Advantage

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Contents

Stand and vegetation development five years after partial cutting in a coastal second-growth forest

Abstract

The Forest Engineering Research Institute of Canada (FERIC) re-visited a coastal second-growth stand that had been harvested in 1997. The stand had been partial cut with a low level of removal by "thinning from below" to meet visual quality objectives. The goals of FERIC's re-visit in 2003 were to report on the growth of the leave trees and to assess windthrow occurrence.

Keywords

Partial cutting, Windthrow, Second-growth forests, Coastal British Columbia.

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Introduction

In 1997, FERIC studied a partial cutting harvesting operation in a coastal second-growth stand, in co-operation with Canadian Forest Products Ltd. (Canfor), Harrison Mills Camp (Phillips 2001). This operation utilized a standing skyline configuration to harvest a second-growth stand by "thinning from below." The harvesting operation removed 46% of the trees, which represented 24% of the volume and 26% of the basal area. This low level of removal had minimal visual impact and met the "retention" visual quality objectives where activities are not visually evident (BCMOF and BC Environment 1995). Partial cutting with low levels of removal is generally more costly than clearcutting or clearcutting with reserves, and is therefore usually prescribed only where non-timber values are present, such as with this study site.

Canfor's long-term management objectives for this stand were to enhance wildlife habitat, and to improve the growth and quality of the remaining, fully-stocked stand. Therefore, FERIC re-visited the site in 2003 to assess the silvicultural implications of the treatment, and to determine the effects of the layout and treatment on windthrow.

Objectives

The objectives of FERIC's site re-visit were to:

- Determine what stand responses—tree growth, canopy closure, windthrow, and mortality—have taken place since the partial cut was completed in 1997.
- Determine if further monitoring with a 10-year re-measurement is justified.

Site, stand, and harvesting description

The study site was located near the community of Harrison Mills, in the Fraser Valley of southwestern British Columbia. It was within the Coastal Western Hemlock dry maritime subzone (CWHdm01). The pre-harvest stand consisted of 60–70-year-old western hemlock (site index (50) Hw = ±28), western red cedar, and Douglas-fir which had naturally regenerated following a 1925 clearcut harvest.[1] The 17.5-ha treatment block was motor-manually felled in 1996 and yarded in late 1997. The topography was convex in profile. It had an average slope of 45% and an average elevation of 315 m. The block was yarded with a swing yarder and carriage configured as a standing skyline configuration (Figure 1). Felled stems were yarded laterally into clear-felled 3.6-m-wide corridors for extraction. One or two intermediate support trees and a backspar were rigged on each corridor to gain partial to full suspension of the logs, which resulted in very little soil disturbance.[2]

The harvesting operation removed primarily smaller-diameter trees to achieve a 6–7-m inter-tree spacing while retaining as much Douglas-fir as possible. Canfor applied the "thinning from below" technique because it believed this would allocate stand growth to dominant trees, while recovering fibre from smaller stems that would likely be lost through mortality before final harvest. In addition, wildlife concerns, primarily northern spotted owl,[3] and maintenance of employment levels were also considerations in the harvest prescription.

Study methods

Measurements were made at 42 post-harvest plots established in the treatment

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1 The 1925 harvesting records do not indicate the harvesting or regeneration specifics but observations of the site indicate the site was not burned.

2 Only 4% of the site showed soil surface disturbance. The average depth of disturbance, soil gouge, and deposit combined was 12 cm.

3 Northern spotted owls are generally associated with old forest attributes. However, thinning does create conditions which may lead to useful habitat in the short term and/or in the long term (Buchanan et al. 1999; Hayes et al. 1997; Knickerbocker 1991; King et al. 1997; North et al. 1999).

