MONTANE ALTERNATIVE SILVICULTURAL SYSTEMS (MASS)

Field Trip Posters

Funding: Forest Renewal BC, FIA Forest Science Program, Company (MacMillan Bloedel Ltd., Weyerhaeuser, Cascadia FP, Western Forest Products, Island Timberlands, Mosaic) and partners

Partners: Canadian Forest Service, FERIC, UBC, U. Victoria, VIU, BC Ministry of Forests

Cooperators:

Natural Resources Canada | Ressources naturelles Canada

FIA Forest Investment Account Forest Science Program

Western Forest Products Inc.

MASS Study Objectives

Problem: concerns over regeneration performance, visual aesthetics and biodiversity with conventional clearcutting

Objectives:

- Test alternative silvicultural systems for BC coastal montane forests
- Document the operational costs and feasibility
- Study the biological and silvicultural impacts

High Elevation Regeneration Problems

Short growing season:
- 150 frost free days
- frost, ice

Snow:
- Heavy snow pack, snow creep
- Tree press and breakage

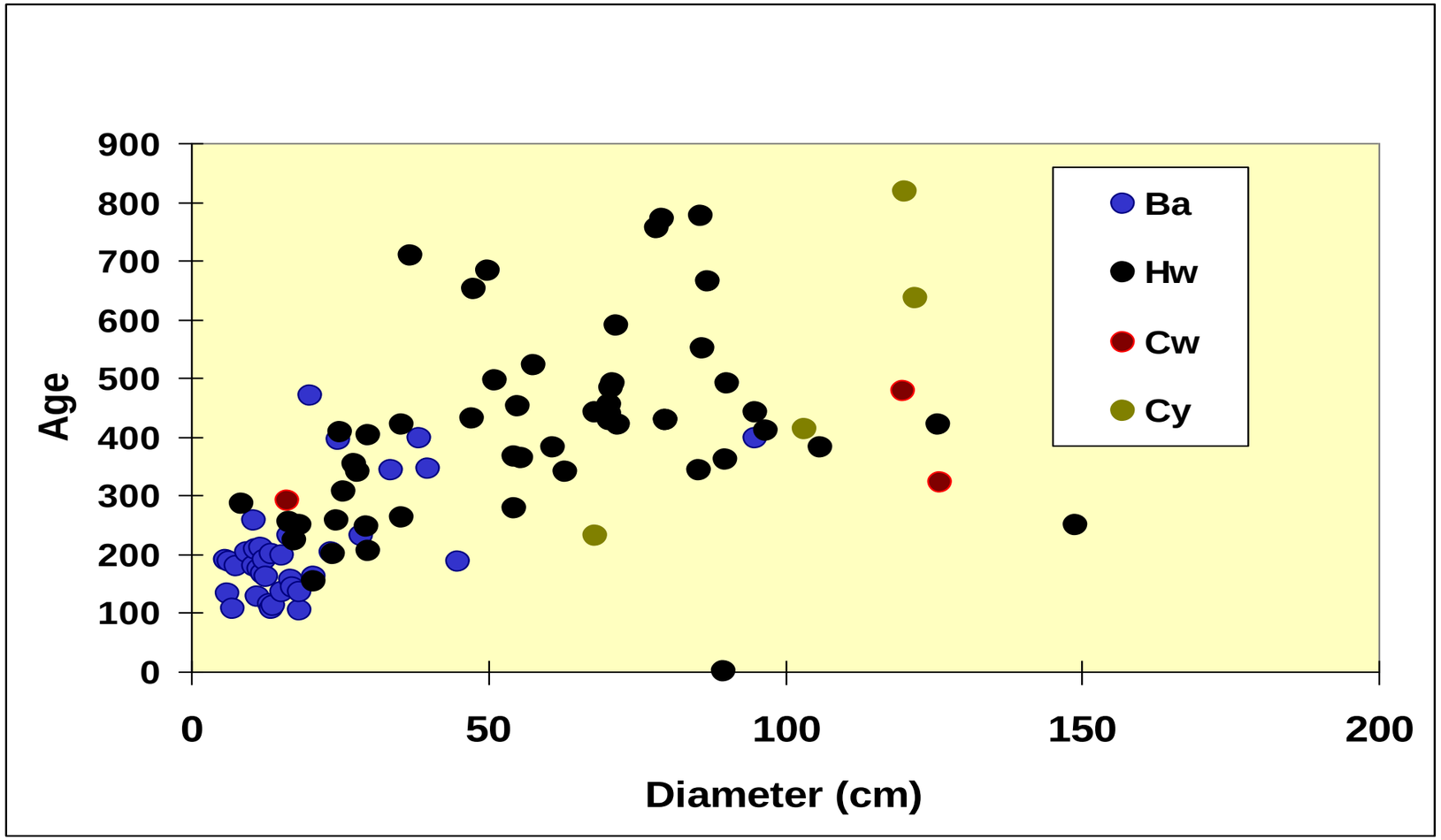
Temperatures:
- Summer heat and moisture stress
- Cool annual temperatures

