CANADIAN FOREST SERVICE
PACIFIC FORESTRY CENTRE
MISCELLANEOUS REPORT

Levels-of-Growing-Stock (LOGS) Co-operative Study in Douglas-fir

LOGS is part of the national Forest Ecosystem Research Network of Sites (FERNS) which is organized by the Canadian Forest Service.

LOGS is a Research & Operations Partnership coordinated by the Pacific Northwest Research Station of the US Forest Service at Portland, Oregon. The Co-operative members are:
US Forest Service
Weyerhaeuser Company
Washington State Dept. Natural Resources
Oregon State University
Canadian Forest Service in partnership with the BC Ministry of Forests (BCMOF)

The Canadian Wood Fibre Centre brings together forest sector researchers to develop solutions for the Canadian forest sector's wood fibre related industries in an environmentally responsible manner. Its mission is to create innovative knowledge to expand the economic opportunities for the forest sector to benefit from Canadian wood fibre. The Canadian Wood Fibre Centre operates within the CFS, but under the umbrellas of FPInnovations' Board of Directors.

FPInnovations is the world's largest private, not-for-profit forest research institute. With over 600 employees spread across Canada, FPInnovations unites the individual strengths of each of these internationally recognized forest research and development institutes into a single, greater force. For more information visits **http://www.FPInnovations.ca**

Additional information on Natural Resources Canada, the Canadian Forest Service, and Canadian Wood Fibre Centre research and publications is also available online at: **cfs.nrcan.gc.ca/subsite/cwfc**. To download or order additional copies of this publication, see our online bookstore at: **http://cfs.nrcan.gc.ca/publications**

Levels-of-Growing-Stock (LOGS) Co-operative Study in Douglas-fir

By members of the LOGS partnership

Natural Resources Canada
Canadian Forest Service
Canadian Wood Fibre Centre
Miscellaneous Report

2012

Natural Resources Canada
Canadian Forest Service
Canadian Wood Fibre Centre
506 West Burnside Road
Victoria, British Columbia
V8Z 1M5
Tel.: 250-363-0600

http://cfs.nrcan.gc.ca/centres/read/cwfc

Cover photo: CFS

Library and Archives Canada Cataloguing in Publication

Levels-of-Growing-Stock (LOGS) co-operative study in Douglas-fir [electronic resource] / by members of the LOGS partnership.

(Miscellaneous report)
Type of computer file: Electronic monograph in PDF format.
Includes abstract in French.
ISBN 978-1-100-20613-4
Cat. no.: Fo149-7/2012E-PDF

1. Douglas fir--Thinning--British Columbia--Campbell River Region. 2. Douglas fir--Thinning--British Columbia--Shawnigan Lake Region. 3. Douglas fir--British Columbia--Campbell River Region--Growth. 4. Douglas fir--British Columbia--Shawnigan Lake Region--Growth. 5. Douglas fir--Yields--British Columbia--Campbell River Region. 6. Douglas fir--Yields--British Columbia --Shawnigan Lake Region. I. Canadian Wood Fibre Centre II. Series: Miscellaneous report (Canadian Wood Fibre Centre)

SD397 D7 L48 2012 634.9'75453097112 C2012-980097-X

Contents

List of Tables

List of Figures

Preface

The contents of this document have been compiled from material gathered from the 1970s to the 1990s, and entered on the LOGS website, which was created and maintained by the Canadian Forest Service. In September 2011, due to increased web accessibility requirements, NRCan conducted a stringent review of its web content to accommodate a 50% reduction of its overall web presence. As a result, many CFS subsites, including those for LOGS, have been archived or adapted for delivery in alternative formats.

The Levels-of-Growing-Stock (LOGS) Co-operative study is the result of collaboration between scientists and researchers from the Canadian Forest Service, the US Forest Service, the Weyerhaeuser Company, Washington State Department of Natural Resources, Oregon State University, and the Canadian Forest Service in partnership with the BC Ministry of Forests, Lands and Natural Resource Operations. The study spans an 800 km latitudinal gradient and 40 years' of data collection. LOGS data have been used in numerous publications, such as reports and scientific articles, to test and refine research theory and practice in growth and yield, silviculture, ecophysiology, and forest ecology. As of 2012, scientists from both sides of the border are researching wood quality and fibre properties using five LOGS locations. The LOGS Co-operative is one of many projects made possible through the establishment and maintenance of long-term research installations.

Préface

Le contenu du présent document est tiré d'ouvrages publiés entre les années 1970 et 1990 et ajoutés au site Web de l'Étude conjointe de la densité de matériel sur pied dans les peuplements de Douglas verts (étude LOGS), site qui a été créé et mis à jour par le Service canadien des forêts (SCF). En septembre 2011, les exigences accrues relativement à l'accessibilité du Web ont poussé Ressources naturelles Canada (RNCan) à mener un examen rigoureux de son contenu Web afin de réduire de 50 % sa présence globale sur le Web. Résultat : bon nombre de sites secondaires du SCF, y compris ceux qui sont associés à l'étude LOGS, ont été archivés ou adaptés pour qu'ils puissent être fournis dans d'autres formats.

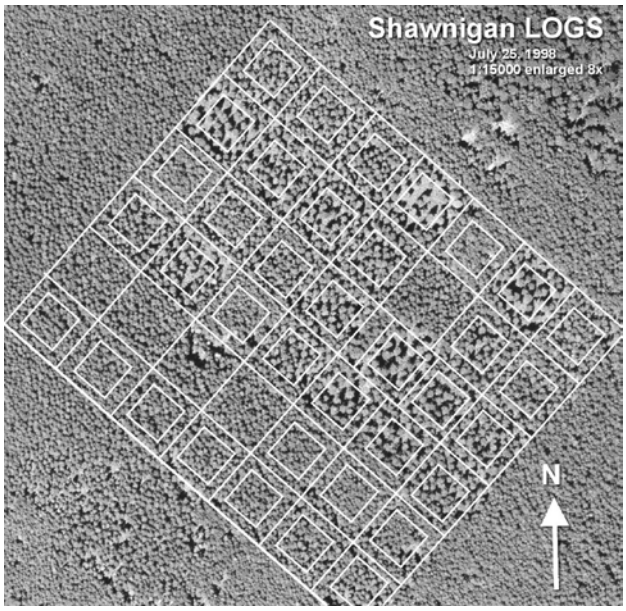
L'étude LOGS est menée conjointement par les chercheurs et scientifiques du du Service canadien des forêts, du Forest Service des États-Unis, de Weyerhaeuser, du ministère des Ressources naturelles de l'État de Washington et de l'Université Oregon State, en collaboration avec le ministère des Forêts, des Terres et de l'Exploitation des ressources naturelles de la Colombie-Britannique. Elle couvre un gradient latitudinal de 800 km et comprend des données recueillies sur plus de 40 ans. Ces données ont été utilisées dans de nombreuses publications, comme des rapports et des articles scientifiques, afin de mettre à l'essai et préciser théorie et pratique dans les domaines de la croissance et du rendement, de la sylviculture, de l'écophysiologie et de l'écologie forestière. Aujourd'hui, en 2012, des chercheurs de part et d'autre de la frontière mènent des études sur la qualité du bois et les propriétés des fibres en utilisant cinq sites de l'étude LOGS. L'étude conjointe LOGS est l'un des nombreux projets rendus possibles grâce à l'établissement et au maintien en place d'installations de recherche à long terme.

1. Introduction

Thinning is an important silviculture tool for controlling and modifying tree and stand development. Objectives may include increasing tree volume, tree size, and wood quality, and developing stand structures and characteristics for other values such as wildlife, biodiversity, and visual aesthetics.

The Levels-of-Growing-Stock (LOGS) Co-operative Study in Douglas-fir, with research installations extending from southern Oregon to Vancouver Island in British Columbia, was initiated in the early 1960s. The study was designed to provide information on the relationship between thinning and tree and stand growth in managed stands of young Douglas-fir in order to increase timber production.

The co-operative continues to provide this information, but the long-term research is also providing valuable information on the potential flexibility in managing Douglas-fir and on designing regimes to meet a wider range of stand management objectives.