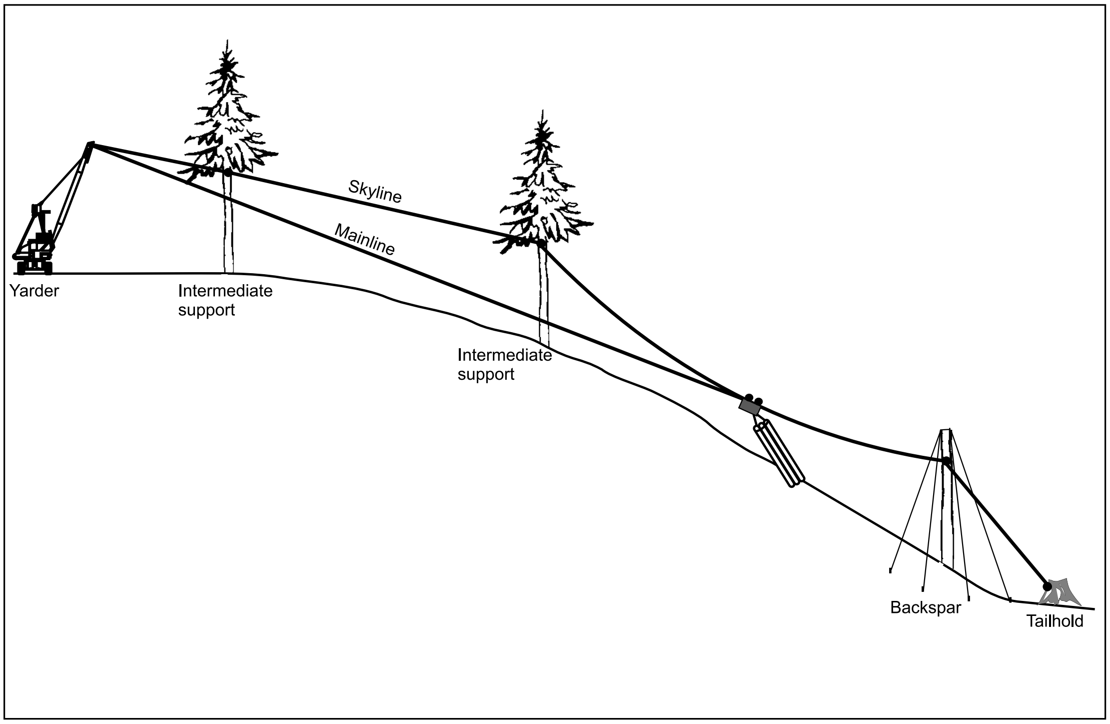

Figure 1. Yarding schematic layout.

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block and at ten plots established in an adjacent unharvested "control" area during 1998, the year following harvest.[4] Each plot had a fixed radius of 8.92 m and covered 250 m^2. The plots were located at points on a 60 × 60 m grid that covered both the harvested and unharvested areas. FERIC re-visited these plots and updated the stand information in the summer of 2003. Four plots in the treatment area were excluded from the analysis because they were too close to the road, on the edge of the treated area, or near a new clear-felled salvage block.[5] The diameter at breast height (dbh) of plot trees was re-measured, and any windthrow or mortality was noted. Vegetation plots were re-assessed and crown opening was re-measured with a spherical densiometer at each plot centre.[6] Increment cores were taken on two primarily dominant trees in each plot, and increments for the last 5 years and the last 5 to 10 years were measured.

Tree volumes were calculated with tree heights from the 1998 measurements and taper equations from Watts (1983). The 1998 post-harvest treatment stand measurements were then compared to the current measurements for both the treatment and control areas. The treatment and control areas were also compared to each other.

Results and discussion

Detailed information about the harvesting operation is provided in Phillips (2001). The characteristics of the stand, pre- and post-harvest, are summarized in Appendix I.

The results of the stand re-measurements are summarized in Table 1, and in Figures 2 and 3. The volume in the control block increased only 0.1%, although the basal area increased by 3.3% and the average diameter increased by 7.6% (Table 1). This was a result of the mortality of 8.6% of the >15 cm dbh trees in the control block—primarily smaller-diameter suppressed trees. If the 24 m^3/ha mortality volume was excluded, the net volume increase would have been 3.7%. In the treatment block, the volume increased by 8.6%, the diameter by 5.6% (Figure 2), and the basal area by 9.9%. Mortality was 1.3%. A paired t-test indicated that the

[4] An unequal number of plots were used because of the limitations of stand type and terrain.

[5] In an area adjacent to the study block, with a similar prescription but with lower levels of retention and in a moisture receiving location, windthrow two years after harvest damaged the retention to the extent the block was subsequently clearcut to salvage the timber.

[6] The model C spherical densiometer used in this study uses a gridded concave mirror to estimate the crown opening.