Environmental Factors:
- Windthrow, wind shear
- High light intensity

Site Limitations:
- Shallow soils
- Competition for nutrients

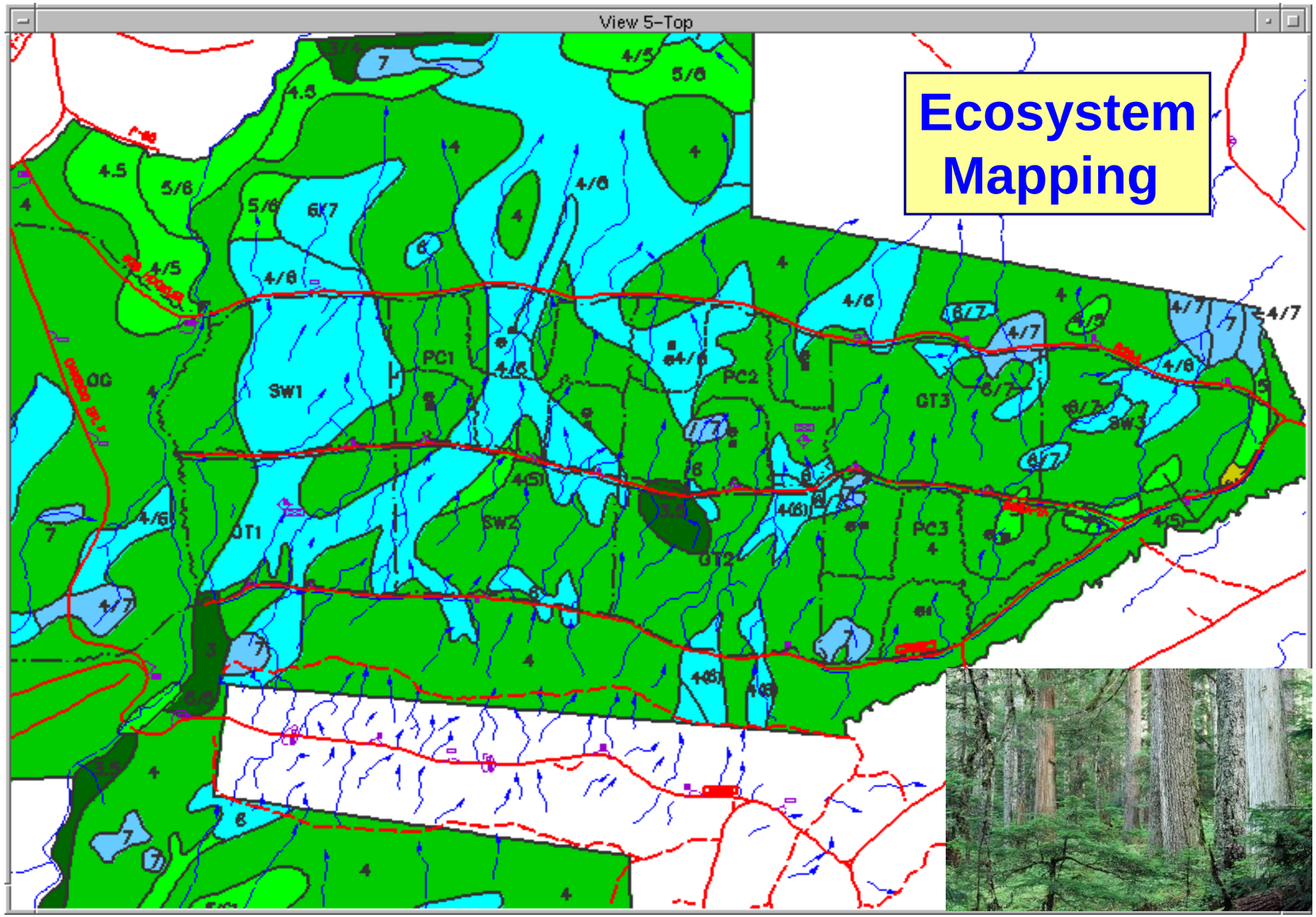
Old Growth – Hemlock-Amabilis fir

Photo: Alex Inselberg



Study by Rüdiger Stolz, Dirk Schiedemann, Dave Clark, Bill Beese and Jeff Sandford

MASS Site Characteristics



Location:

Site:

