Advantage
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Harvesting riparian zones using cable skidders equipped with Spectra® synthetic-fiber mainlines

Abstract

FERIC monitored two harvesting operations in riparian zones. Both used cable skidders for tree-length extraction under varying terrain and stand conditions. In both operations, replacing the heavy wire-rope mainline with a lightweight synthetic-fiber rope reduced haul-out weights, thereby letting operators extend their winching corridors deeper into the riparian zone and minimizing the need for machine travel in these zones.

Keywords:

Riparian zone, Cable skidders, Spectra synthetic-fiber rope, Skidder mainline, Productivity, Ground disturbance.

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Introduction

Riparian zones often have moist, nutrient-rich soils with low bearing capacity that may not support harvesting equipment, and moderate to steep slopes may also limit machine travel. In addition, harvesting opportunities in riparian zones are small in terms of block size and volume, and are often scattered over a large region, creating additional costs to transport equipment between sites.

Treating these areas effectively while minimizing ground disturbance can thus be challenging. Typically, the guidelines for harvesting in riparian zones involve the removal of only a percentage of the basal area (BA), but also specify not reducing BA below a fixed minimum. The actual percentage reduction and the minimum remaining BA vary based upon several factors. In the studies described in this report, the guidelines permitted removal of no more than 33% of the basal area, but in no instance could the residual BA fall below 18 m^2/ha. Machine travel was also not allowed within 15 m of the stream. Ground disturbance had to be minimized, and mineral-soil exposure prevented.

As an alternative to fully mechanized systems, some companies are developing a specialized motor-manual method using cable skidders to treat their riparian zones. In this approach, the skidders remain outside the riparian zone while workers with chainsaws fell and delimb the trees for skidding. Spectra synthetic-fiber ropes can replace conventional wire-rope mainlines on skidders (Golsse 1996), but the abrasion associated with accumulation of the sliders that connect chokers to the mainline during skidding often causes the rope to fail. To address this problem, FERIC developed a means of concentrating the abrasion on a short wire "leader" spliced onto the end of the rope. This streamlined connection lets the sliders move freely between the two sections

(Figure 1). The 18-mm-diameter synthetic-fiber ropes (50 m long) used in the present studies had been coated with polyurethane to improve their abrasion resistance.

Figure 1. The spliced connection between the Spectra rope and the wire leader.

Spectra's most remarkable feature is its low weight-to-strength ratio: Spectra rope is approximately 1/8th the weight of wire rope with similar dimensions and strength (Table 1). In an earlier field test comparing 16-mm wire rope and Spectra mainline, FERIC found that hauling out the Spectra rope required 16% less effort than with wire rope and the operator's estimated energy expenditure was 12% lower.

Operations observed

FERIC's first study was conducted in September 2002 at Weyerhaeuser Company Limited's Miramichi division on the eastern side of the Bay du Vin River, near Miramichi (New Brunswick). "Limited" skidder travel was permitted within the 100-m riparian zone. The zone comprised a spruce–birch stand on a relatively flat, well-drained plateau (CPPA classification 2.1.1) that dropped off abruptly (70% slope) for 20 to 30 m down to the river. This slope was not treated. In part of the study block, the forest cover changed to a mature poplar overstory with underlying

Table 1. The characteristics of Spectra and wire ropes

	Spectra	Wire rope
Description	HMWPE (high molecular weight polyethylene), 12-strand, braided, hollow core	6×19 IWRC/EIPS (independent wire rope core/extra improved plow steel)
Diameter (mm)	18	18
Weight (kg/m)	0.20	1.55
Average breaking strength (kg)	19 000	24 273

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spruce–balsam fir regeneration (CPPA classification 2.1.2).

The second study (November 2002) took place within the Reserve Faunique de Matane with Bowater Canadian Forest Products Inc.'s Price division in the Gaspé region of Quebec. The two 20-m riparian zones in the Bowater operation were located along permanent streams (1 to 2 m wide), and differed in stand density and tree size. In both cases, the stands adjacent to the riparian zones had been previously clearcut. The first zone (CPPA classification 2.2.3) was at the base of a steep (40%) slope that the harvester had been unable to harvest, and that was harvested using the skidder during the riparian zone treatment. The skidder, positioned at the top of the slope, extracted tree-length stems from the slope and the lower riparian zone at a distance of up to 45 m. In Zone 2 (CPPA classification 2.1.1), the cutover abutted the 20-m riparian zone on gently sloping ground and the skidder worked along the edge of the zone (Figure 2). Skidder travel within the zones was not permitted in either case.

Results

Post-treatment stand conditions

Table 2 presents the pre- and post-treatment stand conditions and ground disturbance for all operations. Mineral-soil exposure on the Weyerhaeuser site was less than 1%, and only 2% of residual trees had been damaged. In zones 1 and 2 of the Bowater operation, mineral-soil exposure was 4.6 and <1.5%, respectively. The higher mineral-soil exposure in Zone 1 was located in the upper reaches of the slope and arose when the tree-length stems

Table 2. Pre- and post-treatment stand conditions and ground disturbance[a]

	Weyerhaeuser		Bowater			
			Riparian zone 1		Riparian zone 2	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Density (stems/ha)	1345	732	933	777	2432	1611
Basal area (m^2/ha)	44.5	24.0	31.0	21.0	57.0	35.0
Merchantable volume (m^3/ha)	269	147	176	112	265	150
Average volume (m^3/stem)	0.20	0.20	0.19	0.14	0.11	0.09
Average diameter (cm)	20.5	20.4	20.6	18.5	17.3	16.6
Damage to residual trees (%)	2		<1		<1	
Ground disturbance (% of site)						
Exposed mineral soil	<1		4.6		<1.5	
Scuffing of litter or organic layers	9		6.4		16.5	
Slash coverage	36		54.0		46.0	
Undisturbed	54		35.0		36.0	

[a] Riparian zone only.

