



CANADIAN FOREST SERVICE
PACIFIC FORESTRY CENTRE
MISCELLANEOUS REPORT

Montane Alternative Silviculture Systems (MASS):
Testing operational, economic, and biological impacts of alternatives to
clearcutting in a coastal montane forest on Vancouver Island, British Columbia



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

2012

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Tel.: 250-363-0600

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

Cover photo: CFS

Library and Archives Canada Cataloguing in Publication

Montane Alternative Silviculture Systems (MASS) [electronic resource] :
testing operational, economic, and biological impacts of alternatives to clearcutting
in a coastal montane forest on Vancouver Island, British Columbia / by members
of the MASS partnership.

(Miscellaneous report)

Type of computer file: Electronic monograph in PDF format.

Includes abstract in French.

ISBN 978-1-100-20612-7

Cat. no.: Fo149-6/2012E-PDF

1. Forests and forestry--Environmental aspects--British Columbia
--Vancouver Island. 2. Forests and forestry--Economic aspects--British Columbia
--Vancouver Island. 3. Clearcutting--Environmental aspects--British Columbia
--Vancouver Island. 4. Forest management--British Columbia--Vancouver Island.
5. Upland ecology--British Columbia--Vancouver Island. I. Canadian Wood Fibre
Centre II. Series: Miscellaneous report (Canadian Wood Fibre Centre)

SD401 M66 2012

333.75'14097112

C2012-980096-1

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Preface

The contents of this document have been compiled from material entered on the MASS 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 As a result, many CFS subsites, including those for MASS, have been archived or adapted for delivery in alternative formats.

The Montane Alternative Silvicultural Systems (MASS) project was established in 1991 to address rising concerns about the extent of clearcut harvesting and regeneration performance in high-elevation coastal forests. A multi-disciplinary research and operations partnership tested safety, economic viability, and environmental sustainability of small Patch Cuts, Green Tree Retention, and Shelterwood harvesting, and contributed to the acceptance of Variable Retention as a silvicultural system in British Columbia. Longer term studies evaluated impacts on forest dynamics, soils, microclimate, and biodiversity. In 2012, the study site continues to provide opportunity for further study. Scientists from MacMillan Bloedel (now Island Timberlands) and the Canadian Forest Service led others from University of Victoria, University of British Columbia, and the Forest Engineering Research Institute of Canada (now FPInnovations) in research supported by the Canada-BC Forest Resource Development Agreement (FRDAII), Forestry Practices Initiative of Canada's Green Plan, Forest Renewal BC, and Natural Resources Canada.

Préface

Le contenu du présent document est tiré d'ouvrages ajoutés au site Web du projet Systèmes sylvicoles alpestres de substitution (MASS), 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 (RNC) 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 au projet MASS, ont été archivés ou adaptés pour qu'ils puissent être fournis dans d'autres formats.

Le projet MASS a été établi en 1991 en réponse aux préoccupations grandissantes entourant l'étendue des coupes à blanc et la régénération dans les forêts côtières de haute altitude. Ce partenariat multidisciplinaire de recherche et d'exploitation a permis d'évaluer la sécurité, la viabilité économique et la durabilité écologique des petites coupes par trouées, de la réserve sur coupe et des coupes progressives, et a contribué à l'acceptation de la rétention variable comme système sylvicole en Colombie-Britannique. Les études à plus long terme portaient sur l'incidence sur la dynamique forestière, les sols, les microclimats et la biodiversité. Encore aujourd'hui, en 2012, la zone d'étude présente un grand potentiel sur le plan de la recherche. Des scientifiques de MacMillan Bloedel (maintenant Island Timberlands) et du SCF ont dirigé des recherches en collaboration avec l'Université de Victoria, l'Université de la Colombie-Britannique et l'Institut canadien de recherches en génie forestier (maintenant FPInnovations), recherches soutenues par l'Entente d'association Canada – Colombie-Britannique sur la mise en valeur des ressources forestières (EMVRF II), l'Initiative sur les pratiques forestières financée dans le cadre du Plan vert du Canada, Forest Renewal BC et RNC.

1. Background and Objectives

1.1 Background

Montane forests have a winter snowpack and are found between 700 and 1100 metres in elevation on central Vancouver Island. They contain a large part of the coastal timber harvest (Beese 1995a). Irregular stocking density and growth stagnation in some large montane clearcuts suggest that regeneration may not be meeting current growth expectations.

The apparent growth problems may be related to environmental conditions on large clearcuts that create unfavorable microclimate, vegetation competition, nutrition, or other ecosystem processes affecting forest regeneration (Koppelaar and Mitchell 1992).

