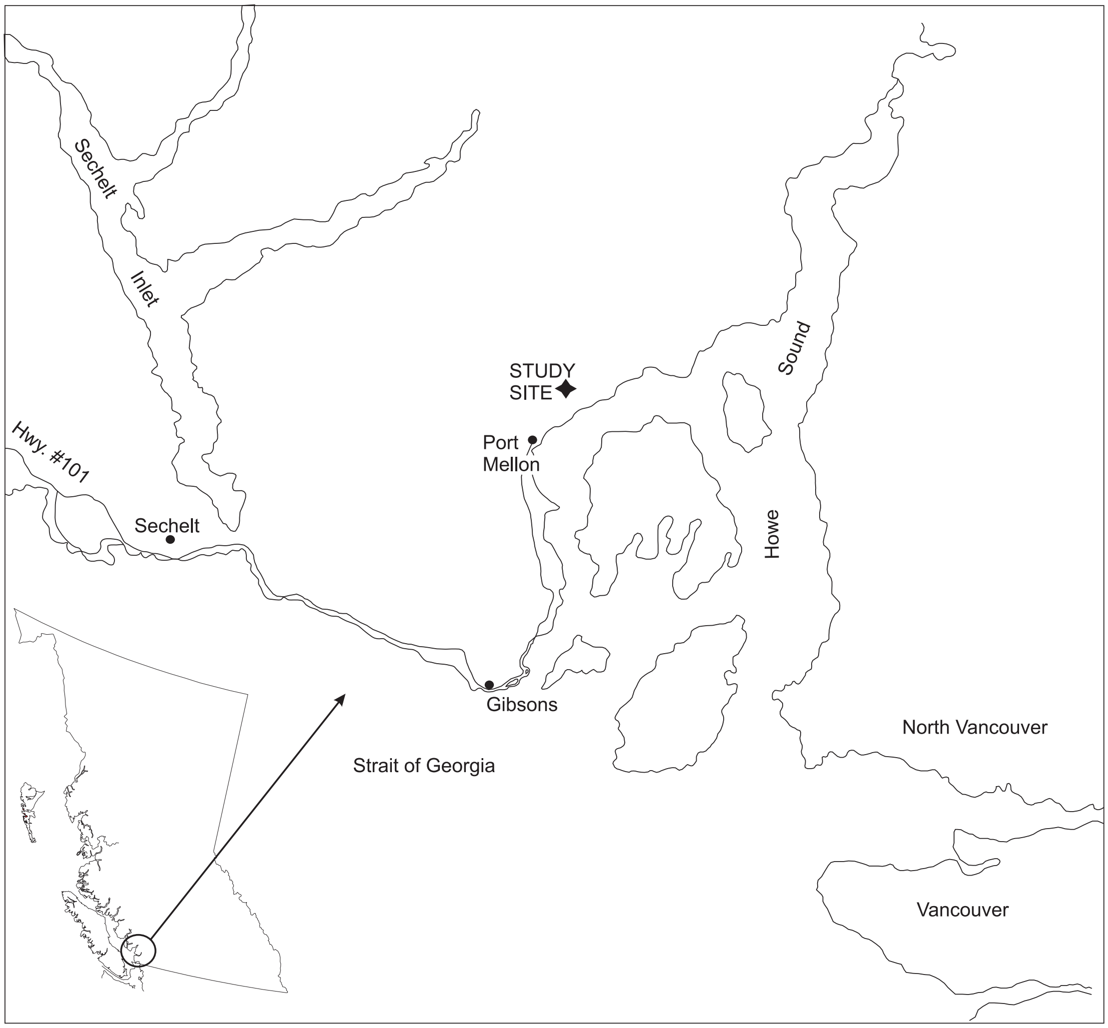
The objectives of this case study were to:

- Describe the harvesting operation.
- Determine productivities and costs for the falling, yarding, and log clearing and decking phases.
- Identify features of the site, stand, harvest plan, and system organization that may influence harvesting productivity and cost.