***BEC:* CWHmm2**

Montane moist maritime variant, Coastal Western Hemlock zone

***Moisture Regime/Site Associations*:**

3,4=HwBa-Pipecleaner moss

5,6=BaCw-Salmonberry

7,8=CwSs-Skunk cabbage

Aspect: North

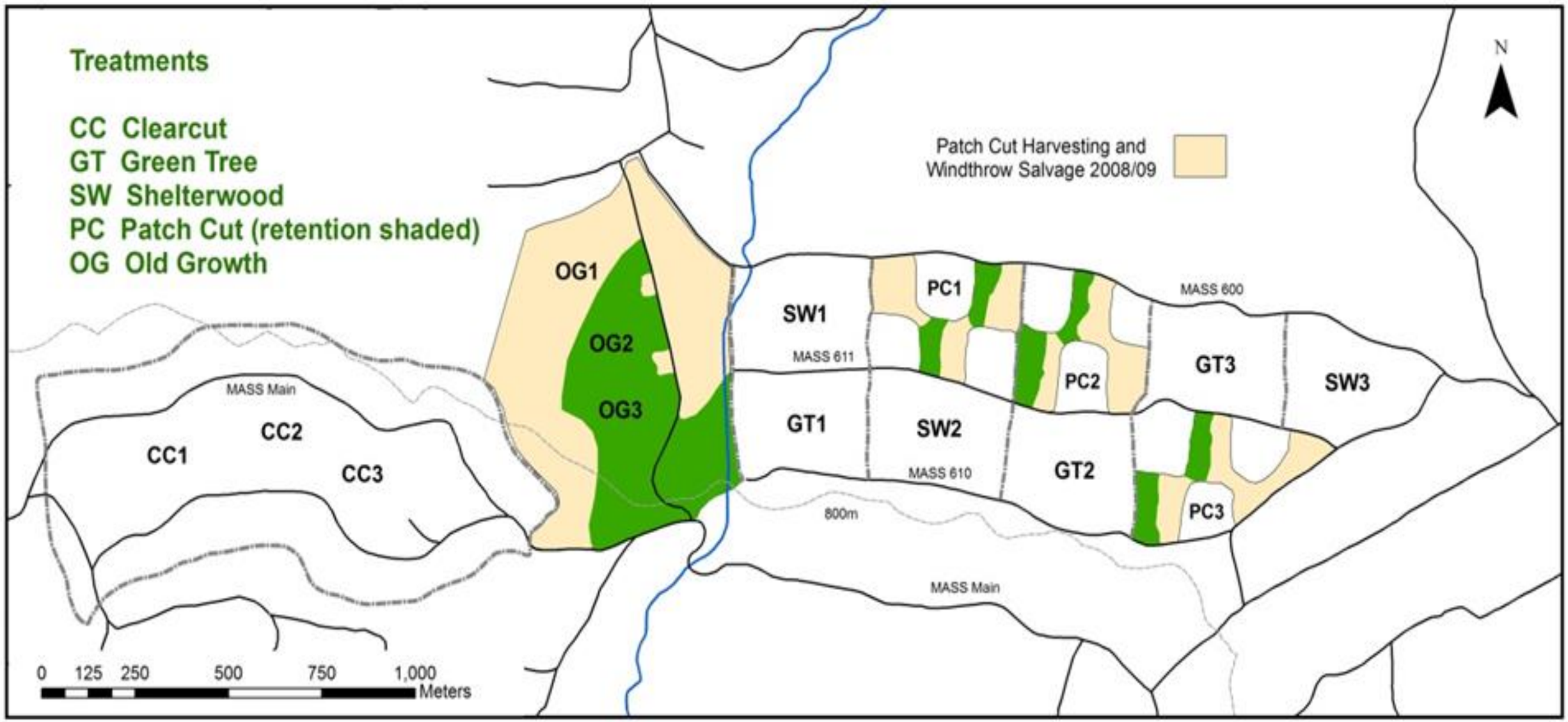
Elevation: 740 to 850m

Slope: Gentle (<20%)

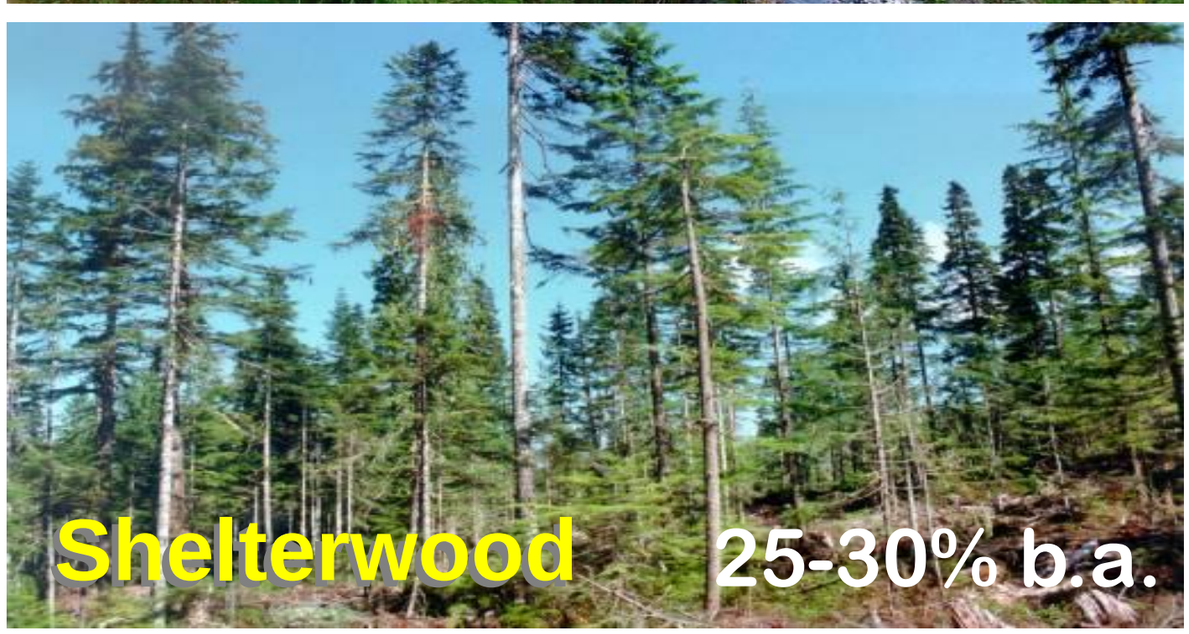
Temperature: Cool, 5.4˚C mean annual

Mapping by Alex Inselberg

MASS Study Area



Silvicultural Systems



Silvicultural Systems at Year 28 (2021)

Clearcut - 69 ha

Patch Cuts 1.5 to 2 ha

GT Retention - 25 sph

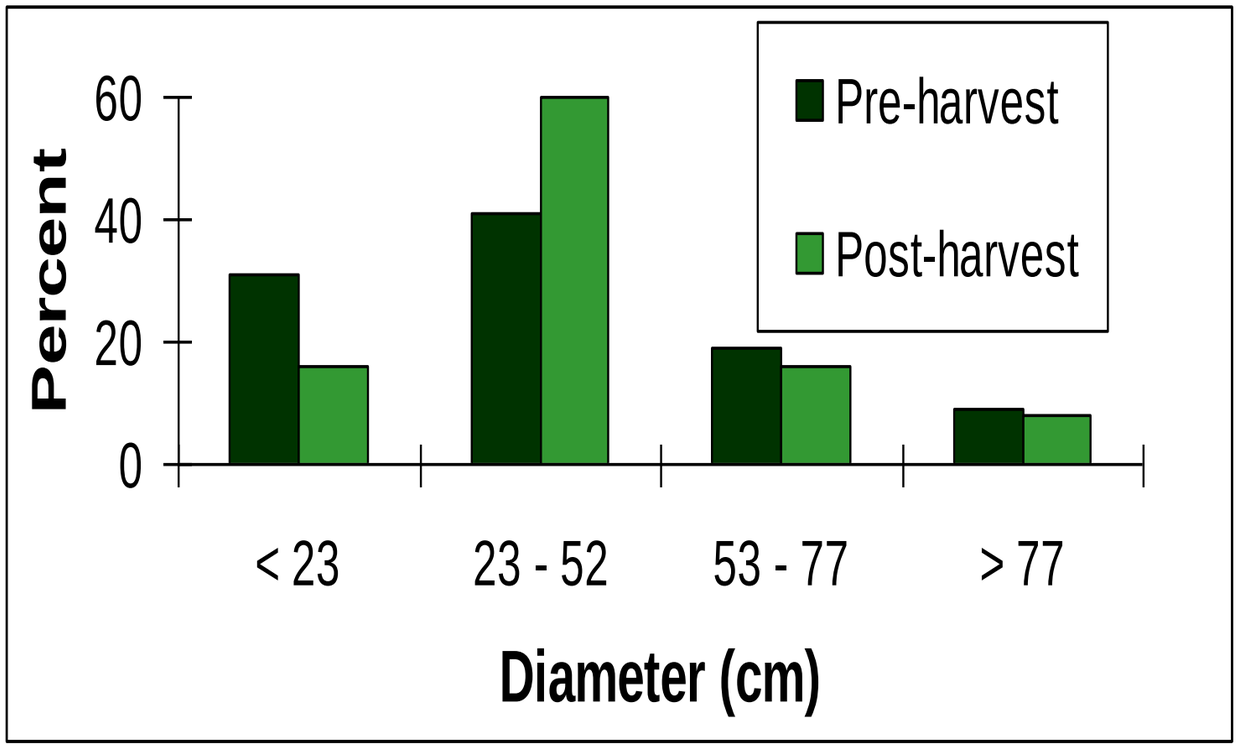
Shelterwood – 25% b.a.