The impetus for the formation of the co-operative was the realization that, with the harvesting of the old-growth Douglas-fir stands in the Pacific Northwest region, more and more of the timber supply would be coming from managed second-growth stands. A common belief was that commercial thinning of second-growth stands could provide timber supplies while enhancing future stand productivity. At that time, there was very little information or experience in thinning Douglas-fir, and reliable yield estimates from thinned stands were needed.

A method was developed for calculating thinning schedules and managed-stand yields based on estimated gross yield of natural stands and estimated diameter growth rates. This methodology was based on two assumptions: one, gross volume yield and periodic gross increment of a fully stocked unmanaged stand at any age represented full capacity of the site to produce wood at any age; two, an approximately full increment could be produced with widely differing combinations of growing stock, tree size, and radial increment.

The Levels-of-Growing-Stock (LOGS) Co-operative Study in Douglas-fir was formed in 1962 to test these assumptions and to examine the tree and stand dynamics of managed Douglas-fir stands under a number of different thinning treatments.

A comprehensive work plan was developed in 1962 to ensure standardized procedures among co-operators, thus acquiring the benefits of shared costs and data. Between 1962 and 1970, nine installations were established in Oregon, Washington, and British Columbia, covering the site productivity range of the region. Each agency is responsible for establishing and maintaining their installations, and the data is shared in a common data bank available to all co-operators.

2. Study Objectives

Study objectives were to determine how the amount of growing stock retained in repeatedly thinned stands of Douglas-fir affects:

- cumulative volume production
- tree size development
- growth/growing stock ratios

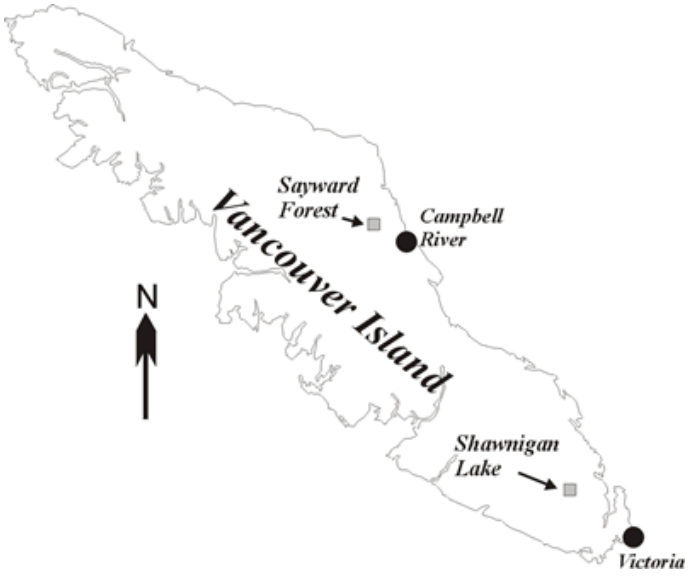
Each installation followed the common work plan:

- 8 thinning regimes plus control, replicated 3 times = 27 plots (0.08 ha), each with a 10.1 m treated buffer surround (0.16 ha)
- treatment regimes differ in the amount of basal area allowed to accumulate in the growing stock (the amount of growth retained is a predetermined percentage of the gross basal area increase of the unthinned control plots)
- treatment plots are calibration thinned at establishment to a common stocking density
- treatment interval is dictated by local site productivity (stand height increment of 3.05 m)

3. Canadian Forest Service (CFS) Study

The Canadian Forest Service, in partnership with the British Columbia Ministry of Forests, Lands, and Natural Resource Operations, has two of the nine LOGS installations: Sayward Forest, established in 1969, and Shawnigan Lake, established in 1970.

Each installation consists of twenty-seven 0.08-ha square plots testing three replicates of eight thinning treatments and a control. Each plot has a buffer surround of 0.16 ha, which is thinned to the same level as the plot. After the treated plots were given a calibration thinning to a common stocking density, growth was controlled using a percentage of the gross basal increment of the unthinned control plots. The treatments were applied over five subsequent periods. Each period interval was defined as the time the stand required to grow 3.05 m in height.



3.1 Sayward Forest LOGS Installation

Site Characteristics

- established in the fall of 1969 in a 22-year-old Douglas-fir plantation
- initial stand density of 2471 stems/ha
- calibration density of 877 stems/ha
- site index 33.8 m at breast height age 50

Treatment thinnings were applied in:

- 1969 – stand age 22 (calibration)
- 1973 – stand age 26
- 1977 – stand age 30
- 1981 – stand age 34
- 1987 – stand age 40
- 1993 – stand age 46

Two additional treatments were created in 1969: a **"**dense 50**"** treatment of 1223 stems/ha at calibration, thinned to 1070 stems/ha in 1973; and a **"**dense 10**"** treatment of 1223 stems/ha at calibration, thinned to 786 stems/ha in 1973.

The installation was remeasured after the 2007 growing season; it received its fifth and final treatment thinning in 1993 and was measured in 1999 (stand age 52). Tables reflect 1999 data.

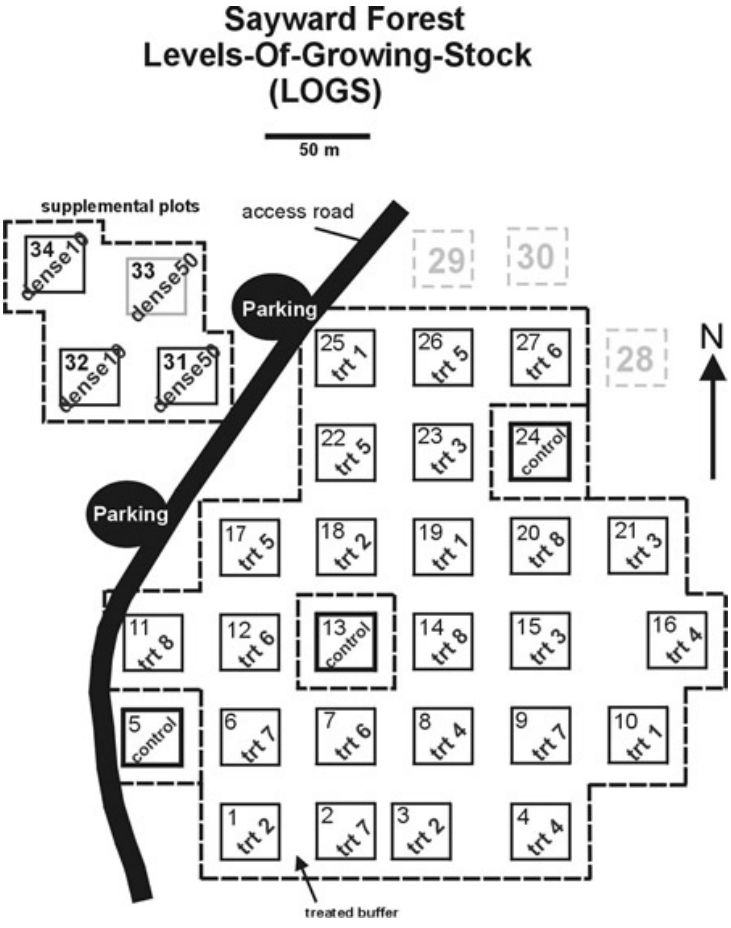


Table 1. Sayward Forest LOGS Installation.

Treatment	Stocking Density (stems/ha)	Average Diameter (cm)	Basal Area (m^2/ha)	Total Tree Volume (m^3/ha)
1	166	39.4	20.1	231.7
2	255	37.8	28.7	333.1
3	284	35.8	28.7	328.0
4	465	32.3	38.0	428.1
5	437	32.5	38.2	444.0
6	292	35.6	29.0	343.8
7	586	31.5	45.4	527.8
8	502	31.0	37.6	425.9
control	1796	20.6	59.6	650.0
dense10	736	27.2	42.6	463.9
dense50	1001	23.4	46.4	499.1

3.1.1 Sayward Treatment Area 1

The ground photograph illustrates the final stocking of a Treatment 1 plot with 166 stems/ha, with an average tree size of 39.4 cm diameter-at-breast-height (dbh), a basal area of 20.1 m^2/ha, and a total tree volume of 231.7 m^3/ha.