Site and stand descriptions

The cutblock was located on crown land approximately 3 km northeast of Port Mellon in the Sunshine Coast Forest District, Vancouver Forest Region (Figure 1). Elevations ranged from 520 to 860 m. The terrain was moderately steep and broken with slopes between 40 and 60%. The study site had generally well-drained, sandy clay loam soils over bedrock with low sensitivity to mass wasting, and was in the Submontane Very Wet subzone of the Coastal Western Hemlock (CWHvm1) biogeoclimatic zone (Green and Klinka 1994). Forest cover consisted of

Figure 1. Location of study site.



western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) with a minor component of Douglas-fir (*Pseudotsuga menziesii*), amabilis fir (*Abies amabilis*) and yellow cedar (*Chamaecyparis nootkatensis*). Merchantable volume averaged 807 m^3/ha.

Harvesting prescription and plan

The silviculture prescription called for a clearcut with reserves using a conventional cable yarding system. Extraction of cedar poles by helicopter was not specified in the original plan. However, Sechelt Creek Contracting proposed that high-value cedar poles could be selectively harvested by helicopter, prior to conventional cable logging operation, to minimize log breakage and damage. With approval from Canfor, Sechelt Creek Contracting solicited bids to harvest 2 800 m^3 of tree-length cedar pole logs using a medium-lift helicopter. A medium-lift helicopter had the capability to handle the tree sizes and pole lengths on this operation, and to recover the pole logs within a short time frame to take advantage of favourable log markets. VIH Logging was the successful

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bidder and proposed to harvest the area with a Kamov KA-32A helicopter.

The cutblock was 38.4 ha in size and irregularly shaped to conform to landscape features and soften the visual impact (Figure 2). The drop zone was on the main road through the cutblock and its location advanced along the road as yarding progressed. Slope distance from the log hook-up sites to the drop zone ranged from 40 to 275 m and averaged 160 m, and the slope of the flight path averaged 40%. The majority of the helicopter logging was downhill.

Helicopter specifications

The Kamov KA-32A is a twin-turbine medium-lift helicopter designed for external lift, fire fighting, and search and rescue operations (Figure 3). It has co-axial contra-rotating rotors, and was designed and built in Russia during the 1970s with first flight in 1980. The helicopter's unique rotor design eliminates the need for a tail rotor, which in turn makes more power available for external lift (i.e., increases payload). Total commercial production of the Kamov KA-32 (all variants) is estimated at 124 units (Helicopter Association International 2001). The Kamov KA-32A is certified to new Russian standards and in 1993 was permitted to operate in Canada under Russian registration until modifications to suit Transport Canada were completed. A Canadian Certificate of Airworthiness was granted to the Kamov Company of Russia in February 1999, following a six-year certification effort.

Specifications for the KA-32A helicopter are presented in Table 1. With a maximum permitted static load of 5 000 kg, the KA-32A is one of the largest medium-lift helicopters routinely used for logging (Appendix I).

Figure 3. Kamov KA-32A helicopter.