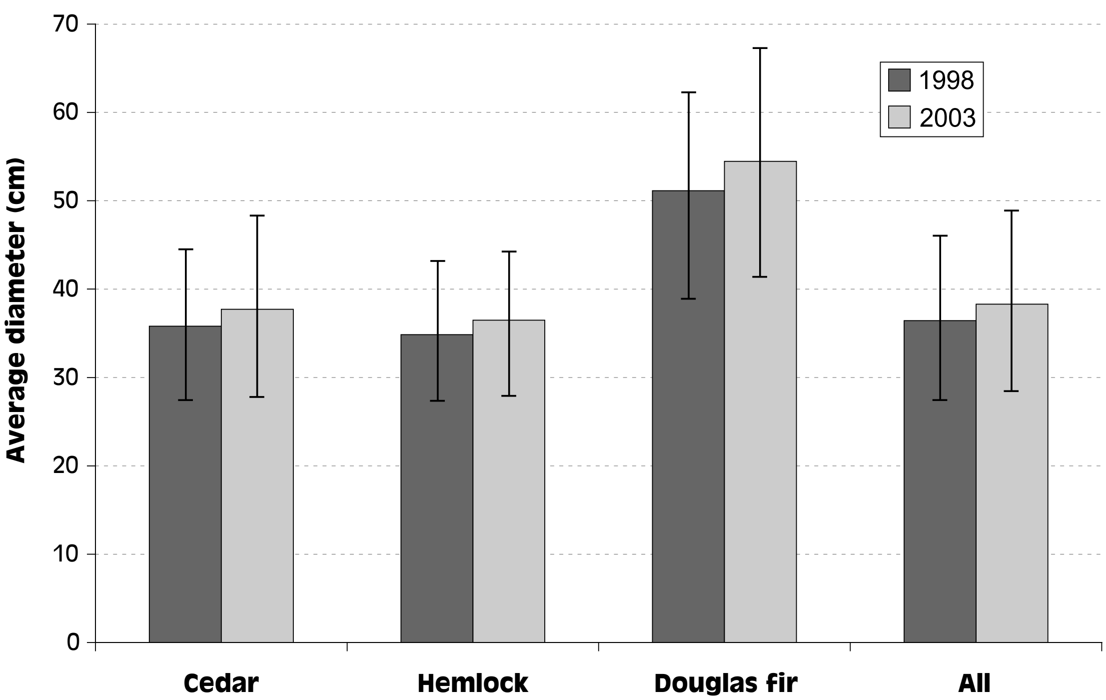


Figure 2. Average diameter by species for the treatment block. Error bars show ±1 standard deviation.

Figure 3. Average diameter by species for the control block. Error bars show ±1 standard deviation.