Local and global demand to sustain multiple values from forest land, such as visual aesthetics and biological diversity, has raised other concerns about clearcutting. Coastal forest managers need to know where alternatives to clearcutting are feasible, economical, and ecologically sound.

The MASS partnership is a multi-agency co-op testing new approaches to harvesting and regeneration. It builds upon knowledge and expertise gained over 20 years of silvicultural and ecological research and operations in montane forests (Arnott and Pendl 1994; Arnott et al. 1995).

1.2 Objectives

The overall objectives of the MASS project are to:

- test alternative silvicultural systems for coastal montane forests
- document the operational costs and feasibility, and
- study the biological and silvicultural impacts.



Ten-year-old planted amabilis fir on the MASS site showing signs of slowing growth, or "growth check," in 2004.



Cold and wet conditions often extend into the summer months in montane areas. Photo taken by Tom Bown, CFS, June 2005.

There are 21 integrated research studies investigating many aspects of this long-term experiment, including:

- feasibility and economics
- soil disturbance and productivity
- decomposition, leaching, and nutrition
- microclimate
- ecophysiology of conifers
- natural and planted regeneration
- seedling response to competition and nutrition
- vegetation succession and forest structure, growth and yield
- forest bird and canopy insect diversity
- forest health, and
- genetic consequences of alternative silvicultural systems.

2. Silvicultural Treatments

The project includes four replicated silvicultural treatments—or systems—which are compared to an unharvested, old-growth control (Beese 1995b, 1995d). In all silvicultural treatments, advanced natural regeneration, seed-in and planted infill (as required) was used to achieve mixed species composition and increase the component of western redcedar and yellow-cedar.



View of surrounding coastal mountains from the MASS site, 2005. Visual aesthetics are important in montane areas.

2.1 Clearcut (CC)

Objective: To harvest a control area using conventional clearcutting methods for comparison to alternative systems.

Treatment: All trees were cut in two adjacent clearcuts over a 2-year period to create a 69-ha opening (Figure 1).



Figure 1. Clearcut, 1994.



Figure 2. Clearcut, 2004.

2.2 Patch Cut (PC)

Objective: To protect regeneration against snow, wind, and temperature extremes, and to extend harvesting over a longer time period to maintain aesthetic value and wildlife habitat.

Treatment: All trees were cut in three 1.5 to 2 ha patches (approx. 120 m x 125 m) within each 9-ha treatment block. The remaining three patches were to be harvested after regeneration reached 10 m in height, but windthrow ultimately altered these plans (Figure 3).



Figure 3. Aerial view of Patch Cuts and adjacent reserves, 1994.



Figure 4. Patch Cut, 2004.

2.3 Green Tree Retention (GT)

Objective: To leave reserve trees in a small (9 ha) clearcut to enhance the structural diversity of future stands to maintain aesthetic value and wildlife habitat.

Treatment: Clearcutting with reserves. A minimum of 25 trees/ha of lower-value dominants and co-dominants, and a mixed species composition of healthy intermediates, were left for the entire rotation. Trees were selected for relatively even distribution, wind firmness, worker safety, and representativeness of the stand profile. Five snags per ha will be created in the future (Figure 5).



Figure 5. Aerial view of Green Tree Retention, 1994.



Figure 6. Green Tree Retention, 2004.

2.4 Shelterwood (SW)

Objective: To protect regeneration against snow, wind, and temperature extremes, and to enhance the structural diversity of future stands to maintain aesthetic values and wildlife habitat.

Treatment: Trees representative of the entire stand profile and making up 30% of the basal area (approx. 200 stems per ha greater than 17.5 cm DBH) were left throughout the stand. Reserve trees were selected for yarding feasibility, worker safety, wind firmness, and residual stand structure. Clumped distribution was necessary to protect smaller trees (Figure 7).

If the treatment is economically and logistically feasible, a portion of the “leave” trees will be recovered when regeneration is established (10 m tall), leaving up to 25 wildlife trees per ha. A second option identified in the stand prescription is to leave all residual trees for the entire rotation, creating a multi-aged “irregular” shelterwood.

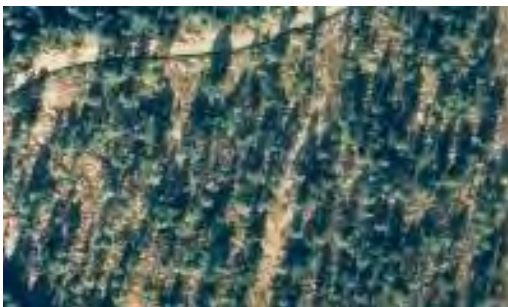


Figure 7. Aerial view of Shelterwood (note extraction corridors), 1994.