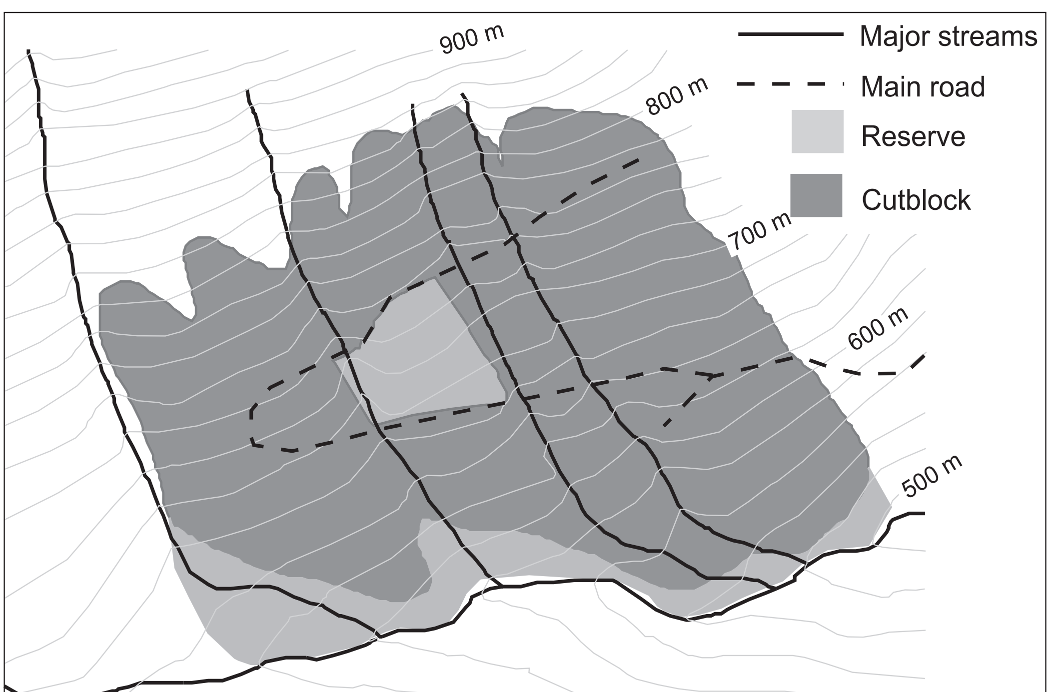

Figure 2. Harvesting area showing cutblock, roads, and topography.

Table 1. Specifications for the Kamov KA-32A helicopter [a]

Maximum permitted static load (kg)	5 000
Engines (no.)	2
Engine power at takeoff (kW) (each)	1 645
Dimensions main rotors (m) (each)	15.9
Service ceiling (m)	4 500
Standard fuel capacity (l)	3 530
Fuel consumption (l/h)	662

[a] Source: www.rotor.com.

Study methods

The study focused on determining production, costs, and factors influencing harvesting productivity. The pole yarding operation was completed over a 7-day period and a FERIC researcher was only on-site during the sixth day of the harvesting operation. Shift-level information for the falling phase of the operation was supplied by Sechelt Creek Contracting. Shift-level information for the yarding and log clearing and decking phases was based on conversations with VIH Logging and Sechelt Creek Contracting personnel. While on-site, FERIC detailed timed a sample of yarding turns[1] and cycles[2] using a handheld datalogger and recorded the number of logs and estimated flight distance from the hook-up sites to the landing.

During the field visit, the researcher discussed the progress of the harvesting operation to identify site, stand, layout and organizational factors that influenced the helicopter's productivity.

Costs for the Kamov KA-32A helicopter were estimated using a modified version of the costing methodology in Guimier and Wellburn (1984), plus information from The Official Helicopter Blue Book (HeliValue$ Inc. and Helibooks Ltd. 1999) (Appendix II). Hourly costs for the other machinery involved in the harvesting operations were calculated using FERIC's standard costing methods (Appendix III). Labour costs were based on the IWA British Columbia Coast Master Agreement using 2001 rates. FERIC's cost estimates do not include stumpage or profit. It is stressed that the costs presented in this report are FERIC's estimates only and are not the actual costs incurred by either the licensee or the contractors.

Results and discussion

Description of the operation

Sechelt Creek Contracting crews and equipment were used for the falling, bucking, loading and trucking phases, and VIH Logging provided its own crews and equipment for the yarding phase. Road access was limited, and equipment was transported to and from the area by barge. The crew came in daily by boat, and the helicopter and pilots flew in each day. Sechelt Creek's crews had no previous experience with helicopter logging but had considerable experience with conventional pole logging operations.

Three or four fallers were responsible for locating, selecting, and falling cedar trees suitable for pole logs. In this helicopter operation, work sites were not far from the main road, and the fallers walked into the cutblock. All falling was completed before yarding began. Trees were felled across slope and stems were topped and delimbed for tree length yarding.

The Kamov was equipped with a 680-kg grapple attached to a 60-m longline (Figure 4). A 46-t-class hydraulic log loader cleared and decked logs in the drop zone during yarding.

VIH Logging used flight, hill, and helicopter maintenance crews, for a total of six members. Additionally, Sechelt Creek Contracting employed a woods foreman and

[1] A yarding turn is defined as the sequence of activities required to transport one load of logs from the stump to the landing. A turn consists of the following elements: flying from the landing to the hook-up site (fly empty); securing the load of logs (hook-up); flying from the hook-up site to the landing with the load of logs (flying loaded); and placing and releasing the logs on the landing (unhook).