Figure 1 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

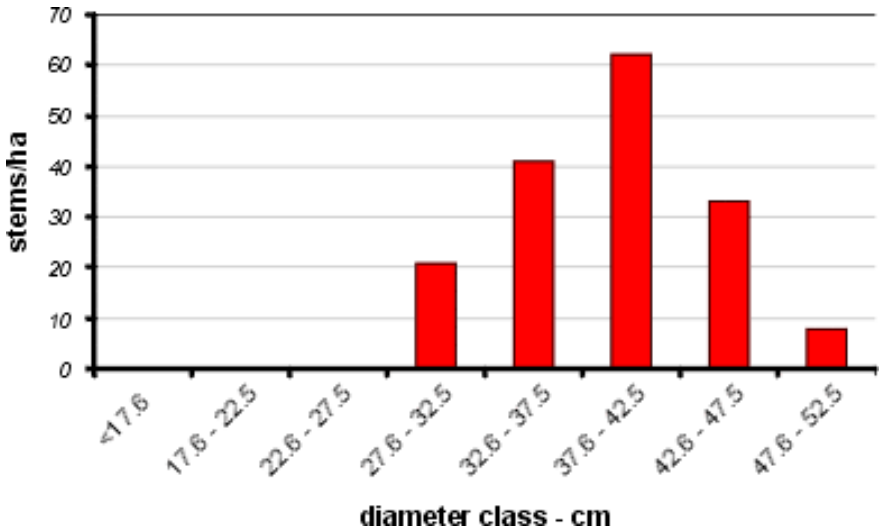


Figure 1. Stocking density by diameter class at Treatment Area 1 of the Sayward site.

3.1.2 Sayward Treatment Area 2

The ground photograph illustrates the final stocking of a Treatment 2 plot with 255 stems/ha, with an average tree size of 37.8 cm diameter-at-breast-height (dbh), a basal area of 28.7 m^2/ha, and a total tree volume of 333.1 m^3/ha.

Figure 2 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

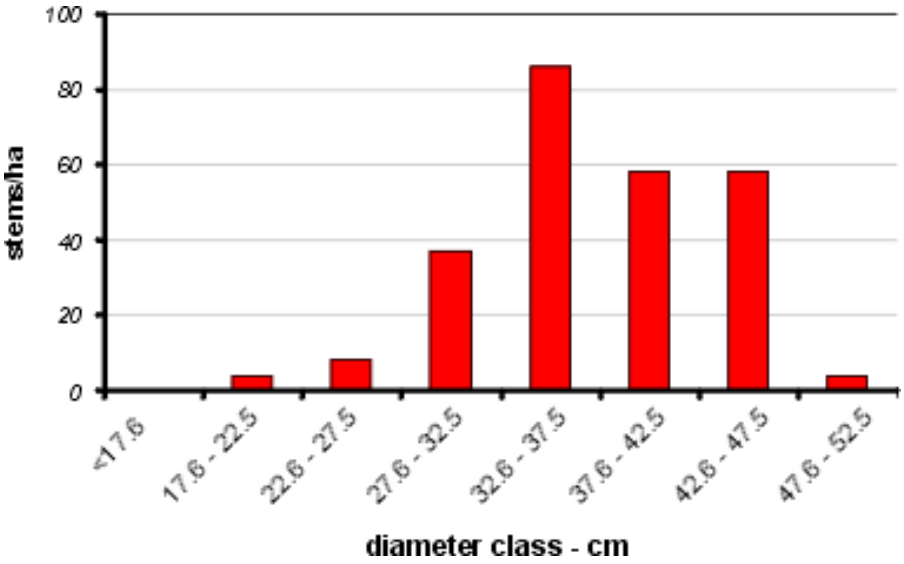


Figure 2. Stocking density by diameter class at Treatment Area 2 of the Sayward site.

3.1.3 Sayward Treatment Area 3

The ground photograph illustrates the final stocking of a Treatment 3 plot with 284 stems/ha, with an average tree size of 35.8 cm diameter-at-breast-height (dbh), a basal area of 28.7 m^2/ha, and a total tree volume of 328.0 m^3/ha.

Figure 3 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

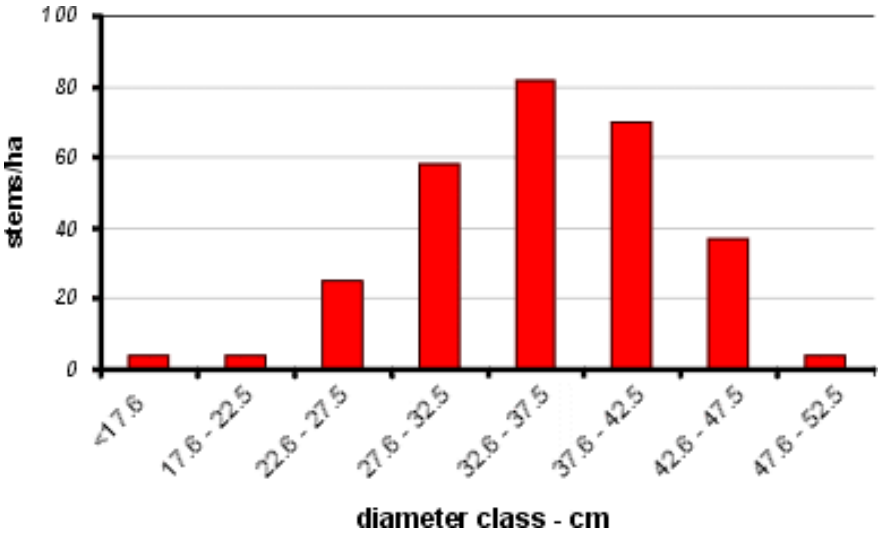


Figure 3. Stocking density by diameter class at Treatment Area 3 of the Sayward site.

3.1.4 Sayward Treatment Area 4

The ground photograph illustrates the final stocking of a Treatment 4 plot with 465 stems/ha, with an average tree size of 32.3 cm diameter-at-breast-height (dbh), a basal area of 38.0 m^2/ha, and a total tree volume of 428.1 m^3/ha.

Figure 4 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

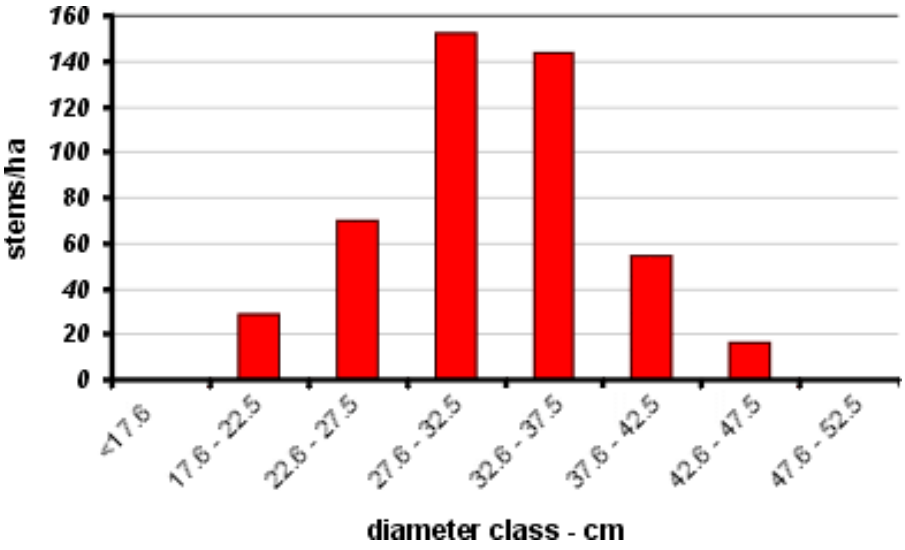


Figure 4. Stocking density by diameter class at Treatment Area 4 of the Sayward site.

3.1.5 Sayward Treatment Area 5

The ground photograph illustrates the final stocking of a Treatment 5 plot with 437 stems/ha, with an average tree size of 32.5 cm diameter-at-breast-height (dbh), a basal area of 38.2 m^2/ha, and a total tree volume of 444.0 m^3/ha.