Figure 8. Shelterwood, 2004.

2.5 Old Growth (OG)

Objective: To provide an undisturbed, old-growth baseline monitoring reserve.

Treatment: A 20-ha contiguous reserve of old-growth forest adjacent to the clearcut and alternative silvicultural treatment plots has been set aside for future study and monitoring (Figure 9).



Figure 9. Old Growth Reserve, 1994.



Figure 10. Old growth remains unchanged, 2004.



Figure 11. Aerial view of entire experiment area after logging.

3. Stand Description and Harvesting

3.1 Stand Description

Pre- and post-harvest data for two of the alternative silviculture treatments are provided in Table 1. For further detail, see Section 6: Summary Reports, 1992–1998, subsection Site and Stand Characterization.

3.2 Harvesting



Figure 12. Backhoe forwarding logs in clearcut.

Field layout of road systems and silvicultural treatments was carried out in 1992. "Leave" trees were marked prior to harvest in all alternative silvicultural treatments. Trees were felled manually in all treatments, beginning in May 1993. A hydraulic log loader (backhoe) was used to move the logs from stump to roadside, lifting or swinging the logs to avoid damage to standing timber (Figure 12).

In the shelterwood, some trees were felled and yarded to 15- to 20-m-wide corridors before felling the remaining trees. Logs in the corridors were ground-skidded to roadside with a flexible-tracked skidder. All yarding was completed by November 1993 (Phillips 1995a).

Table 1. Pre-and post-harvest forest characteristics for the Green Tree Retention and Shelterwood blocks.

Species Composition (by basal area)	Green Tree		Shelterwood	
	Pre	Post	Pre	Post
Western hemlock	44	51	43	49
Amabilis fir	23	16	28	33
Western redcedar	28	28	25	17
Yellow-cedar	5	5	4	1
Gross merchantable volume (m ³ /ha)	1024	47	978	172
Percent of gross volume retained	-	5	-	18
Net merchantable volume (m ³ /ha)	723	n/a	553	148
Basal area (m ² /ha)	85	4	73	18
Percent basal area retained	-	5	-	25
Stems per hectare (over 17.5 cm DBH)	593	21	499	207
Windthrow (trees per ha) Nov/93–July/97	-	8	-	9
Windthrow (percent) Nov/93–Jun/97	-	31	-	9
Average stand height (m)	25	23	28	18
Average diameter (cm at 1.3 m)	1	40	45	31
Understorey trees (sph > 1.3 m tall, < 17.5 cm DBH)	560	n/a	580	311

Source: Beese and Bryant 1997; Beese et al. 1998.

4. Operational Findings

4.1 Logistics

Contacts: Gord Eason, Ken Mackenzie, Jim Jackson, and Eric Phillips.

- This trial shows that alternative harvesting systems can be applied to old-growth montane forests in gentle terrain with reasonable falling and forwarding success. The biological and economic implications will determine if these treatments are feasible elsewhere (Phillips 1996).
- Crew involvement, especially in the planning and layout stages, was key in successful implementation of the trial.
- The equipment size used was generally appropriate for the tree/log size. The hydraulic excavators (backhoes) used to forward logs to the roadside could lift and swing or slide all logs of all sizes. The excavator, modified specifically for forwarding, was the most maneuverable of the three. Although the flexible-tracked skidder was satisfactory for cleanup and yarding corridors, it would have been more efficient for general skidding if it had a swing grapple.
- In compliance with Workers' Compensation Board check-in requirements, fallers used earmuff or collar microphone portable radios to maintain regular contact with their partners.
- Close on-site supervision was essential for a project of this nature. Scheduling phases among the multiple blocks was challenging. Logging "hotter" (i.e., yarding concurrently with felling and loading sooner after yarding to reduce the height of roadside log decks and damage to "leave" trees) would improve future operations.
- When residual trees were left in clumps in the shelterwood treatments, harvesting productivity was maintained with minimal damage. Tree marking to account for tree lean and bucking short log lengths was effective in the SW.
- Calculated costs do not account for value of timber left behind or increased breakage. The amount of broken sound wood (from falling and forwarding) left on site was similar in the CC and PC, but was 25% lower in the SW and 80% higher in the GT treatments.



4.2 Productivity and Cost Summary

Contacts: Eric Phillips and Bill Beese.

The combined costs of falling and forwarding were 10% higher for the PC and GT treatments, and 38% higher for the SW treatment than for the CC base (Table 2).

When extra costs for tree marking and layout were included, total harvesting costs were 12% higher for PC and GT, and 49% higher for SW than for the CC base cost (Beese 1995d). Costs were highly variable due to differences in timber, terrain, and crew experience. The trial succeeded because of crew willingness to modify existing skills.