[2] A cycle is defined as the period of continuous flight operations between refuelling and/or maintenance breaks, during which a series of turns is yarded. In helicopter logging, typically 25–45 turns are yarded in a 50–90 minute cycle.

a first aid attendant during the yarding and log clearing and decking operation.

The maintenance crew had two helicopter flight engineers, and maintenance equipment included a truck-mounted service trailer, a standard highway fuel tank, and an aircraft refuelling system. The length of maintenance shift varied daily depending on the number of hours flown.

The hill crew, two spotters, worked a scheduled 10-hour shift. The spotters marked logs with paint prior to yarding to make them more visible to the pilots from the air and directed the pilots by radio if they were unable to see the logs to position the grapple.

The flight crew consisted of the Kamov pilot and copilot. The Kamov flew between 4.5 and 9 hours/shift, yarding 28–32 turns in a 60–70 minute yarding cycle. At the end of each cycle the Kamov returned to the service landing for about 10 minutes, while the pilot and copilot changed positions and a "hot" refuelling was performed. Following every fourth or fifth consecutive cycle, the Kamov was shut down and the flight engineers performed a mandatory mechanical inspection, which took 1–1.5 hours.

The landing crew consisted of one landing bucker and a log loader operator, and worked a scheduled 10-hour shift. During yarding operations the log loader worked in the drop zone to clear and deck logs (Figure 5). Bucking was limited because the drop zone was often too congested to work safely.

Figure 4. Helicopter grapple.

Figure 5. Drop zone within the cutblock.

Harvesting productivity

A total of 2 837 m^3 of cedar poles was harvested from the study site in this operation. Table 2 summarizes shift-level productivities for the falling, yarding, and log clearing and decking phases. Table 3 summarizes detailed-timing data for the yarding phase.

Falling

Falling of cedar poles began in mid-May and was completed by late June. Late winter snowfall periodically interrupted the falling schedule. In the 22 scheduled falling days during this period, 75 faller-shifts were worked.

Table 2. Shift-level productivities for the falling, yarding, and log clearing and decking phases

Falling	
Scheduled shifts worked (no.)	22
Average fallers per shift (no.)	3.5
Total faller shifts worked (no.)	75
Production per 6.5-h falling shift (m^3)	37.8
Yarding	
Logging helicopter	
Total shifts worked (no.)	7
Scheduled shifts with production (no.)	7
Scheduled shifts lost to weather (no.)	0
Scheduled shifts lost to mechanical problems (no.)	0
Average flight-hours per productive yarding shift (no.)	6.4
Production per productive yarding shift (m^3)	405
Log clearing and decking	
Total shifts worked (no.)	7

Based on the net volume, each faller produced an average of 37.8 m^3/6.5-hour shift worked. Falling productivity was low because the fallers had to find, select and fall the appropriate trees in closed canopy conditions. The late winter snowpack, up to 1.5 m deep on lower slopes, further reduced productivity.

Table 3. Detailed timing results for helicoper yarding	
Yarding turn elements	
Fly empty (min) (%)	0.34 (16)
Hookup (min) (%)	0.89 (43)
Fly loaded (min) (%)	0.40 (19)
Unhook (min) (%)	0.46 (22)
Total turn time (min) (%)	2.09 (100)
Logs/turn (no.)	1.1
Average payload/turn (kg) [a]	2 841
Average flight distance (m)	160

[a] Average payload/turn is calculated based on an average weight per flight hour estimate provided by VIH Logging.

Yarding

Helicopter yarding was carried out in mid-July and required seven productive shifts to complete. No full shifts were lost to weather or mechanical problems. In total, the Kamov required an estimated 45 flight hours to yard the volume of 2 837 m^3. On average, the logging helicopter flew 6.4 hours or 6 yarding cycles per shift, and produced 405 m^3/production shift, and about 63 m^3/flight hour.[3]

FERIC conducted detailed timing on 3.1 flight hours, or 3 complete yarding cycles, consisting of 87 turns. On average, the yarding cycles were 62.0 minutes long. No aborted turns were recorded during detailed timing. The Kamov averaged 79 550 kg of payload per flight-hour during the detailed- timing period, resulting in an average payload/turn of 2 840 kg. The average turn time was 2.1 minutes, with 1.1 logs/turn. Forty-three percent of the turn time was spent hooking up and breaking out the turn, 22% was spent unhooking the turn, and the remainder was spent flying to and from the drop zone.