Figure 5 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

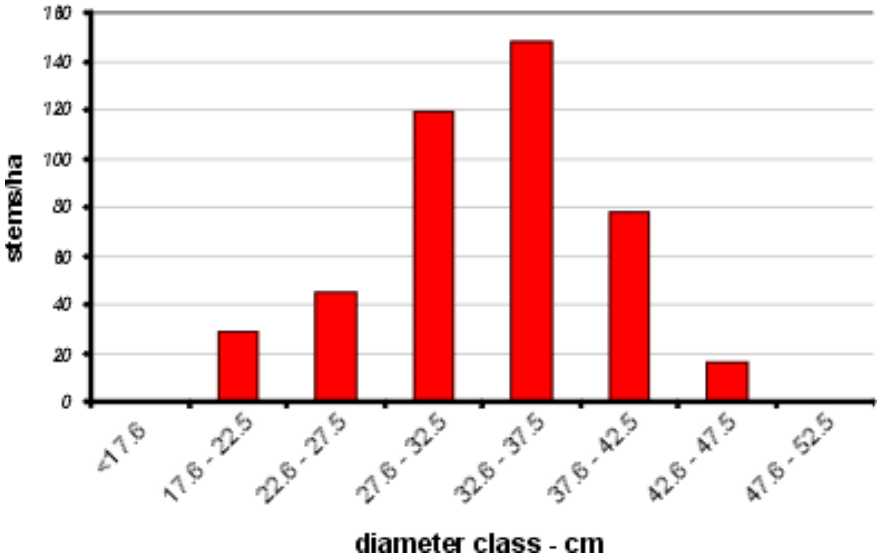


Figure 5. Stocking density by diameter class for Treatment Area 5 of the Sayward site.

3.1.6 Sayward Treatment Area 6

The ground photograph illustrates the final stocking of a Treatment 6 plot with 292 stems/ha, with an average tree size of 35.6 cm diameter-at-breast-height (dbh), a basal area of 29.0 m^2/ha, and a total tree volume of 343.8 m^3/ha.

Figure 6 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

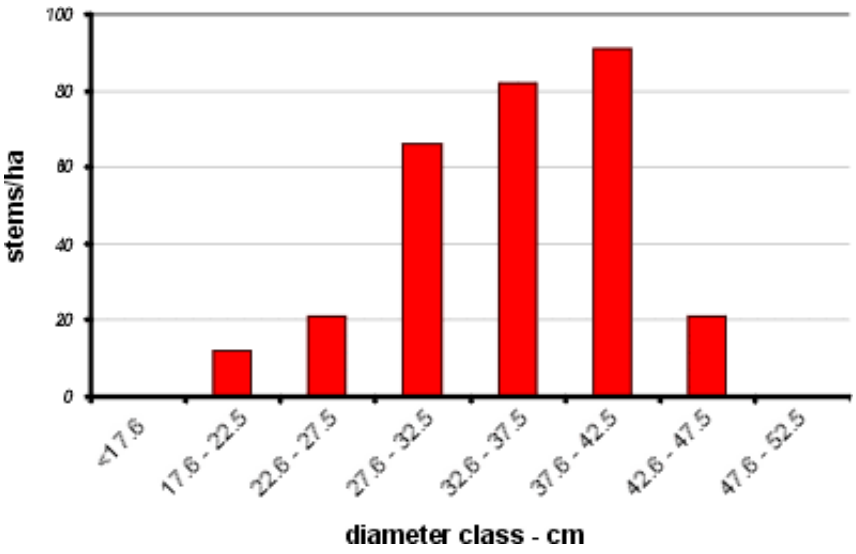


Figure 6. Stocking density by diameter class for Treatment Area 6 of the Sayward site.

3.1.7 Sayward Treatment Area 7

The ground photograph illustrates the final stocking of a Treatment 7 plot with 586 stems/ha, with an average tree size of 31.5 cm diameter-at-breast-height (dbh), a basal area of 45.4 m^2/ha, and a total tree volume of 527.8 m^3/ha.

Figure 7 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

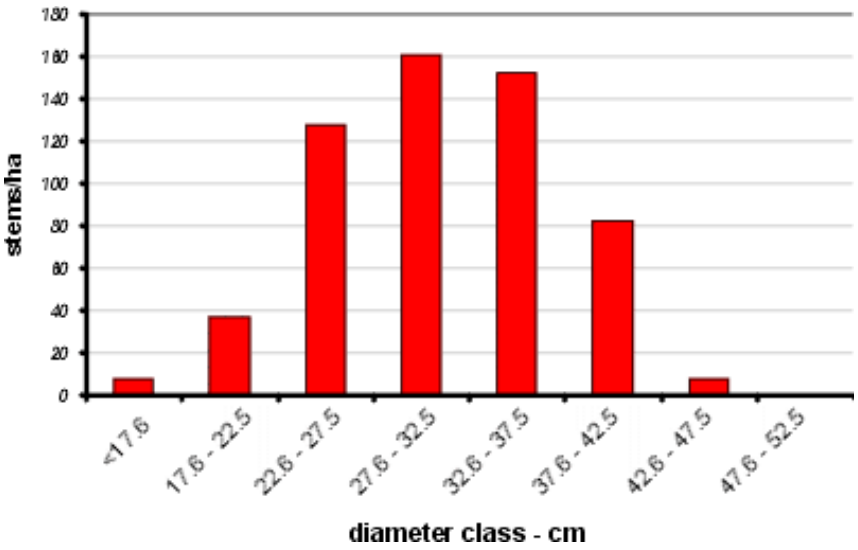


Figure 7. Stocking density by diameter class for Treatment Area 7 of the Sayward site.

3.1.8 Sayward Treatment Area 8

The ground photograph illustrates the final stocking of a Treatment 8 plot with 502 stems/ha, with an average tree size of 31.0 cm diameter-at-breast-height (dbh), a basal area of 37.6 m^2/ha, and a total tree volume of 425.9 m^3/ha.

Figure 8 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

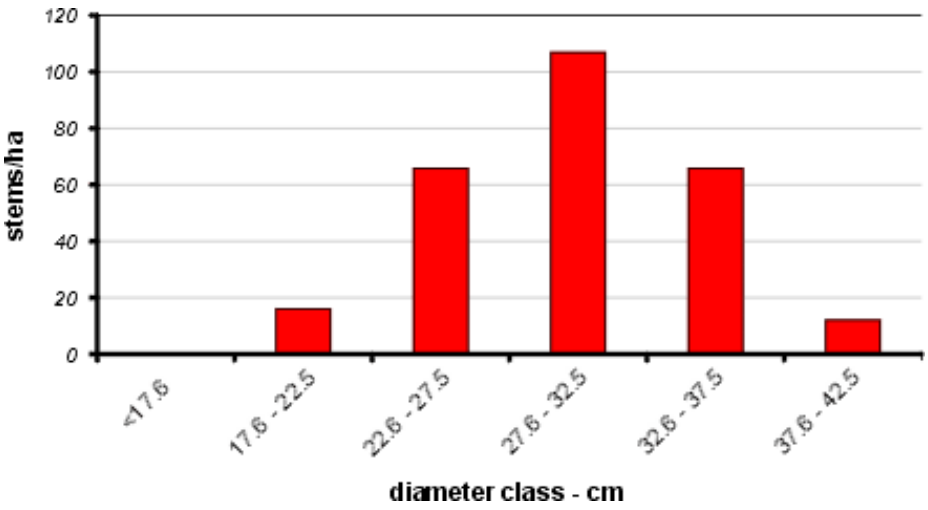


Figure 8. Stocking density by diameter class for Treatment Area 8 of the Sayward site.

3.1.9 Sayward Treatment Control Area

The ground photograph illustrates the stocking of a Control plot with 1796 stems/ha, with an average tree size of 20.6 cm diameter-at-breast-height (dbh), a basal area of 59.6 m^2/ha, and a total tree volume of 650.0 m^3/ha.