Table 2. Productivity and cost summary.

	Shelterwood (SW)	Green Tree (GT)	Patch Cut (PC)	Clearcut (CC)
Area	27.5	27.3	17.1	69.1
Volume	14 503	18 425	11 175	45 360
Piece Size	1.25	1.12	1.12	1.15
Falling				
Time (h)*	1069	1138	807	2868
Productivity (m ³ /h)	13.6	16.2	13.8	15.8
Cost (\$/h)	59.14	59.14	59.14	59.14
Cost (\$/m ³)	4.35	3.65	4.29	3.74
Forwarding				
Time (h)**	646	569	292	1001
Productivity (m ³ /h)	22.4	32.4	38.3	45.3
Cost (\$/h)	125.00	136.58	137.40	156.20
Cost (\$/m ³)	5.57	4.22	3.59	3.45
Cost at Roadside (\$/m ³)	9.92	7.87	7.88	7.19

*including pro-rated delays

**including pro-rated delays, all machines

Source: Phillips (1996).

5. Research Findings

Ten-year assessments for growth and foliar nitrogen were completed in 2003. Published reports were available by late 2006.

In both species, height and stem volume were reduced in the SW. Very low percentages of foliar nitrogen are expected to result in growth reductions in all treatments.

Table 3. Ten-year growth and foliar nitrogen results as least squared means for planted control (no post-planting treatment) Amabilis Fir (*Abies amabilis*) and western Hemlock (*Tsuga heterophylla*) at MASS. Each mean represents 200–240 trees.

	Height (cm)	Stem Volume (cm³)	% Foliar Nitrogen
Amabilis Fir			
Clearcut (CC)	176.5 (23.1)	769 (387)	0.672 (.025)
Patch Cut (PC)	189.8 (22.8)	672 (382)	0.627 (.020)
Green Tree (GT)	183.0 (22.8)	721 (384)	0.690 (.041)
Shelterwood (SW)	124.9 (23.8)	318 (398)	0.788 (.047)
Western Hemlock			
Clearcut (CC)	327.1 (29.3)	3383 (964)	0.746 (.033)
Patch Cut (PC)	347.3 (29.1)	3045 (958)	0.766 (.027)
Green Tree (GT)	328.8 (29.2)	3077 (962)	0.662 (.050)
Shelterwood (SW)	229.7 (29.9)	1596 (981)	0.809 (.049)

6. Summary Reports, 1992–1998

6.1 Problem Identification

A comprehensive review of the literature concluded that challenges in achieving regeneration and growth objectives are focused on species selection, microclimatic extremes, and nutrient availability (Koppenaar and Mitchell 1992).

6.2 Site and Stand Characterization

6.2.1 Soils

Soils are predominantly Orthic and Gleyed Ferro-humic Podzols with a relatively thick (20–40 cm) humimor humus layer. The C horizon, which is calcareous, is generally found below 100 cm depth. Turbated soil horizons, accompanied by frequent voids, are common, indicating that windthrow has played a major role in soil and forest cover development (Senyk and Craigdallie 1995).

John Senyk

6.2.2 Forest Stand

MASS is located within the CWHmm2 biogeoclimatic unit on Vancouver Island. Site associations were mapped at 1:5000 prior to harvest. Age of overstorey trees and advanced regeneration varied by species: western redcedar and yellow-cedar were the oldest, up to 800 years; western hemlock ranged from 200 to 800 years; and amabilis fir were generally less than 250 years (Beese et al. 1995a). Data were also collected on numbers of snags (80/ha) and amounts of coarse woody debris by decay class. Trees in the more open GT treatment were more vulnerable to windthrow, with 31% losses among the “leave” trees (Beese et al. 1998). However, the SW lost greater numbers of stems due to higher retention densities (Figure 13). Western redcedar appeared to be more windfirm than either amabilis fir or western hemlock. Most of the windthrow occurred in the first year after logging and during a 25-year storm event on 17 October 1996 (Year 4).