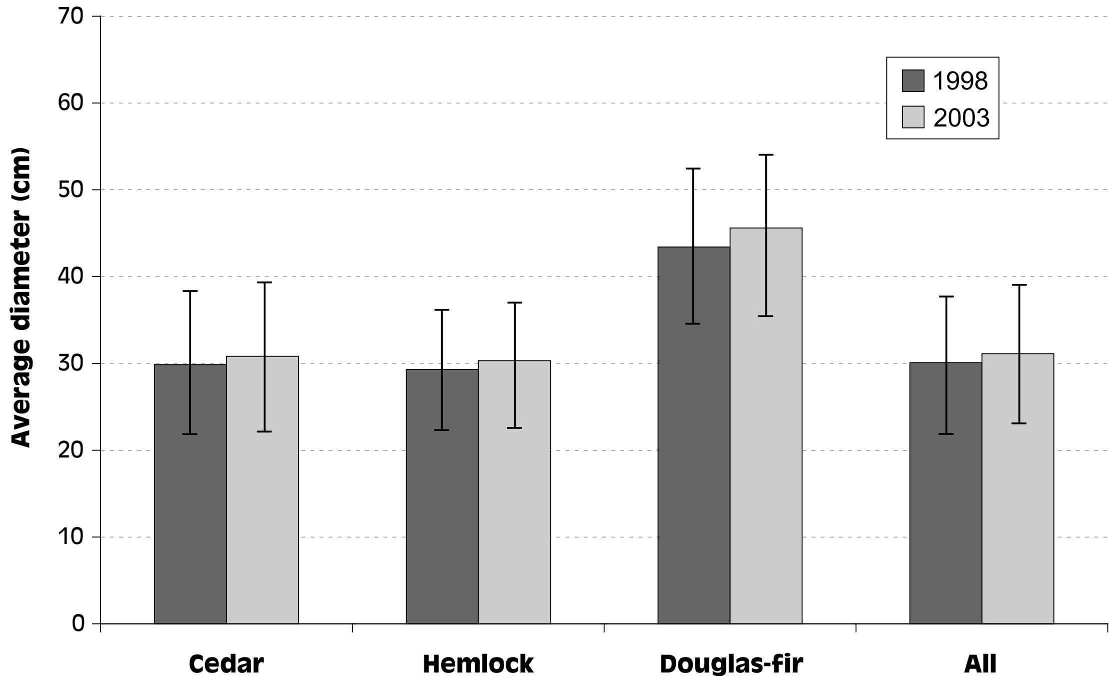


Table 1. Stand description

	Control 1998	Control 2003	Treatment 1998	Treatment 2003
Average basal area (m^2/ha)				
Western red cedar	23.1	22.7	15.0	16.6
Western hemlock	30.5	32.3	21.9	23.8
Douglas-fir	4.2	4.7	6.4	7.2
Total	57.8	59.7	43.3	47.6
Increase from 1998 (%)		3.3		9.9
Average diameter (cm)				
Western red cedar	25.3	27.7	34.5	36.5
Western hemlock	28.6	30.0	34.2	36.1
Douglas-fir	43.2	45.6	51.2	55.2
All	27.5	29.6	35.6	37.6
Increase from 1998 (%)		7.6		5.6
Average volume (m^3/ha)				
Western red cedar	247	243	168	183
Western hemlock	409	406	314	339
Douglas-fir	53	61	87	96
Total	709	710	569	618
Increase from 1998 (%)		0.1		8.6
Windfall				
% of stem/ha		0.0		0.2
volume (m^3/ha)		0		3
Tree mortality				
% stems/ha >15cm		8.6		1.3
Volume (m^3/ha)		24		2
Crown opening (%)	0.1	1.5	7.4	6.2

diameter growth in the treatment block was significantly larger than in the control block for all species.

The larger dominant trees were generally growing faster than the smaller intermediate and suppressed trees (Figures 4 and 5). Within the treatment plots, western red cedar had the most consistent diameter/growth-rate relationship with an $r^2 = .43$, while western hemlock had the lowest with an $r^2 = .06$. In the control plots, western red cedar had an $r^2 = .49$ and western hemlock had an $r^2 = .29$. The proximity to clear-felled corridors and other stand openings likely accounted for the greater variation in the treatment hemlock trees. The data from the increment cores (Figures 6 and 7) confirm that the dominant trees in the control plots grew at about the same rate in the five years before and after 1998, while the dominant trees in the treatment block experienced increased growth in the five years since harvest.

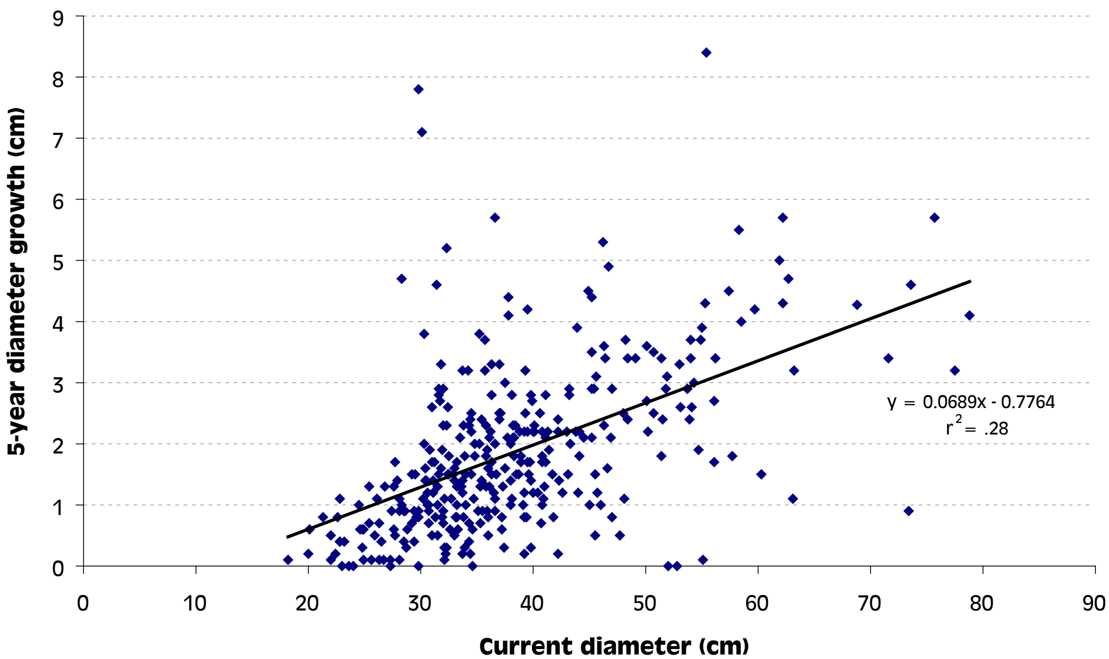


Figure 4. Growth regression for treatment plots (1998–2003).