Figure 9 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

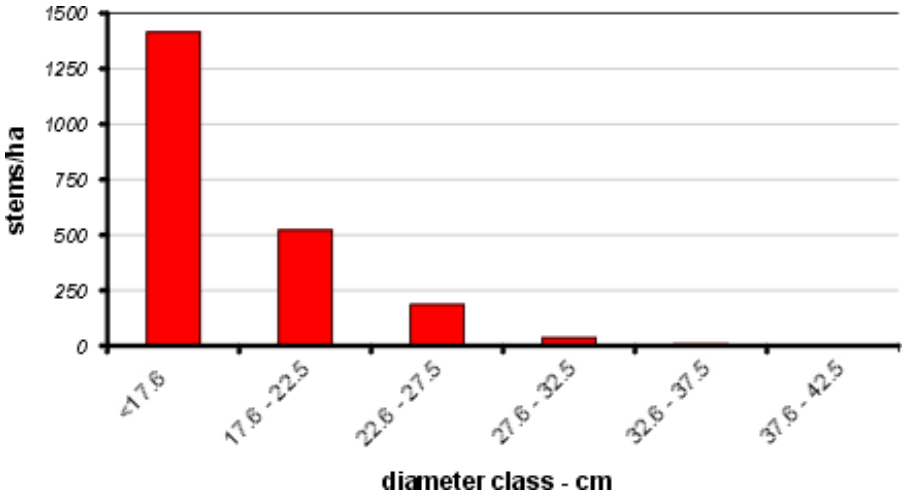


Figure 9. Stocking density by diameter class of Control Area, Sayward site.

3.1.10 Sayward Treatment Area D10

The ground photograph illustrates the final stocking of a Treatment D10 plot with 1001 stems/ha, with an average tree size of 27.2 cm diameter-at-breast-height (dbh), a basal area of 42.6 m^2/ha, and a total tree volume of 463.9 m^3/ha.

Figure 10 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

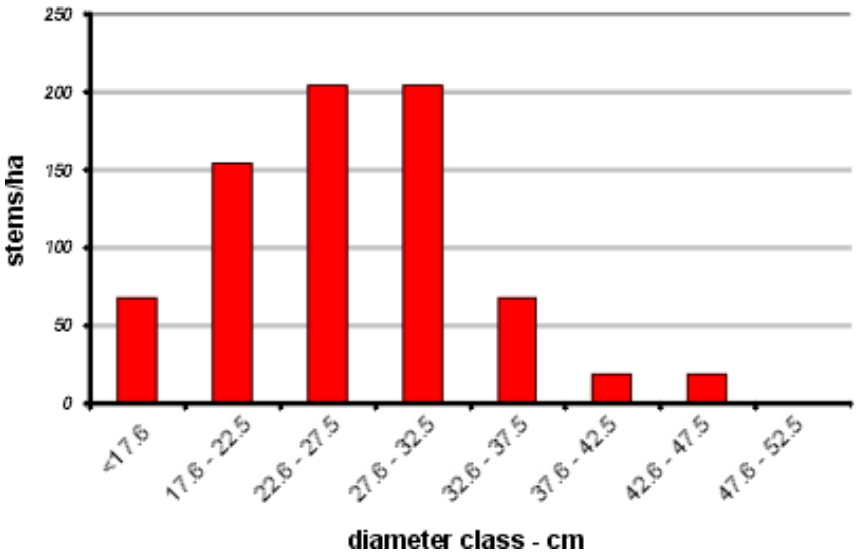


Figure 10. Stocking density by diameter class for Treatment Area D10 of the Sayward site.

3.1.11 Sayward Treatment Area D50

The ground photograph illustrates the final stocking of a Treatment D50 plot with 736 stems/ha, with an average tree size of 23.4 cm diameter-at-breast-height (dbh), a basal area of 46.4 m^2/ha, and a total tree volume of 499.1 m^3/ha.

Figure 11 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

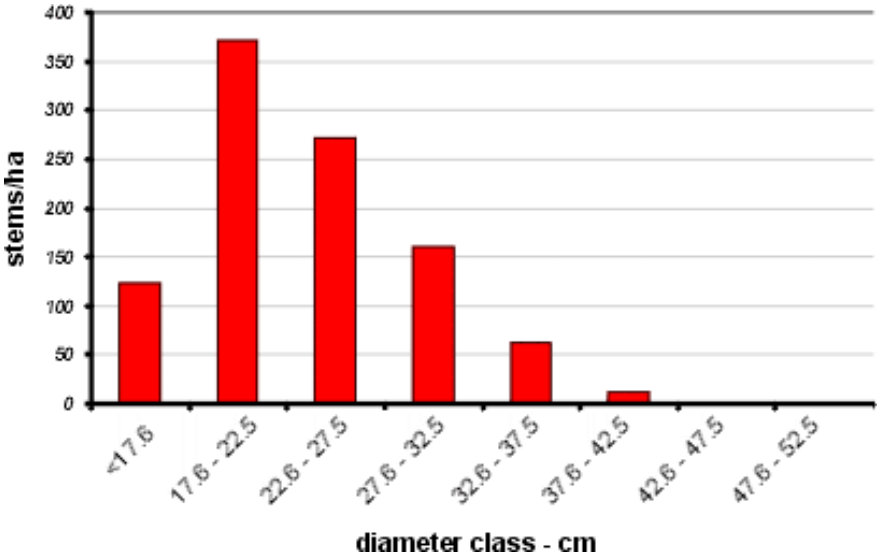


Figure 11. Stocking density by diameter class for Treatment Area D50 of the Sayward site.

3.2 Shawnigan Lake LOGS Installation

Site Characteristics

- established in the winter of 1970–71 in a 25-year-old Douglas-fir plantation
- initial density of approximately 2965 stems/ha
- calibration density of 927 stems/ha
- site index 28.7 m at breast height, age 50

Treatment thinnings were applied:

- 1970 – stand age 25 (calibration)
- 1976 – stand age 31
- 1982 – stand age 37
- 1989 – stand age 44
- 1996 – stand age 51

Two additional treatments were created in 1970: an "open" treatment (704 stems/ha), and a "dense" treatment (1322 stems/ha). No other thinning has occurred in these treatments.
The final thinning was done after the 2007 growing season (stand age 62). Tables reflect 1996 data.

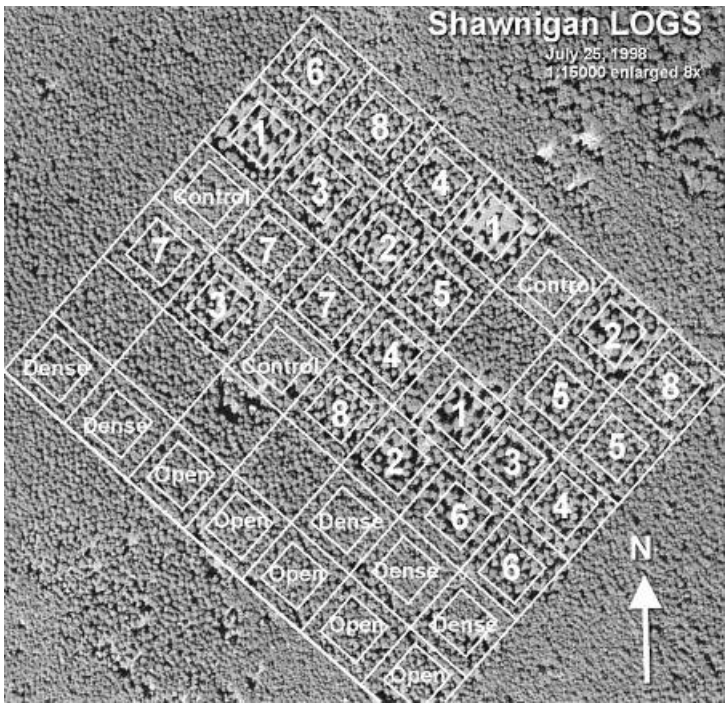


Table 2. Shawnigan Lake LOGS Installation.

Treatment	Stocking Density (stems/ha)	Average Diameter (cm)	Basal Area (m^2/ha)	Total Tree Volume (m^3/ha)
1	177	29.6	12.2	109.5
2	218	30.6	16.0	148.1
3	301	27.0	17.2	161.1
4	416	25.7	21.6	196.6
5	461	25.8	24.1	221.5
6	362	26.6	20.2	190.2
7	708	23.1	29.7	262.3
8	593	23.4	25.3	218.7
control	2162	17.0	49.3	389.4
dense	1295	21.6	45.8	433.9
open	694	25.7	35.8	319.8

3.2.1 Shawnigan Treatment Area 1

The ground photograph illustrates the present stocking of a Treatment 1 plot with 177 stems/ha, with an average tree size of 29.6 cm diameter-at-breast-height (dbh), a basal area of 12.2 m^2/ha, and a total tree volume of 109.5 m^3/ha.