Bill Beese

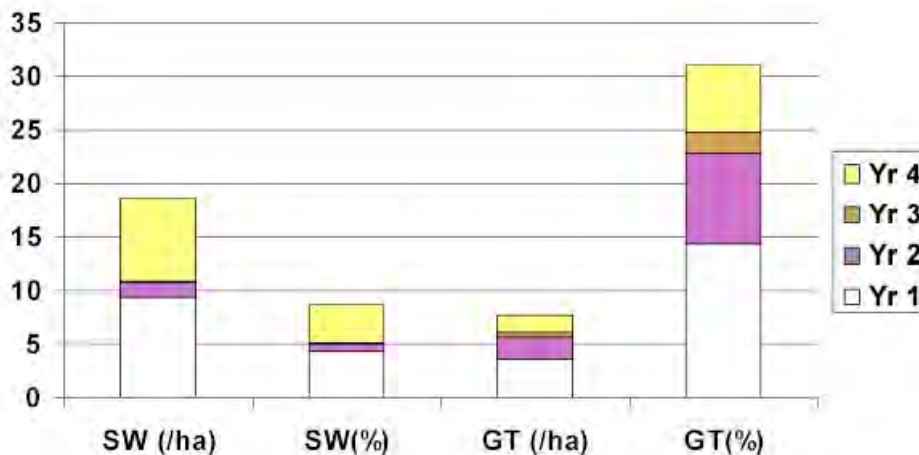


Figure 13. Total windthrow (stems/ha and %) 4 years after harvest (from Beese et al. 1998).

6.2.3 Snow Hydrology

Alternate silvicultural systems within coastal montane forests influence the amount of snow accumulation and distribution within a forest stand. The objective of this study was to monitor and compare snowpack accumulations among all five treatments on a monthly basis throughout the winter using radial snow course transects. Results from the winter surveys indicate that average snow depths are highest within the CC, moderate within SW, and lowest within the OG (Askin and Dragunas 1995; Askin 1996).

Peter Dragunas

6.2.4 Growth and Yield

Permanent sample plots have been established in all treatment types to provide information for long-term growth and yield (Smith 1995).

Nick Smith

6.2.5 Genetic Consequences

Genetic quality of the various alternative silvicultural systems is being evaluated using two species (balsam fir and western hemlock). The null hypothesis is that no change in genetic diversity or levels of inbreeding of the two species will occur as a result of the different silvicultural systems being tested at MASS. The ultimate objective of this study was to determine the genetic costs of alternative silvicultural systems compared to clearcutting.

Preliminary analysis of the mating system in balsam fir indicates a significant amount of inbreeding (Table 4). The control (i.e., OG) produced significant outcrossing rate estimates (0.737). The PC and SW produced higher estimates, indicating that pollen flow in the SW (reasonable opening and reduction of family structure) and the PC (edge effect) is better than in the control (family structure and less pollen flow); however, the level of inbreeding observed with fewer trees per unit area (i.e., GT) was high. The most interesting observation is the correlated mating results in which OG and PC produced the lowest estimates, indicating that many males are participating in the pollination and fertilization. However, the two treatments with the fewest numbers of trees per unit area (GT and SW) produced higher estimates of correlated matings, indicating that the progeny produced from these treatments is genetically uniform (Table 4).

Yousry El-Kassaby and Glen Dunsworth

Table 4. Population estimates of single-locus (t_s), multilocus (t_m), and correlated paternity (r_p) for four populations using a sample size of 10 seeds/tree.

Estimate	OG	PC	SW	GT
t_s	0.650	0.707	0.739	0.582
t_m	0.737	0.753	0.883	0.637
r_p	0.355	0.278	0.616	0.652

Source: El-Kassaby and Dunsworth (1998).

6.2.6 Forest Health

Incidence of dwarf mistletoe on western hemlock overstorey was reduced by harvest from 18% in the undisturbed stand to an average of 6% in the SW and 3% in the GT treatments. Principal stem decay fungi present in the residual western hemlock and amabilis fir were identified as *Phellinus pini* and *Echinodontium tinctorium* (Nevill and Wood 1995).

Ambrosia beetles and other wood-boring insects were recovered from all windthrown western hemlock and amabilis fir sampled 18 months after harvesting. (No ambrosia beetles or other wood-boring insects were recovered from other windthrown trees 6 months after harvesting). Only one ambrosia beetle species, *Trypodendron lineatum* (Oliv.), was identified from both western hemlock and amabilis fir (Nevill and Whitehead 1996).

Ralph Nevill

6.2.7 Forest Birds

Twenty-six bird species were recorded in 1992 during a pre-harvest study of breeding bird communities (Bryant 1994; 1995). The 4 most abundant species (chestnut-backed chickadee, winter wren, varied thrush, and red-breasted sapsucker) accounted for 64% of all detections; the 10 most abundant species accounted for 96% of all detections. Standing dead trees (snags) are known to be important habitat elements for several of the bird species recorded.