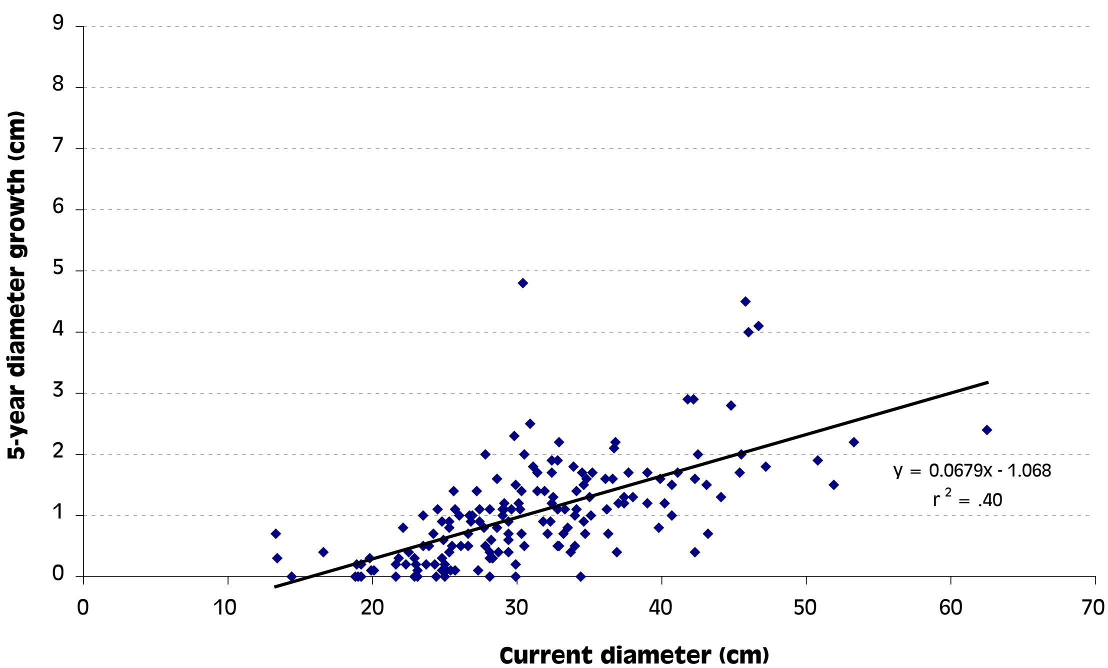


Figure 5. Growth regression for control plots (1998–2003).

Figure 6. Growth rate in treatment block, from cores.