Figure 12 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

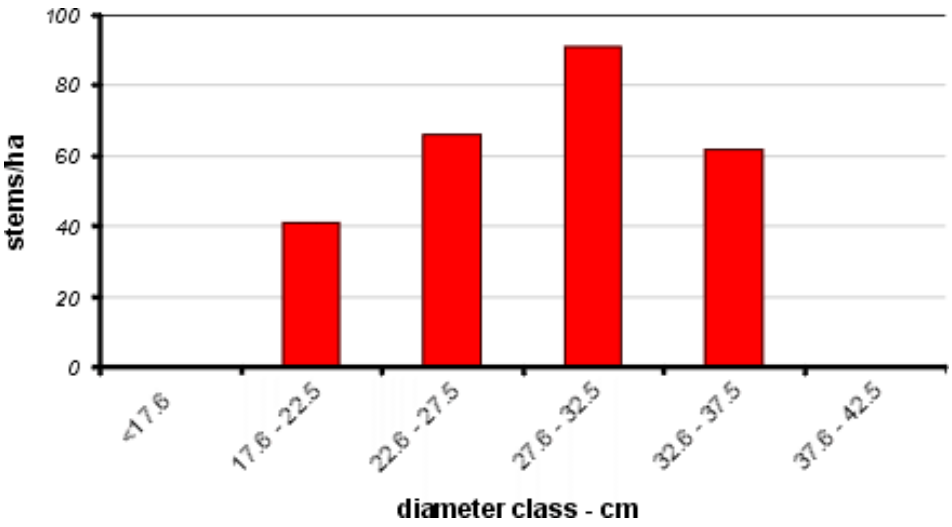


Figure 12. Stocking density by diameter class for Treatment Area 1, Shawnigan site.

3.2.2 Shawnigan Treatment Area 2

The ground photograph illustrates the present stocking of a Treatment 2 plot with 218 stems/ha, with an average tree size of 30.6 cm diameter-at-breast-height (dbh), a basal area of 16.0 m^2/ha, and a total tree volume of 148.1 m^3/ha.

Figure 13 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

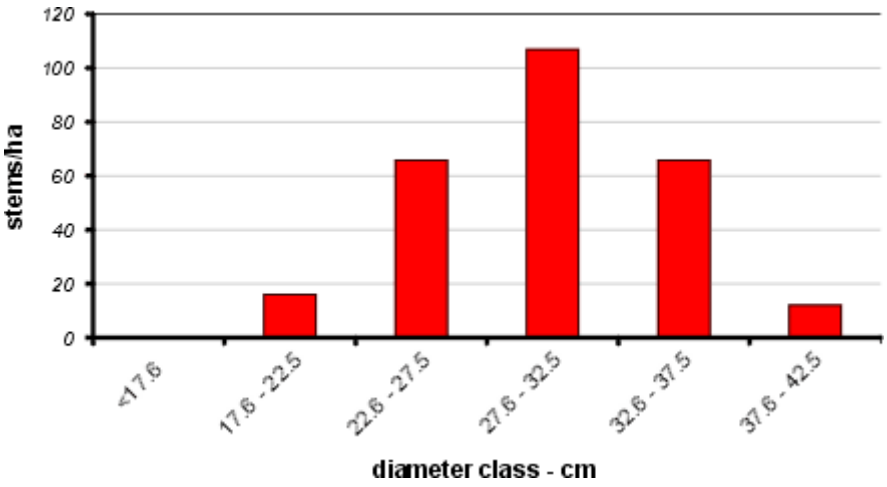


Figure 13. Stocking density by diameter class for Treatment Area 2, Shawnigan site.

3.2.3 Shawnigan Treatment Area 3

The ground photograph illustrates the present stocking of a Treatment 3 plot with 301 stems/ha, with an average tree size of 27.0 cm diameter-at-breast-height (dbh), a basal area of 17.2 m^2/ha, and a total tree volume of 161.1 m^3/ha.

Figure 14 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

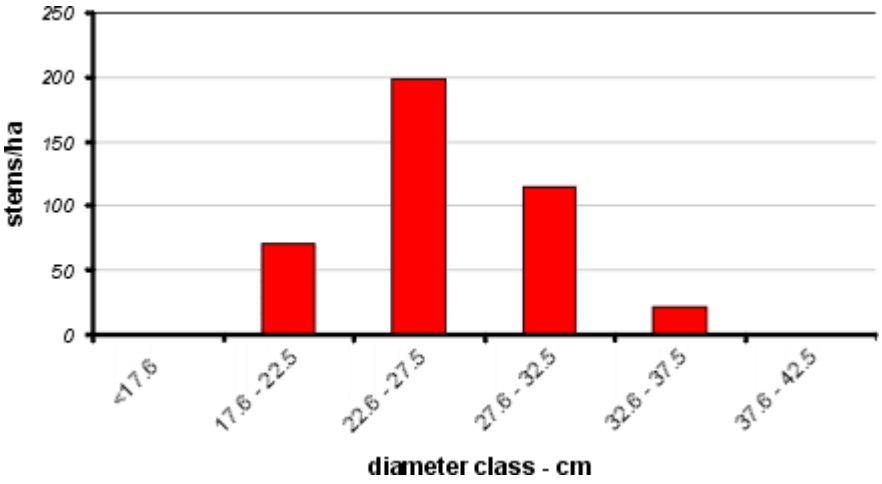


Figure 14. Stocking density by diameter class for Treatment Area 3, Shawnigan site.

3.2.4 Shawnigan Treatment Area 4

The ground photograph illustrates the present stocking of a Treatment 4 plot with 416 stems/ha, with an average tree size of 25.7 cm diameter-at-breast-height (dbh), a basal area of 21.6 m^2/ha, and a total tree volume of 196.6 m^3/ha.

Figure 15 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

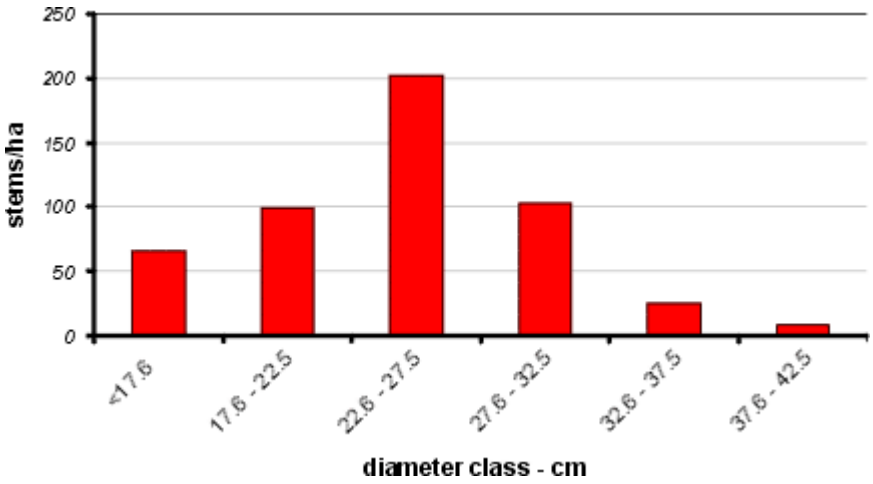


Figure 15. Stocking density by diameter class for Treatment Area 4, Shawnigan site.

3.2.5 Shawnigan Treatment Area 5

The ground photograph illustrates the present stocking of a Treatment 5 plot with 461 stems/ha, with an average tree size of 25.8 cm diameter-at-breast-height (dbh), a basal area of 24.1 m^2/ha, and a total tree volume of 221.5 m^3/ha.

Figure 16 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

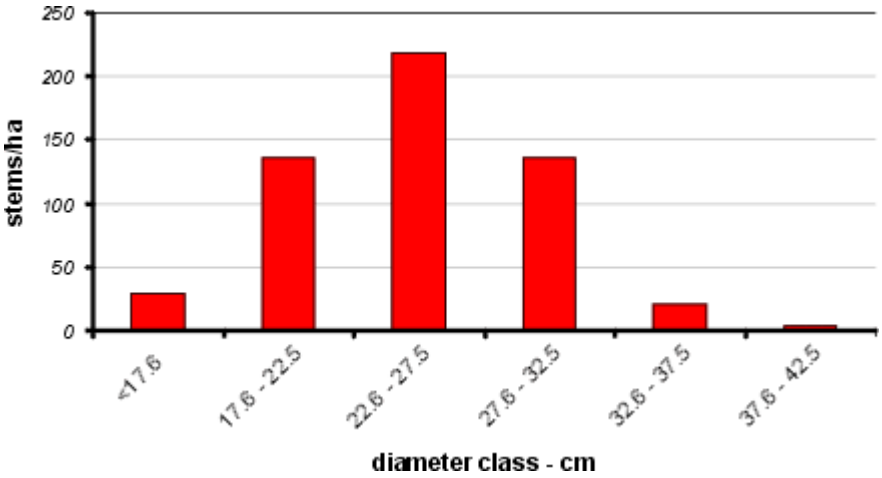


Figure 16. Stocking density by diameter class for Treatment Area 5, Shawnigan site.