Pre-Harvest Stands

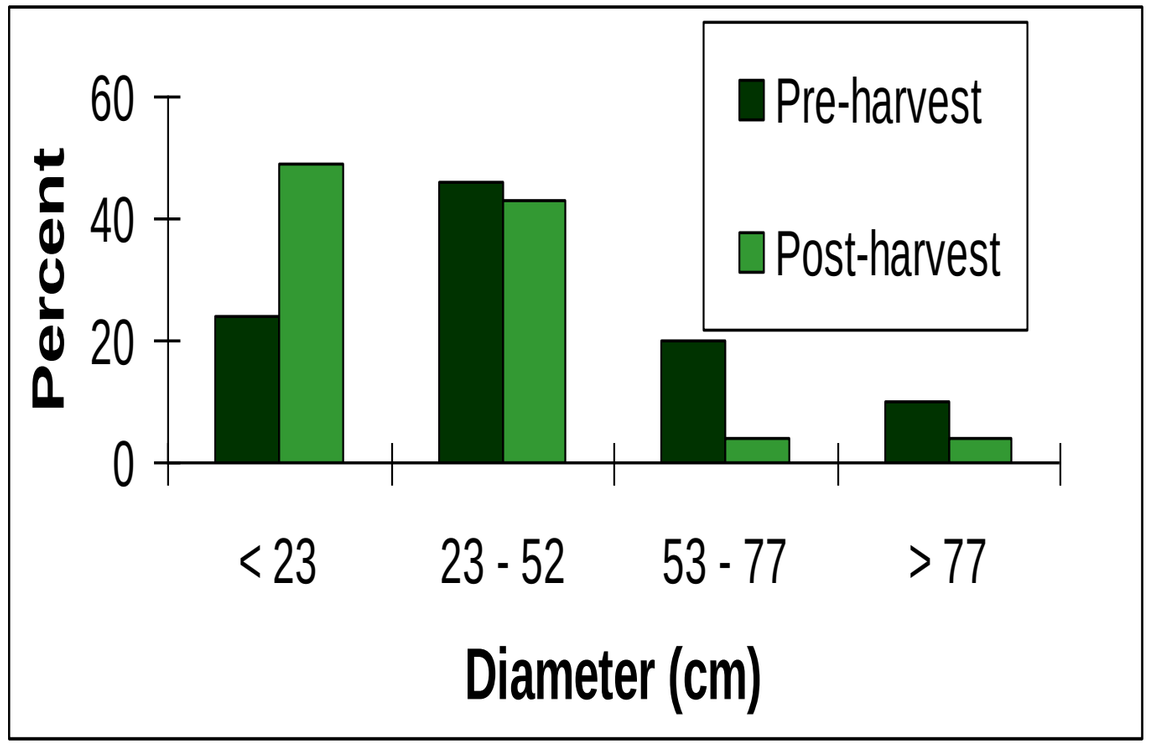
Treat-ment	Block	B.A. (m^2 ha^{-1})	Density (sph)	Mean Ht. (m)	Dom. Ht. (m)	Species Composition				
						DBH (cm)	Ba	Hw	Cw	Yc
GT	1	71	461	30	43	50	41	46	13	0
GT	2	91	751	16	41	26	18	47	29	6
GT	3	94	568	28	40	46	13	38	41	8
SW	1	69	401	31	40	48	35	48	15	2
SW	2	72	604	26	40	42	32	44	23	1
SW	3	78	493	28	39	44	16	37	36	11
PC	1	71	496	27	38	44	41	33	24	2
PC	2	82	489	26	39	46	30	33	33	4
PC	3	83	525	24	44	45	12	42	37	9
OG		71	431	28	38	46	37	44	19	0
CC		74	508	27	41	43	45	47	7	1