Different levels of canopy retention produced different effects, some dramatic, upon breeding birds. Twenty six species were identified in pre-harvest survey. Species richness and bird abundance were reduced 3 years after harvesting (Figure 14). The 9 most common species showed population decline, 2 species showed significant increase, and 3 species showed unchanged abundance. Few species were completely lost or added to the avifauna. Only 17 species were recorded during winter surveys, 2 of which accounted for the majority (68%) of detections. The vast majority (85%) of winter resident birds was concentrated in the OG and in the unlogged portions of PC blocks (Beese and Bryant 1997).

Andrew Bryant

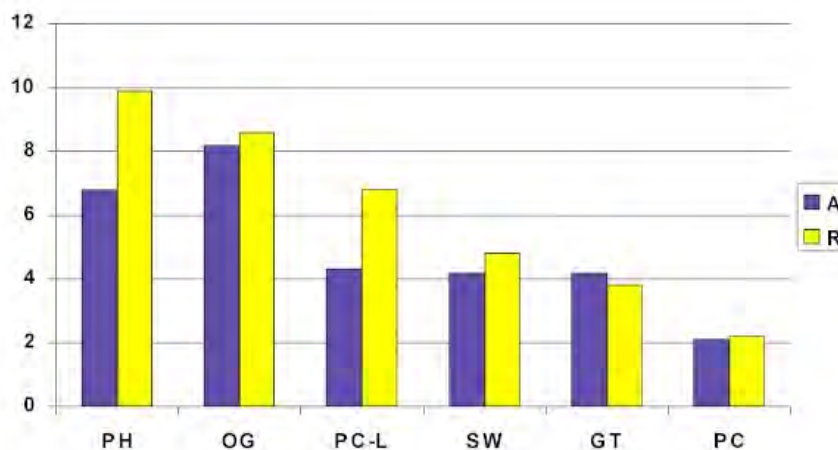


Figure 14. Between treatment effects on breeding bird richness (R) and abundance (A). Data are mean values/sampling station. (PH=Pre-harvest, OG=Old Growth; PC-L=Patch Cut-Leave; SW=Shelterwood, GT=Green Tree; PC=Patch Cut). From Beese and Bryant, 1997.

6.2.8 Canopy Arthropod Diversity

A census of arthropods in the canopy of amabilis fir and western hemlock among 2 of the 5 silvicultural treatments (OG, SW) was started in 1996. In order to identify transient from resident forest arthropods within the forest canopies, comparisons were made between arthropods on branch and lichen samples collected monthly by tree climbers and those collected by the following trapping techniques: Malaise flight-intercept traps for flying insects, window traps for canopy Coleoptera, Luminoc® light traps for night-flying Lepidoptera, and terpene-baited Lindgren funnel traps. Identifications of the taxa recovered are continuing. Some of the findings are presented below.

Spiders (Arachnida: Araneae) were present in 76% of the canopy branch and lichen samples. Sixty-three species and 13 families of spiders were represented in the 3 781 specimens recovered (Figure 15). Two of the spiders recovered were recorded for the first time in Canada.

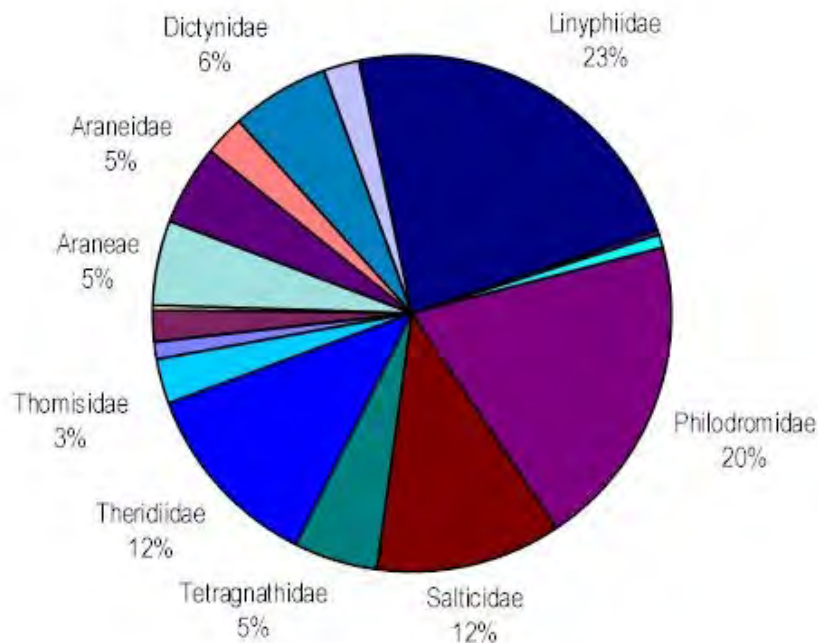


Figure 15. Proportional representation (by family) of spiders from MASS canopy (from Humble et al. 1998).