3.2.6 Shawnigan Treatment Area 6

The ground photograph illustrates the present stocking of a Treatment 6 plot with 362 stems/ha, with an average tree size of 26.6 cm diameter-at-breast-height (dbh), a basal area of 20.2 m^2/ha, and a total tree volume of 190.2 m^3/ha.

Figure 17 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

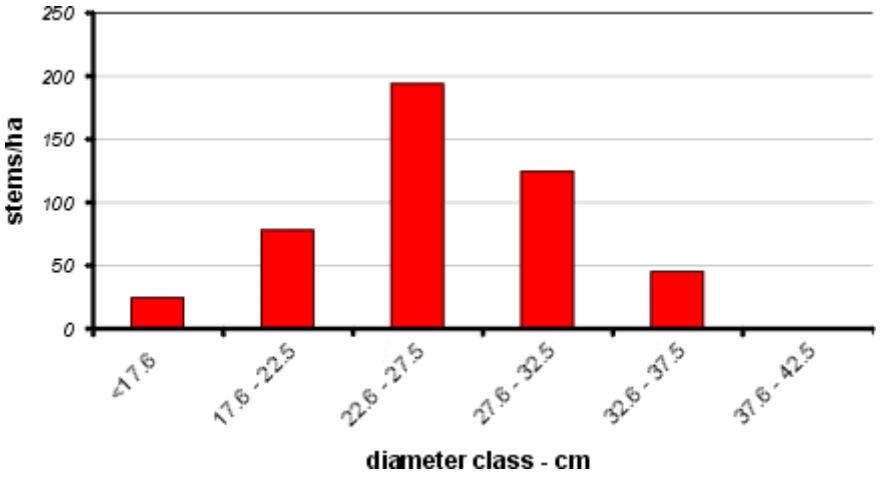


Figure 17. Stocking density by diameter class for Treatment Area 6, Shawnigan site.

3.2.7 Shawnigan Treatment Area 7

The ground photograph illustrates the present stocking of a Treatment 7 plot with 708 stems/ha, with an average tree size of 23.1 cm diameter-at-breast-height (dbh), a basal area of 29.7 m^2/ha, and a total tree volume of 262.3 m^3/ha.

Figure 18 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

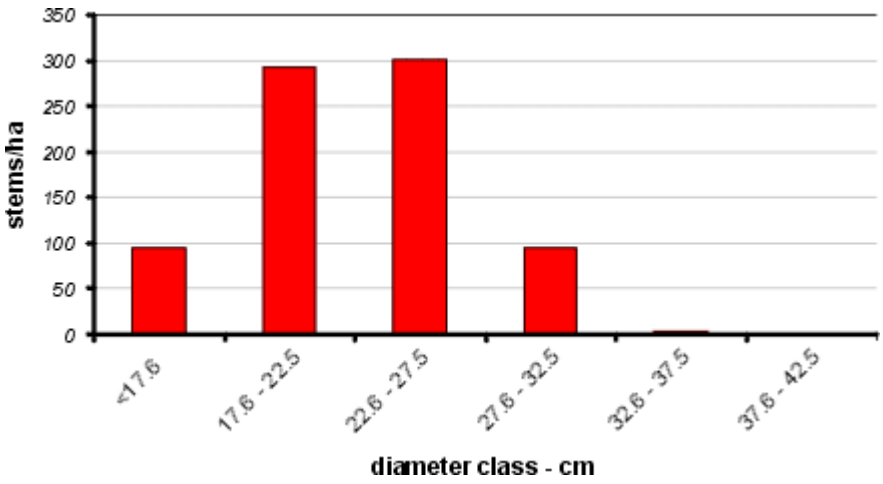


Figure 18. Stocking density by diameter class for Treatment Area 7, Shawnigan site.

3.2.8 Shawnigan Treatment Area 8

The ground photograph illustrates the present stocking of a Treatment 8 plot with 593 stems/ha, with an average tree size of 23.4 cm diameter-at-breast-height (dbh), a basal area of 25.3m^2/ha, and a total tree volume of 218.7 m^3/ha.

Figure 19 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

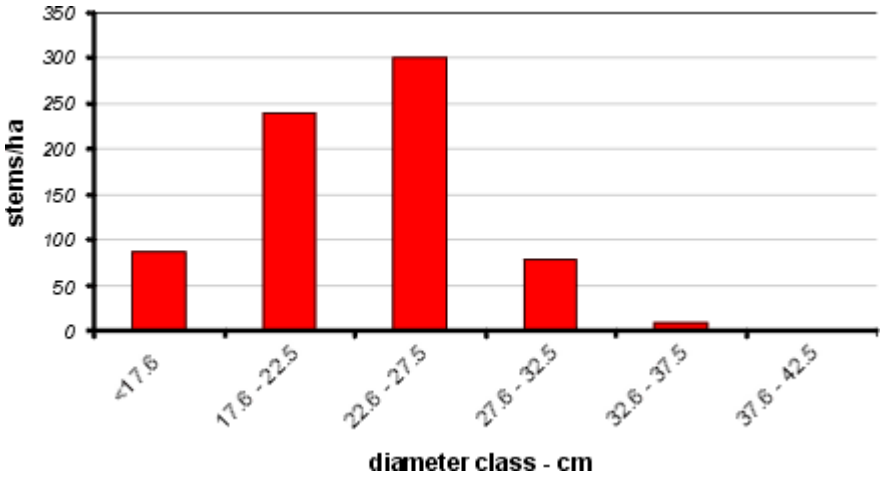


Figure 19. Stocking density by diameter class for Treatment Area 8, Shawnigan site.

3.2.9 Shawnigan Treatment Control Area

The ground photograph illustrates the present stocking of a Control plot with 2162 stems/ha, with an average tree size of 17.0 cm diameter-at-breast-height (dbh), a basal area of 49.3 m^2/ha, and a total tree volume of 389.4 m^3/ha.

Figure 20 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

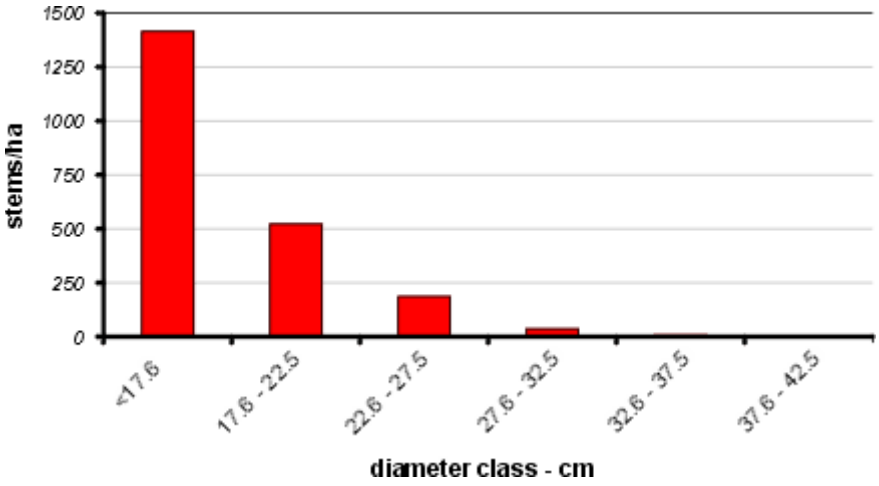


Figure 20. Stocking density by diameter class for Control Area, Shawnigan site.