MB Inventory Section, Woodlands Services Division, 1992

Comparison of Pre/Post Harvest Stands



Dispersed (Green Tree) Retention



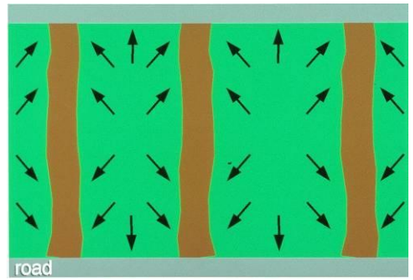
Shelterwood

MB Inventory Section

Harvesting and Costs

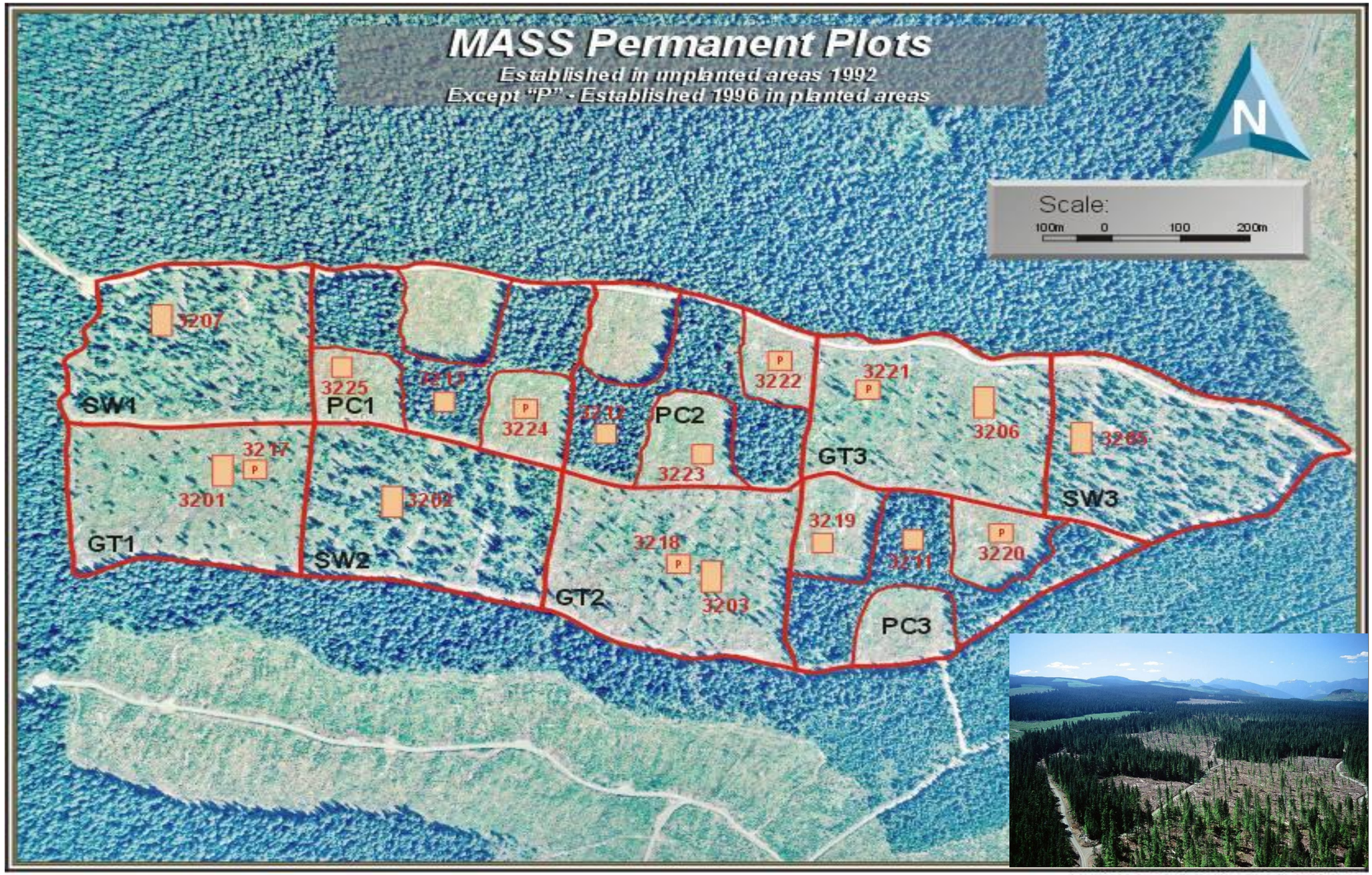
	Shelter-wood	Green Tree	Patch Cut	Clearcut
Area (ha)	27.5	27.3	17.1	69.1
Total Volume (m^3)	14503	18425	11175	45360
Average piece size (m^3)	1.25	1.12	1.12	1.15
Falling				
Time* (hr)	1069	1138	807	2868
Productivity (m^3/hr)	13.6	16.2	13.8	15.8
Cost ($/hr)	$59.14	$59.14	$59.14	$59.14
Cost ($/$m^3$)	$4.35	$3.65	$4.29	$3.74
Increase over Clearcut	17%	-2%	14%	--
Forwarding				
Time**(hr)	646	569	292	1001
Productivity (m^3/hr)	22.4	32.4	38.3	45.3
Cost ($/hr)	$125.00	$136.58	$137.40	$156.20
Cost ($/$m^3$)	$5.57	$4.22	$3.59	$3.45
Increase over Clearcut	61%	21%	4%	--
Total Cost at Roadside ($Cdn/$m^3$)	**$9.92**	**$7.87**	**$7.88**	**$7.19**
Increase over Clearcut	**38%**	**10%**	**10%**	**--**