Sixteen species of Oribatid mites (14 genera and 11 families) have been found in the canopy branch samples to date. One taxon, *Dendrozetes* n. sp., previously known in North America only from Sitka spruce in the Carmanah Valley, has been found at MASS, while 4 spp. recovered at MASS were not found in the Carmanah Valley.

More than 20 000 specimens of Coleoptera have been extracted, sorted, and identified (Figure 16). Staphylinids (rove beetles) were predominate in the Lindgren trap captures. The rove beetle samples from the montane forests sampled at and near MASS reveal a rich fauna consisting of at least 128 species of Staphylinidae, in 76 genera and 15 subfamilies. This diversity compares to the

approximately 90 species of Staphylinidae recovered from all habitats sampled in the Sitka spruce forests of the Carmanah Valley.

Significant early findings from the branch sampling program include the discovery of active populations of the damaging pest balsam woolly adelgid in old growth amabilis fir and the discovery of both a new species of gall midge attacking newly-flushed growth and significant populations of hemlock woolly adelgid in old growth western hemlock.

Lee Humble, Neville Winchester, and Richard Ring

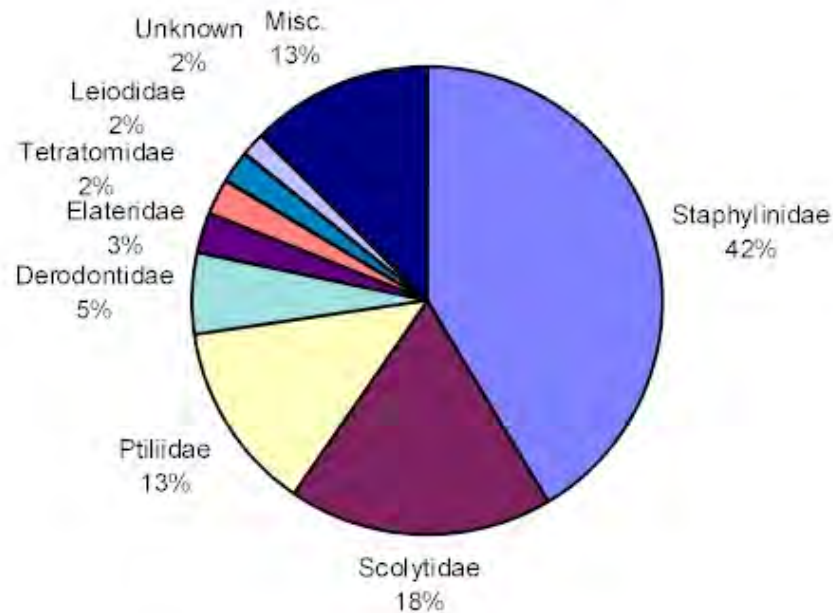
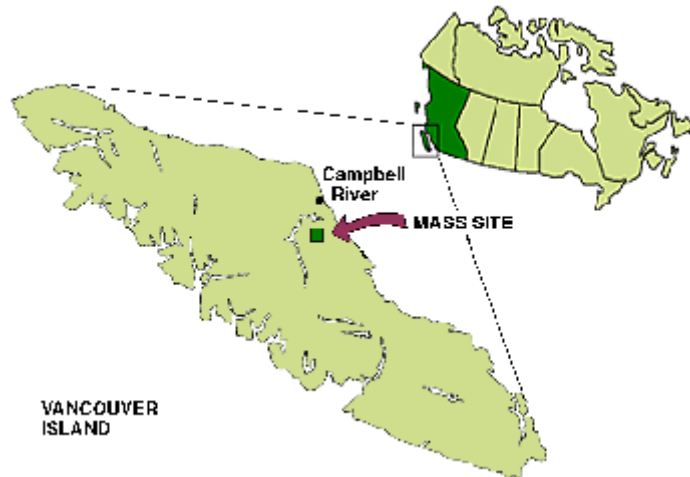


Figure 16. Relative abundance of Coleoptera from 1996 Lindgren trapping program, n = 18 356 individuals. The Misc. category includes 2304 individuals included 37 Families (from Humble et al. 1998).