Figure 2. Skidder equipped with Spectra mainline positioned outside the riparian zone

crested the slope. Fewer than 1% of the residual trees were damaged. On both sites, the low level of exposed mineral soil and the distance from the stream suggest that there is minimal chance of sediment entering the streams, and leaf fall from the poplars on the Weyerhaeuser site would likely cover any exposed mineral soil. Wheel rutting was not detected within any of the riparian areas; however, rutting was present in some of the extraction trails leading away from the zone toward the landings. Much of this rutting had been created during the earlier harvesting of the adjacent stand.

Productivities and costs

Both operations used early-1980s Timberjack 200-series skidders equipped with $^{7}/_{16}$-in. wire-rope chokers and Spectra mainlines. In their normal operations, up to 12 chokers were typically used by each contractor, but during the trials, 6 to 8 chokers were sufficient. Productivity in the Weyerhaeuser operation ranged from 3.1 to 5.4 m^3/PMH, and cycle times averaged 28 and 19 min. in the spruce and birch and poplar areas, respectively. The slightly larger poplar stems required minimal effort to delimb compared with the spruce and birch stems, and thus the skidder operator spent

Table 3. Skidding productivities and harvesting costs (at a standard 150-m skidding distance)

	Weyerhaeuser		Bowater	
	Spruce–birch	Poplar	Riparian Zone 1	Riparian Zone 2
Skidder	Timberjack 230-D		Timberjack 240-E	
Study duration (PMH)	15.8	6.8	14.2	8.0
Estimated winching distance (m)	15–20	15–20	34	20
Average volume/turn (m^3)	1.4	1.7	1.9	1.5
Productivity (m^3/PMH)	3.1	5.4	3.0	2.7
Estimated harvesting cost ($/m^3)[a]	31	18	32	35

[a] The harvesting cost is based on an estimated direct operating cost of $95/PMH that excludes transport and supervision costs, profits, and other overhead, but includes the wages of the feller and skidder operator. Costs are based on the purchase price of a new skidder and thus may not reflect the actual costs given that 15- to 20-year-old skidders are more commonly used in such operations.

less time waiting for the feller to delimb the loads. If necessary, the skidder operator performed some delimbing of stems (if missed by the feller) once the load had been winched in and before leaving for the landing. In the Bowater operations, productivity was comparable in zones 1 and 2 (3.0 and 2.7 m^3/ PMH, respectively), with average cycle times of 37 and 32 min. The skidder operator also performed delimbing, if required, before skidding the load to the landing; moreover, once at the landing, he bucked and piled all stems into 2.7-, 3.0-, and 4.8-m lengths. Unchoking, decking and (in particular) bucking at the landing were the most significant work elements in both zones 1 and 2. At both Weyerhaeuser and Bowater, the time required to pull out the mainline, choke the load, and winch it in represented about 20% of the total cycle time on average, despite the long winching distances.

Both Spectra mainlines were used until the end of the operating season. The Weyerhaeuser crew continued to use the Spectra (primarily in clearcutting operations) for 35 days, until the eye splice of the wire-rope leader failed; the crew then knotted the Spectra rope and continued using it for 21 days until the end of the season. Based on operator estimates, daily production averaged 29.5 m^3 with an average of 11 turns per day. The Bowater crew, operating on sloping terrain, used the rope for 10 days until the metal fitting (the "stopper") at the end of the wire-rope leader failed; they then knotted the Spectra rope and continued working for another 17 days until a failure occurred along the rope. The shortened rope was used for the remaining 4 days of the season. This crew estimated daily production at 15 m^3 with an average of 11 turns per day.

Implementation

These studies demonstrate the viability of treating riparian zones with cable skidders: this approach produces wood at a reasonable cost, with acceptable levels of ground disturbance. Riparian zones with restricted machine access or with conditions too difficult for mechanized harvesting can often be treated motor-manually. However, winter operations would prove impractical in deep snow. Treatment of riparian zones should coincide with harvesting of the adjacent stand to reduce the amount of travel by machines (thus, ground disturbance) on the site and avoid the need to return to the site.

Spectra mainlines offer limited advantages in clearcutting because their lower weight is less important over shorter winching distances. However, they are well-suited to operations in riparian zones or other sensitive areas, where the long pull-outs permitted by their low weight let operators reach farther, thereby minimizing travel by the skidder. Although productivities with Spectra ropes were no higher than productivities observed in comparable operations using wire-rope mainlines, operators reported having more energy at the end of the day, found the rope easier to handle (more supple, does not kink), and appreciated the greater safety (no hand injuries from frayed metal ropes; low stretch, thus reducing the potential for violent backlash if the rope breaks). The Spectra rope also permitted long-distance winching that provided access to wood fiber that would not normally have been reachable with standard 30-m wire-rope mainlines. The value of the additional wood fiber must be taken into account when evaluating the economics of these operations.

Operators found the rope to be strong, durable, and easy to work with. However, one operator reported that the cable froze into the drum one night after a heavy rain and was difficult to unwind the following morning. The wire-rope leader eventually failed in both operations, and was replaced by knotting the end of the Spectra rope. This is not recommended, as it decreases the effective rope strength by up to 50%. Further development is currently underway to improve the reliability of the connection between the Spectra rope and the wire-rope leader. In addition, field testing of prototype 12-mm Spectra chokers will take place in 2003.

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