*including pro-rated delays
**including pro-rated delays, all machines



Study by Eric Phillips

Growth and Yield Plot Locations – PC, GT and SW



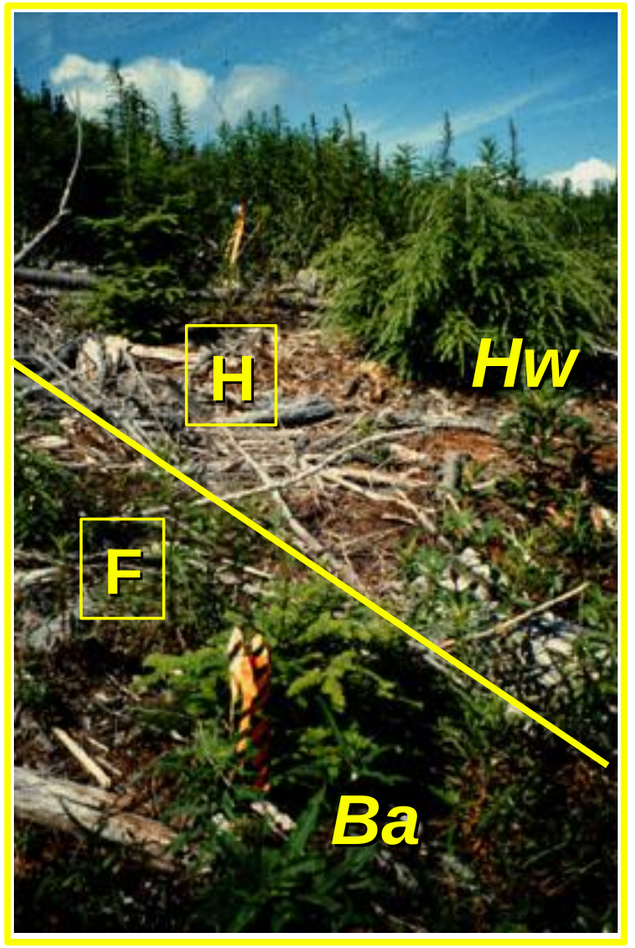
Study by
Nick Smith

Overview of Post-Planting Treatments

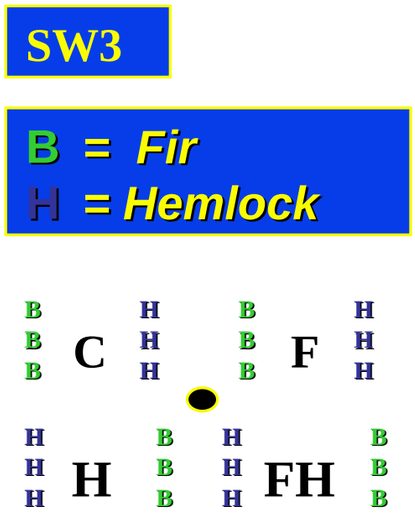
Plot Selection: A 30X30m grid was used to locate 12 sub-plots (12X 16m). Each subplot was divided into four quadrants (6X8m) with one of four randomly assigned planting treatments.

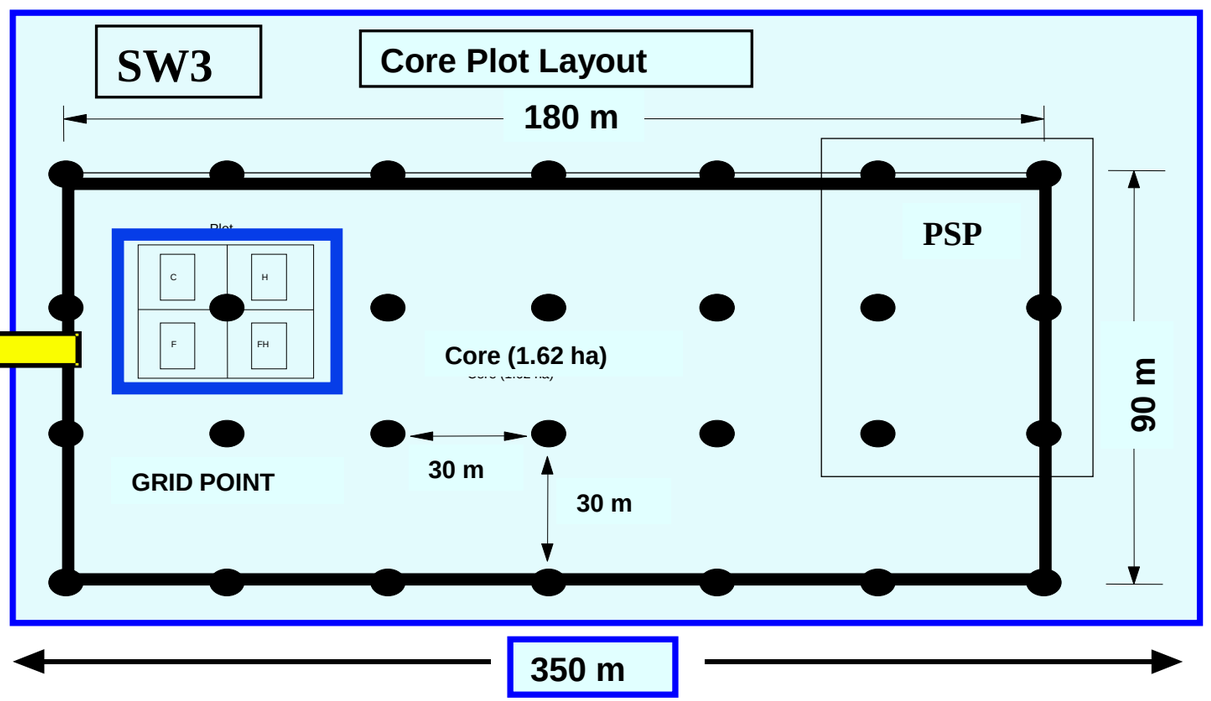
Post Planting Treatments

- C - Control (no treatment)
- F - Fertilization (at planting)
- H - Herbicide (annually, 3 years)
- FH - Fertilization and Herbicide