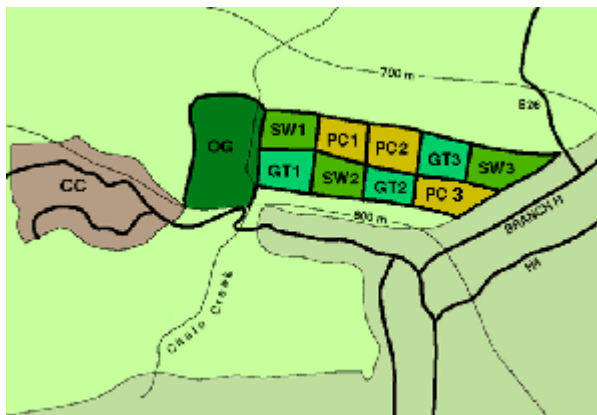
7. Site Maps and Images

7.1 Site Maps

7.1.1 Location of the MASS Research Site



7.1.2 Diagram of the MASS Research Site



The experimental design includes three 9-hectare replicates of each alternative system:

- Patch Cut (PC)
- Green Tree Retention (GT)
- Shelterwood (SW)

Adjacent to these treatments is a 69-hectare Clearcut (CC) and a 20-hectare Old Growth (OG) baseline monitoring reserve.

7.2 Images

7.2.1 Aerial Photograph of the MASS Research Site



Aerial view of the 3 alternative silvicultural systems. See diagram of the site for legend.

7.2.2 MASS Research Activity: Images



CFS Biologist Donna Macey and Ann Harris (Head of PFC Chemical Services) take soil samples at Mass, 2005.



CFS Researcher Dr Doug Maynard measures growth on compacted skid trails 10 years after harvesting, 2005.

7.2.3 Technology Transfer and MASS Visitors: Images



The MASS research site has been toured by hundreds of national and international researchers, educators, and government officials. This group was delegates from the North American Forest Biology Workshop held in Victoria in 1998.



CFS Biologist Leanne McKinnon takes MASS results on the road with a display for government officials and the public at Canadian Forces Base Esquimalt, 2000.

7.2.4 MASS Biodiversity Images



Chute Creek runs through the MASS site. This was the site of a logging road bridge which was later removed and the creek restored, photo 2005.



Restored Creek bed, 2005.



Section of natural creek bed unaffected by harvesting, 2005.



Western Trillium *Trillium ovatum*, 2004.



Fireweed *Epilobium angustifolium* in seed, fall 2004.



Amabilis fir and *Vaccinium* compete for light and nutrients.



Devil's club, *Oplopanax horridus*, 2004.



Hairy Cat's Ear, *Hypochaeris radicata*, 2004.

7.2.5 Winter 2006–2007 Aerial Photos and Storm Damage



MASS looking east, Winter 2006–2007.



MASS looking west, Winter 2006–2007.



PC1, SW1, and GT1, Winter 2006–2007.



Winter storm damage in the "leave" portion of PC1, Winter 2006–2007.



Severe winter storm damage near the OG reserve, Winter 2006–2007.

8. Contact Information

8.1 MASS Project Leaders

Over the years since the initiation of the MASS study, many of the individuals involved have changed positions, titles, affiliations, and/or careers. To avoid confusion, only their names and affiliations which were current at the time of their involvement with the project are listed here.

Mr. W. J. (Bill) Beese, MF, RPF
Forest Ecologist
Western Forest Products Inc.

Dr. Al Mitchell
Research Scientist – Physiology
Pacific Forestry Centre
Canadian Forest Service, CWFC

Mr. Jeff Sandford
Western Forest Products Inc.

Dr. Nick Smith
Mensurationist
Consultant

8.2 Site Access and Information

Ally Gibson
Area Engineer
Island Timberlands

8.3 Study Leaders, 1992–Present

Note: Not all study leaders remain active at MASS

Mr. Ross Benton
Research Officer – Meteorology
Pacific Forestry Centre
Canadian Forest Service

Dr. Robert Bradley
Professor – Soil Ecology
Biology Department – Faculty of Science
University of Sherbrooke



Dr. Andrew Bryant
Wildlife Biologist
A. A. Bryant Services

Mr. Glen Dunsworth, RPBio
Ecological Consulting

Dr. Yousry A. El-Kassaby
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Dr. Jonathan Moran

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University of Victoria

Mr. Michael Peterson

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Mr. Eric Phillips

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Research Director
The Finnish Forest Research Institute (Metla)
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Dr. Richard Ring

Professor – Forest Biology
Biology Department
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Mr. Jeff Sandford

Western Forest Products Inc.

Dr. Nick Smith

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Western Forest Products Inc.

Dr. Jack Sutherland

Research Pathologist
Applied Forest Science

Dr. Brian Titus

Research Scientist – Forest Ecology
Pacific Forestry Centre
Canadian Forest Service

Dr. Joe Webber

Research Scientist – Reproduction Biology
Glyn Road Research Centre
BC Ministry of Forests

Dr. Neville Winchester

SLI, Adjunct Assistant Professor
Biology Department
University of Victoria

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