Based on field observations and discussions with cooperators, the principal factors affecting yarding productivity were the single tree selection conditions and the requirement to minimize log damage.

Helicopter yarding in single tree selection has been found to increase hook-up and breakout time when compared to clearcut helicopter yarding. Additional time is required to lift stems above the top of the tree canopy before beginning forward flight and turn hang-ups also increase (Krag 1998).

Single tree selection: Based on the detailed-timing information, the Kamov's payload was under-utilized, averaging only 57% of the aircraft's rated payload capacity. (Target turn payload for this helicopter is generally set at 80–85% of rated payload capacity.) This under-utilization was a result of yarding only one log per turn because the logs were dispersed. Additionally, a large portion of helicopter turn time was attributed to log hook-up and breakout, also a result of yarding in closed-canopy conditions. Such conditions made spotting logs and grapple placement more difficult for pilots.

Log damage: To minimize log breakage, damage, and consequently loss in market value, considerable effort was made during turn breakout to carefully extract logs from the residual stand. Effort was also made to lay logs in the drop zone carefully and to release them from the grapple without damaging them. This added to the turn time and reduced productivity.

Log clearing and decking

Log clearing and decking activities were carried out for seven productive shifts in conjunction with the yarding operation. Because, for the most part, logs could not be safety bucked during active yarding, additional log handling was required to process and load them once yarding was completed.

Harvesting cost

Table 4 summarizes the main cost centers and harvesting phase costs for this operation.[4]

[3] Flight hours were estimated by FERIC from discussions with VIH Logging and Sechelt Creek Contracting personnel.

[4] In order to more realistically reflect harvesting costs associated with helicopter logging, cost estimates for this and other recent FERIC helicopter logging studies are derived using a methodology that departs from FERIC's conventional costing approach.

Table 4. Phase costs for falling, yarding, and log clearing and decking	Falling ($/m³)	Yarding ($/m³)	Log clearing and decking ($/m³)	Total ($/m³)
Prime costs				
Yarding helicopter	-	50.93	-	50.93
Other equipment	-	0.49	2.43	2.92
Chainsaw	1.51	0.14	0.14	1.79
Labour	10.64	1.84	2.09	14.57
Subtotal	12.15	53.40	4.66	70.21
Other costs				
Mobilization	-	1.82	0.09	1.91
Crew transport	1.38	0.26	0.18	1.82
Supervision	-	1.28	-	1.28
Crew room and board	-	1.18	-	1.18
Overhead	0.68	4.18	0.25	5.11
Project costs	-	2.26	-	2.26
Subtotal	2.06	10.98	0.52	13.56
Total	14.21	64.38	5.18	83.77

The per unit harvesting cost includes falling, yarding, and log clearing and decking, and was estimated at $83.77/m^3. The yarding phase comprised the largest portion of the harvesting cost (77%) followed by falling (17%) and log clearing and decking (6%).

Falling, and log clearing and decking costs were estimated at $14.21/m^3 and $5.18/m^3, respectively. The cost for falling reflects the effects of faller selection, working in deep snow, and falling in closed canopy conditions, while log clearing and decking costs reflect the effect of limited space at the drop zone.

The average yarding cost was estimated at $4 059/flight-hour or $64.38/m^3 and reflects the effects of single tree selection conditions and the requirement to minimize log damage. The yarding helicopter alone accounted for 79% of total yarding cost, and for 61% of the total cost.

Conclusions and implementation

A total of 2 837 m^3 of cedar logs was harvested from the study site. Falling productivity averaged 38 m^3/6.5-hour production shift and was adversely affected by single tree falling in closed canopy conditions, and a deep, late winter snowpack. A Kamov KA-32A helicopter completed the yarding phase in seven production shifts and averaged 405 m^3/shift. Yarding productivity was adversely affected by single-tree selection conditions and the requirement to minimize log damage. A hydraulic log loader was used for seven production shifts during the yarding operation, to clear the drop zone and deck logs. Limited space at the drop zone prevented safe log processing and loading during yarding operations and therefore logs had to be re-handled after yarding was completed. The total per-unit harvesting cost, including falling, yarding, and log clearing and decking, was estimated at $83.77/m^3.