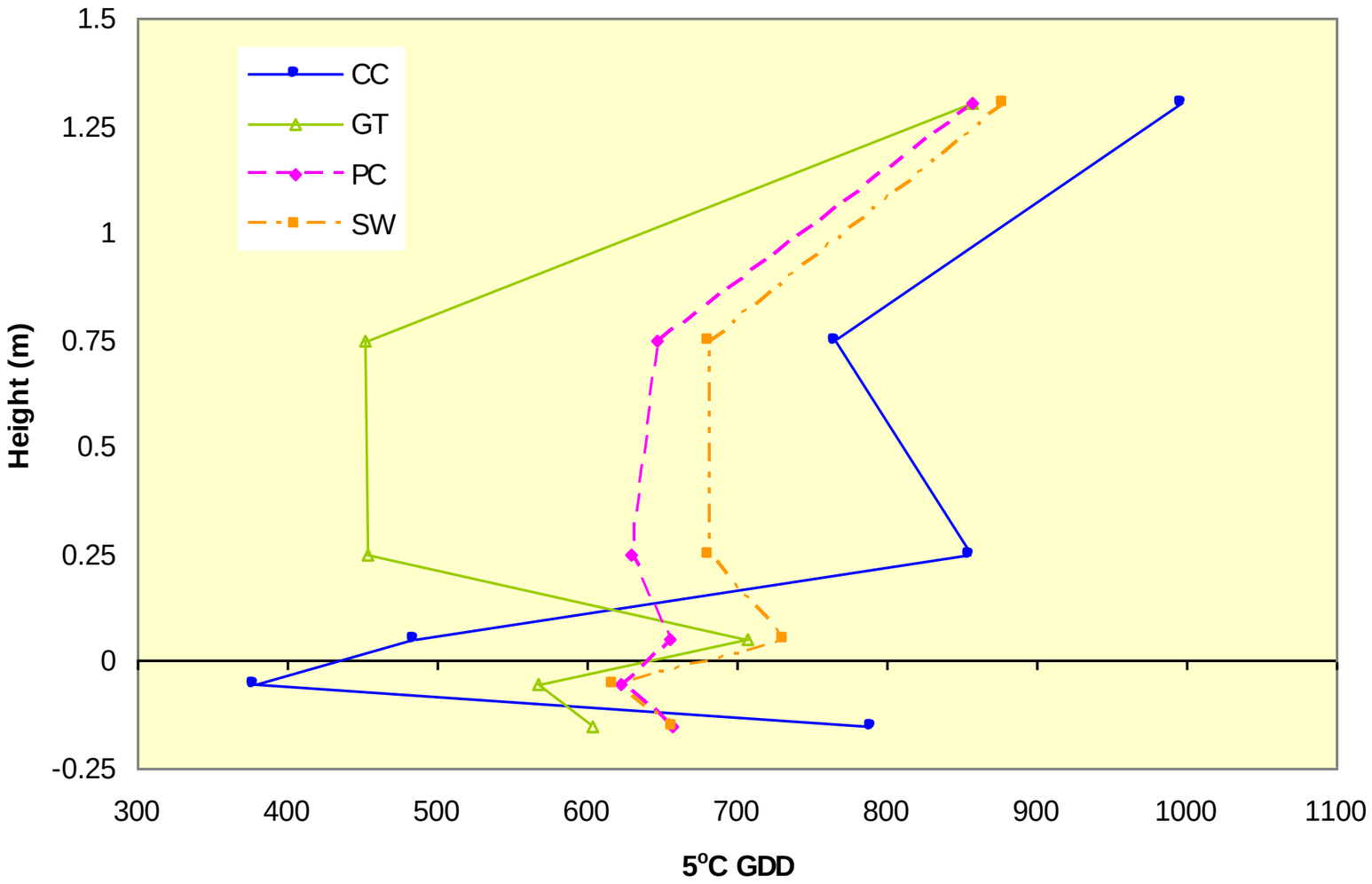
Regeneration Plot (Year 3)





Study design and establishment by Jim Arnott and Glen Dunsworth

Microclimate



Study by Ross Benton

Results:

- Average daily wind speed was highest in the CC, intermediate in the GT and lowest in the PC and SW.
- There were cooler rooting zone (-5 cm) temperatures and lingering snowpacks in the CC.
- Air and soil GDDs near the soil surface were reduced in the CC compared to other treatments.
- GDDs were highest in the Clearcut and lowest in the Green Tree
- There was no difference in GDD between the Patch Cut and the Shelterwood

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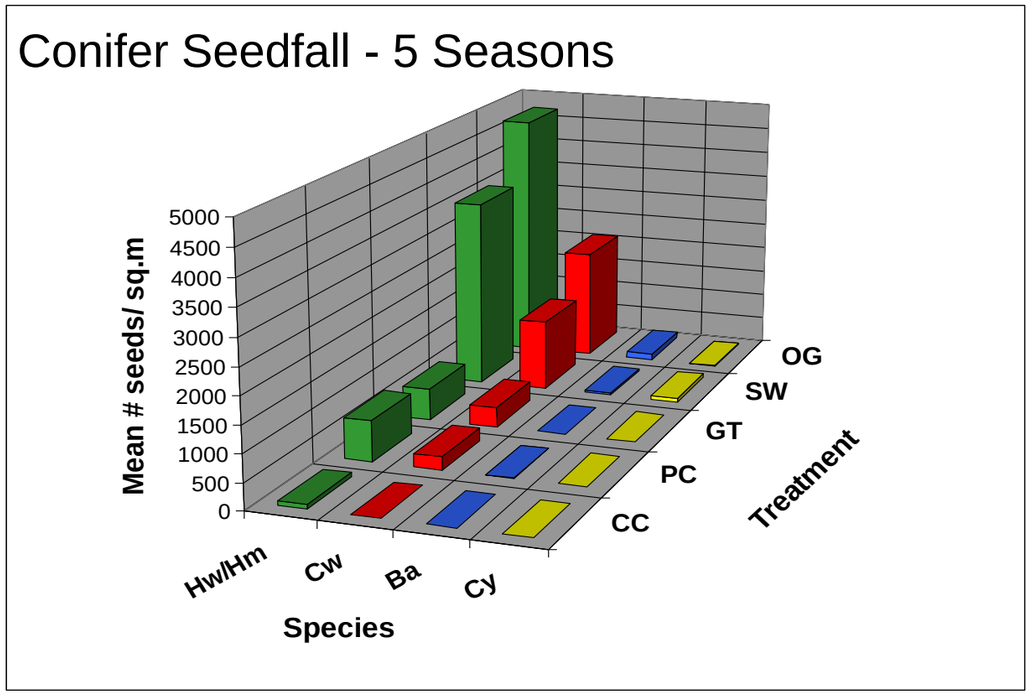
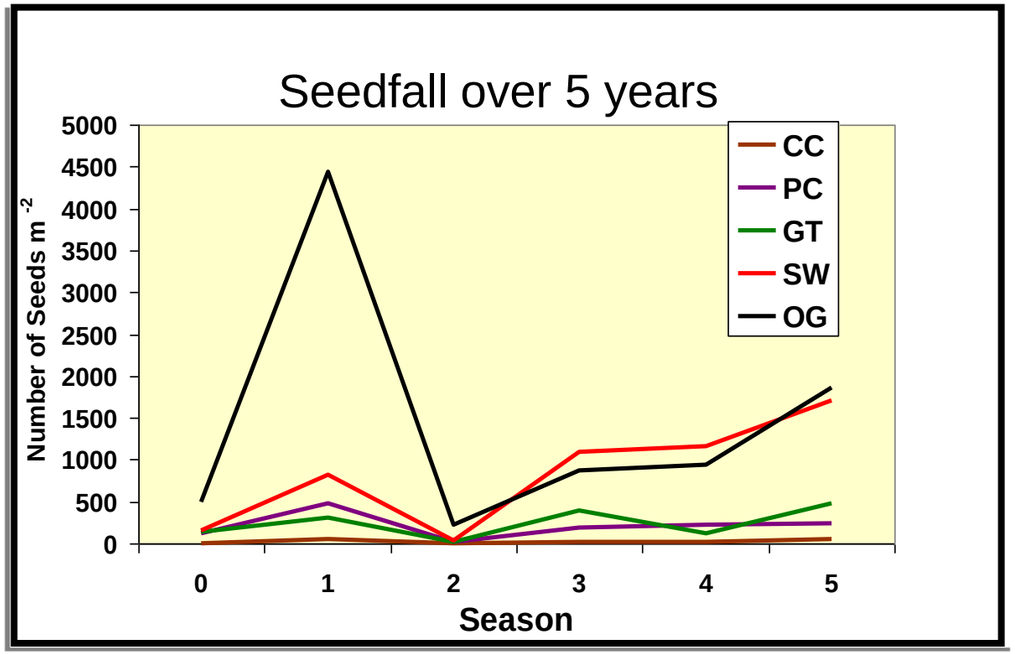
Natural Regeneration – Seedfall and Germination