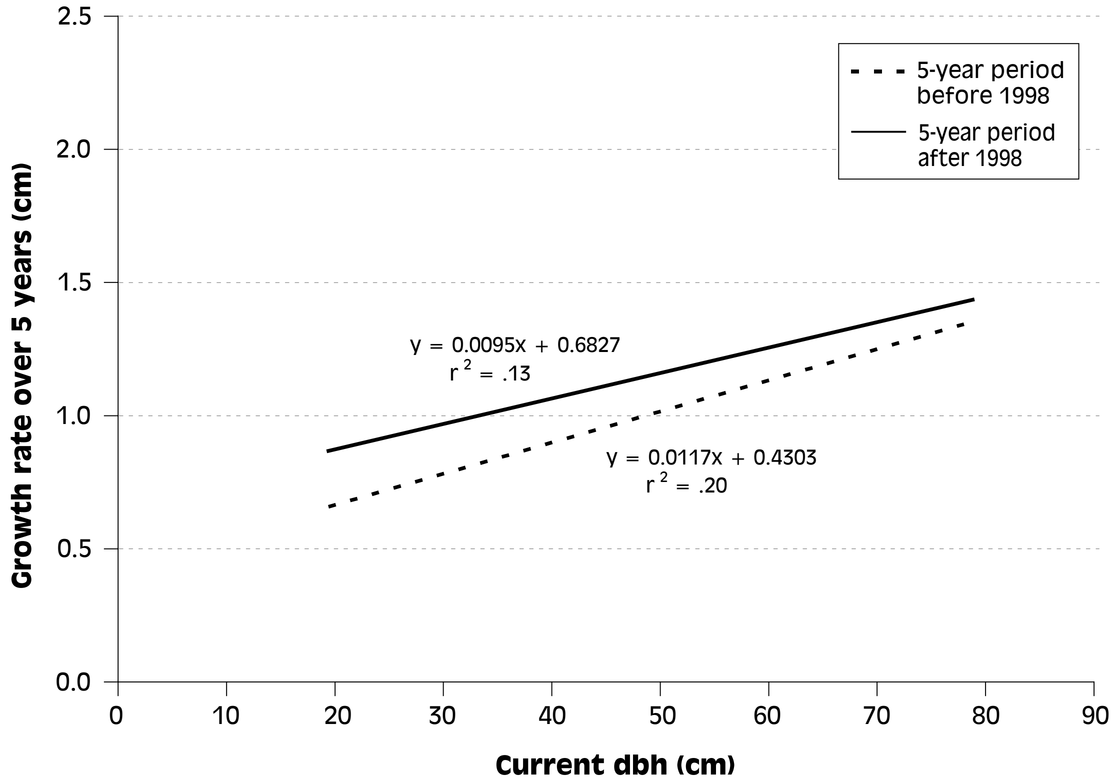
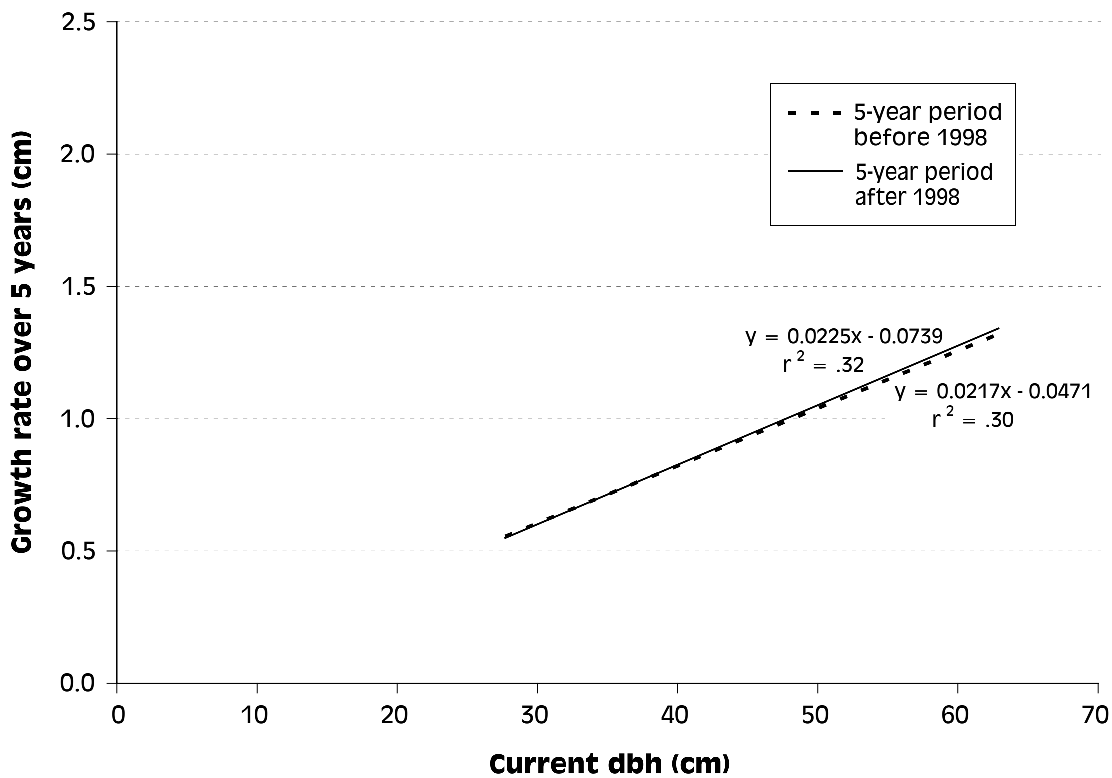


Figure 7. Growth rate in control block, from cores.