Harvesting pole logs with helicopters is a very different alternative to conventional pole-logging methods and this study reflects some of the challenges associated with the operation. Important considerations identified during this study include:

- Fall to ensure proper log placement. Trees were felled cross-slope, which is typical when falling for conventional cable or clearcut and patch-cut helicopter logging operations. However, in this situation falling trees uphill, when it was safe to do so, may have been more appropriate and may have increased yarding productivity. Uphill log placement would have facilitated a "cleaner", faster log breakout during yarding and may have also reduced log damage.
- Match the capabilities of the logging helicopter to the expected piece size. In this case study, the Kamov's payload was underutilized because the average piece size was less than its payload, but the logs were too widely dispersed to accumulate optimally sized turns. One strategy for increasing payload is to connect widely separated logs with a series of chokers, but this increases the likelihood of hangups in partial cutting situations. Although a helicopter with a smaller payload capacity would have been more efficient in terms of average payload, the use of a lighter-lift helicopter might have required bucking long (>18 m) poles into shorter lengths. This would have significantly reduced revenues because long poles have a substantially higher market value than utility poles (<18 m in length).
- Ensure landing (drop zone) size is adequate to accommodate the volume yarded each day. In this operation, overall harvesting cost may have been decreased if a few centralized landings had been used. Because the cutblock was clearcut after pole logging was completed, small pockets of trees along the road could have been felled and cherry-picked with a log loader prior to yarding, to allow more room for landing, processing, decking, and loading logs during yarding. Additionally, larger landings or drop zones may have increased yarding productivity because landing logs may have been faster and easier.
- Employ skilled, conscientious pilots. Sechelt Creek Contracting's foreman felt that less log breakage and damage occurred from helicopter yarding than would have from conventional yarding. Employing skilled and conscientious pilots is likely the best tool for achieving minimal log damage and breakage.

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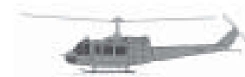
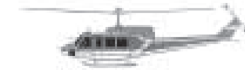
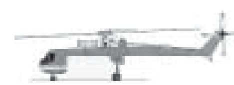
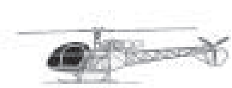
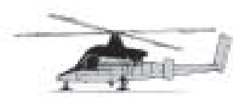
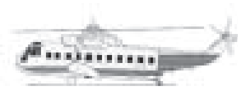
Appendix I

Specifications for helicopters commonly used for logging in B.C. [a]

Manufacturer	Model	Rated payload capacity (kg)	Engines (no.)	Engine power [b] (kW)	Diameter main rotor (m)	Diameter tail rotor (m)	Diagram
Bell	204B	1814	1	820	14.6	2.6	
Bell	205A	2268	1	1044	14.6	2.6	
Bell	212	2268	2	671 (each)	14.7	2.6	
Bell	214B	3636	1	2185	15.2	2.6	
Boeing	V-107 II	4773	2	932 (each)	15.5	n/a	
Boeing	CH-234LR	12727	2	3039 (each)	18.3	n/a	
Sikorsky [c]	S-64E	9072	2	3356 (each)	22	5	
Sikorsky [c]	S-64F	11340	2	3579 (each)	22	5	
Eurocopter	SA-315B Lama	1134	1	640	11.0	1.9	
Kaman	K-1200	2722	1	1342	14.7 (×2)	n/a	
Kamov	KA-32A	5000	2	1645 (each)	15.9 (×2)	n/a	
Sikorsky	S-58T	2268	2	700 (each)	17.1	2.9	
Sikorsky	S-61N	3629	2	1044 (each)	18.9	3.2	
Sikorsky	S-61N Shortski	4084	2	1044 (each)	18.9	3.2	

[a] Helicopter capabilities will vary with flight conditions and installed options.
[b] Engine power at takeoff.
[c] Now manufactured by Erickson Air-Crane Inc.