3.2.10 Shawnigan "Dense" Treatment Area

The ground photograph illustrates the present stocking of a Treatment "dense" plot with 1295 stems/ha, with an average tree size of 21.6 cm diameter-at-breast-height (dbh), a basal area of 45.8 m^2/ha, and a total tree volume of 433.9 m^3/ha.

Figure 21 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

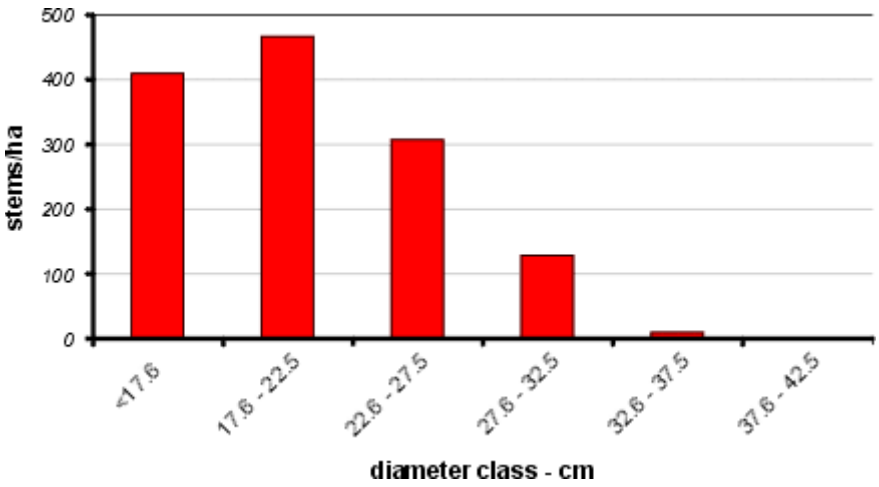


Figure 21. Stocking density by diameter class for "dense" Treatment Area, Shawnigan site.

3.2.11 Shawnigan "Open" Treatment Area

The ground photograph illustrates the present stocking of a Treatment "open" plot with 694 stems/ha, with an average tree size of 25.7 cm diameter-at-breast-height (dbh), a basal area of 35.8 m^2/ha, and a total tree volume of 319.8 m^3/ha.

Figure 22 depicts stocking density (stems/ha) by diameter class (5 cm dbh classes).

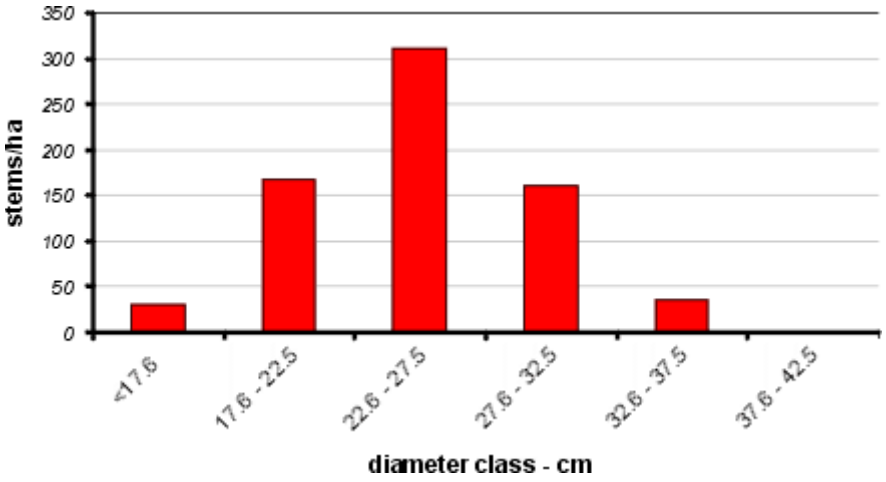


Figure 22. Stocking density by diameter class for "open" Treatment Area, Shawnigan site.

4. Study Results for the CFS–BCMoF LOGS Installations

The results, to date, for the two Canadian studies are similar to the Shawnigan Lake Research Forest and Sayward installations with gross basal area and volume increments directly related to basal area growing stock. With the passage of time and the aging of the stands, suppression mortality, present only in the control plots, has reduced the net total tree volume increment of the controls to less than those of some of the lightest thinning treatments, and continues to play an increasingly important factor in the comparison of treatments versus control.

Cumulative total tree volume production of the controls has exceeded that of all treatments with the exception of the "dense" treatment at Shawnigan Lake; however, when measured in merchantable volume, several thinning treatments exceed the net merchantable volume production of the controls. This difference between cumulative total tree and merchantable volume production is expected to increase as the stands age, and suppression-related mortality in the controls and the gradual increase in growing stock of the thinned treatments take effect.

Thinning has markedly increased diameter growth, resulting in dramatically different diameter and volume distributions between treatments.

In summary, gross total tree volume increment increases with stocking, though at a decreasing rate, up to a point at which suppression-related mortality becomes important. In thinning, one trades reduced gross total tree volume growth for increased diameter growth, improved stem quality, and increased resistance to wind and snow damage.

5. Future Potential

The original objectives of the study have, by enlarge, been met. However, the value of these installations is increasing as long-term permanent plot studies are the source of much of our knowledge about the effects of silvicultural treatments on stand development and potential yields. They provide information obtainable in no other way, and such on-the-ground examples are far more convincing than extrapolation and statistical manipulations of one-time or short-term measurements.

As these installations approach harvest age, they have produced stands that differ widely among treatments in appearance, tree size, understorey development, and crown development, and offer the following opportunities for further study:

- evaluating the effects of thinning treatments on wood quality and value
- evaluating trends in mean annual increment and periodic annual increment in relation to age and treatment
- quantifying the visually striking differences in understorey vegetation composition and development in relation to wildlife, biodiversity concerns, and non-timber values
- demonstrating the enormous influence that thinning can have on stand development patterns and stand characteristics, even over a relatively short period of time

6. Contact Information

Dr. Cosmin Filipescu
Pacific Forestry Centre
Canadian Forest Service
Natural Resources Canada
506 West Burnside Rd
Victoria, BC V8Z 1M5
Telephone: 250-298-2552
Email: Cosmin.Filipescu@NRCan-RNCan.gc.ca

7. Reports and Publications

King, James E.; Marshall, David D.; Bell, John F. 2002. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 17—Skykomish study, 1961–1993; Clemons study, 1963–1994. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-RP-548.

Beddows, D. 2002. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 16–Sayward Forest and Shawnigan Lake. Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. Information Report BC-X-393.

Marshall, David D.; Curtis, Robert O. 2002. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 15—Hoskins: 1963–1998. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. Research Paper PNW-RP-537.

Curtis, Robert O.; Marshall, David D. 2001. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 14—Stampede Creek: 30-year results. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. Research Paper PNW-RP-543.

Curtis, Robert O.; Marshall, David D.; Bell, John F. 1997. LOGS: A pioneering example of silvicultural research in Coast Douglas-fir. Journal of Forestry 95(7):19–25.

Hoyer, Gerald E.; Andersen, Norman A.; Marshall, David. 1996. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 13—Francis study: 1963–1990. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-RP-488.

Curtis, Robert O.; Clendenen, Gary W. 1994. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 12—Iron Creek study: 1966–1989. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-RP-475.

Curtis, Robert O. 1992. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 11—Stampede Creek: a 20-year progress report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-RP-442.

Marshall, David D.; Bell, John F.; Tappeiner, John C. 1992. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 10—Hoskins study, 1963–1983. US Department of Agriculture, Forest service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-RP-448.

Curtis, Robert O.; Marshall, David D. 1986. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 8—LOGS study: Twenty-year results. US Department of Agriculture, Forest service, Pacific Northwest Research Station. Portland, OR. Research Paper PNW-356.

Arnott, J.T.; Beddows, D. 1981. Levels-of-growing-stock co-operative study in Douglas-fir: Report No. 6 – Sayward Forest, Shawnigan Lake. Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. Information Report BC-X-223.

Diggle, P. K. 1972. Levels-of-growing-stock co-operative study in Douglas-fir in British Columbia. Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. Information Report BC-X-66.

Williamson, Richard L.; Staebler, George R. 1971. Levels-of-growing-stock co-operative study on Douglas-fir: Report No. 1—description of study and existing study areas. US Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, OR. Research Paper PNW-111.

Williamson, Richard L.; Staebler, George R. 1965. A co-operative levels-of-growing-stock study in Douglas-fir. US Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, OR.