Tree damage from harvesting has started to heal, especially on dominant trees. Figure 8 shows a scar from an injury which was 3 cm by 15 cm and had the phloem exposed but not gouged.[7] Thirty-one percent of the leave trees sampled after harvest had at least one scar in this depth class.[8]

Very little windthrow has occurred overall, and it appears the stand has stabilized with no additional windthrow in the plots since the previous assessment in 2001 (Phillips 2001). In the treatment area, windthrow affected an average of 2.1 trees/ha, which is less than 1% of the trees.

Overall, the crown opening has decreased slightly in the treatment block, from 7.4 to 6.2%, during the 5-year period. However, the crown opening increased from 0.1 to 1.5% in the control block—probably because of the mortality in the stand around the plots. Vegetation coverage increased in all layers (moss, herb, and shrub) in the treatment block (Figures 9, 10, and Appendix II) but remained relatively unchanged in the control block (Figure 11). The increase of vegetation cover in the treatment block was pronounced, especially in the yarding corridors.

Conclusions

Five years is a short time frame in the rotation age of a coastal forest stand and the observations of this stand are site-specific. However, the stand response since harvesting indicates the treatment stand is growing at a faster rate than before thinning, has more understorey vegetation, and has had little windthrow. Also, the volume of the treatment stand is converging with that of the control stand, partly because of mortality in suppressed

Figure 8. Healing scar.

Figure 9. Post-harvest vegetation.

Figure 10. Vegetation at 5 year re-measurement.

Figure 11. Control block vegetation at re-measurement.

7 This damage is classified as “Class B” by the Canadian Forest Service, Pacific Forestry Centre damage classification system (Mitchell 1994). Stem damage classes in this system range from surface bruised (“Class A”) to wood gouged $\geq$1 cm deep (“Class D”).

8 The average scar area was 92 cm^2 and there was, on average, 2.3 scars per tree.

trees in the control. Even if the mortality was excluded from the control block calculations, a comparison of the stand volumes would still show them to be converging. At least one more follow-up measurement at 10 or 15 years from harvest would determine if this trend continues, especially when crown closure occurs.

Overall, the harvesting was successful at meeting the company objectives of creating employment while removing stems that would otherwise be lost to mortality. This low level of removal has also, to date, prevented the much more severe windthrow observed in an adjacent stand with heavier removal.

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Appendix I

Stand characteristics (from Phillips (2001))

	Treatment		
	Pre-harvest	Post-harvest	Removal
Average basal area (m^2/ha)	59.8	44.4	15.4
Average dbh (cm)	30	36	20
Average volume (m^3/ha)	765	583	182
Western hemlock (%)	57	55	63
Western red cedar (%)	29	29	31
Douglas-fir (%)	13	15	6
Average density (trees/ha)	754	406	348
Western hemlock (%)	54	56	53
Western red cedar (%)	41	37	45
Douglas-fir (%)	5	7	2
Average density (trees/ha)			
<15 cm dbh alive and dead	-	0	448
<15 cm dead	-	0	328
15–20 cm dead	-	2	32
Crown opening (%)	0.1	7.4	-

Appendix II

Vegetation summary by layer

Moss layer:

	Percent of area occupied by all species (%)
Control at harvest	64.0
Control at year 5	68.5
Treatment at harvest	73.1
Treatment at year 5	92.3

Herb layer:

	Percent of area occupied							
						New species		
	Sword fern (%)	Wood fern (%)	Deer fern (%)	Strawberry (%)	Violet (%)	Bracken fern (%)	Alumroot (%)	Lady fern (%)
Control at harvest	0.5							
Control at year 5	1.7					0.5		
Treatment at harvest	7.4	2.4	<0.1	0.1	<0.1			
Treatment at year 5	15.1	7.8	7.9	<0.1	0.1	0.7	1.8	0.2

Shrub layer:

	Percent of area occupied						
	Salal (%)	Huckleberry (%)	Oregon grape (%)	Thimbleberry (%)	Blackberry (%)	Devil's club (%)	Elderberry (%)
Control at harvest	0.4	<0.1	0.7				
Control at year 5	0.7	0.2	0.4				
Treatment at harvest	1.0	0.3	0.2	0.1	<0.1	<0.1	<0.1
Treatment at year 5	1.5	1.9	0.3	7.9	2	0.8	2