Appendix II

Helicopter costs [a] ($/flight-hour)

	Kamov KA-32A helicopter
OWNERSHIP COSTS	
Total purchase price (P) $	8 050 000
Expected life (Y) y	10
Expected life (H) h	25 000
Scheduled hours/year (h) = (H/Y) h	2 500
Net flight hours/year (fh) h	2 000
Salvage value as % of P (s) %	50
Interest rate (Int) %	9.0
Insurance rate (Ins) %	12.0
Salvage value (S) = ((P•s)/100) $	4 025 000
Average investment (AVI) = ((P + S)/2) $	6 037 500
Loss in resale value ((P-S)/(fh•Y)) $/flight-hour	201.25
Interest ((Int•AVI)/fh) $/flight-hour	271.69
Insurance ((Ins•AVI)/fh) $/flight-hour	362.25
Total ownership costs (OW) $/flight-hour	835.19
OPERATING COSTS	
No. of pilots required for the operation (pil)	5
Annual pilot base salary (PS) $/y	40 000
Annual flight hours/pilot (pilh) h/y	800
Flight hour rate (pil$) $/h	80
Annual pilot flight pay (PF) = (pilh•pil$) $/y	64 000
Wage benefit loading (WB) %	45
No. of engineers (eng)	5
Engineer salary (ES) $/y	80 000
Fuel consumption (F) L/flight-hour	662
Fuel (fc) $/L	0.85
Oil as % of fuel (fp) %	1.5
Annual parts inventory (Inv) = % of P $/y	5
Wages for the operation, including fringe benefits	
Pilot (((PS•pil) + (pil$•pilh•pil))/fh)•(1 + (WB/100)) $/flight-hour	377.00
Engineer (ES•(1 + (WB/100))/fh $/flight-hour	290.00
Total wages (W) $/flight-hour	667.00
Fuel (F•fc) $/flight-hour	562.70
Oil ((fp/100)•(F•fc)) $/flight-hour	8.44
Maintenance $/flight-hour	925.00
Parts inventory ((Inv/100)•P/fh $/flight-hour	201.25
Helicopter registration fees $/flight-hour	11.17
Total operating costs (OP) $/flight-hour	2 375.56
TOTAL OWNERSHIP AND OPERATING COSTS (OW + OP) $/flight-hour	3 210.75

[a] These costs are estimated using FERIC's standard costing methodology for determining machine ownership and operating costs for new machines. The costs shown here do not include supervision, profit and overhead, and are not the actual costs for the contractor or the company studied.

Appendix III

Machine costs [a] ($/scheduled machine hour (SMH)) (excluding labour)

	Hydraulic log loader (46 000 kg class)
OWNERSHIP COSTS	
Total purchase price (P) $	550 000
Expected life (Y) y	10
Expected life (H) h	14 400
Scheduled hours/year (h) = (H/Y) h	1 440
Salvage value as % of P (s) %	30
Interest rate (Int) %	9.0
Insurance rate (Ins) %	3.0
Salvage value (S) = ((P • s)/100) $	165 000
Average investment (AVI) = ((P + S)/2) $	357 500
Loss in resale value ((P-S)/H) $/h	26.74
Interest ((Int • AVI)/h) $/h	22.34
Insurance ((Ins • AVI)/h) $/h	7.45
Total ownership costs (OW) $/SMH	56.53
OPERATING COSTS	
Fuel consumption (F) L/h	25.0
Fuel (fc) $/L	0.40
Lube & oil as % of fuel (fp) %	15
Annual operating supplies (Oc) $	2500
Annual repair & maintenance (Rp) $	41 300
Fuel (F • fc) $/h	10.00
Lube & oil ((fp/100) • (F • fc)) $/h	1.50
Operating supplies (Oc/h) $/h	1.74
Repair & maintenance (Rp/h) $/h	28.68
Total operating costs (OP) $/SMH	41.92
TOTAL OWNERSHIP AND OPERATING COSTS (OW + OP) $/SMH	98.44

[a] These costs are estimated using FERIC's standard costing methodology for determining machine ownership and operating costs for new machines. The costs shown here do not include supervision, profit and overhead, and are not the actual costs for the contractor or the company studied.