Results:

- Larger crops Cw, Yc, Ba every 3 years; Hw every 4 years; adequate for success
- Shelterwood seedfall similar to old growth
- Hw germination in lab 6 - 50%; Cw 2 - 33%
- No differences in germination or pathogens on seeds by treatment or seedbed; fungi do not apparently affect germination or germinants

Species	*Period (yrs)*	*Release*	*Distance (m)*
Hw	3-5	Sep-Jul	1600
Cw	3-5	Sep-May	120
Ba	2-5	Sep-Apr	115
Cy	2-4	Sep-Oct	120
Hm	3	Sep-Oct	115

Study by Bill Beese, Jeff Sandford and Ralph Nevill

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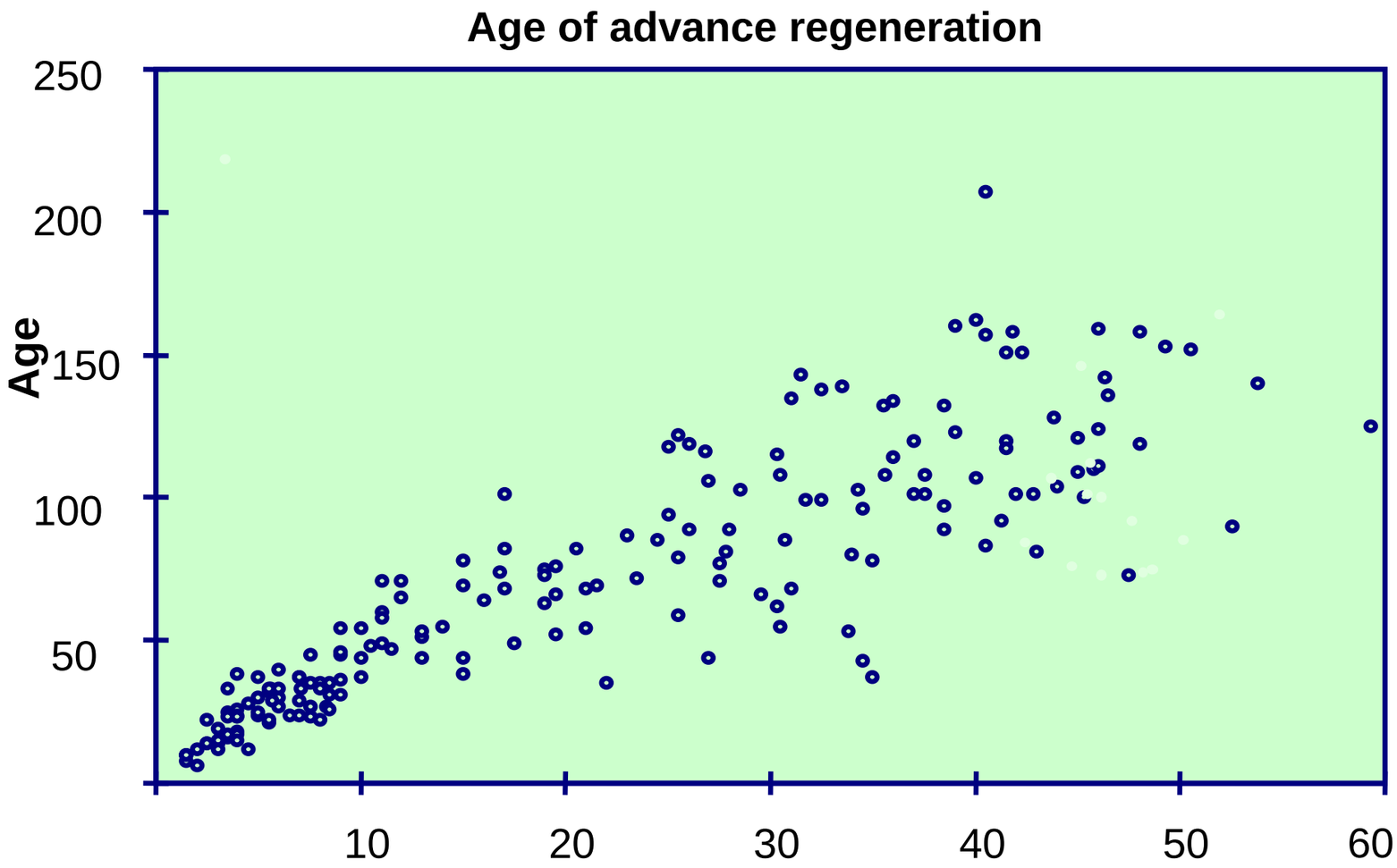
Natural Regeneration - Establishment and Stocking

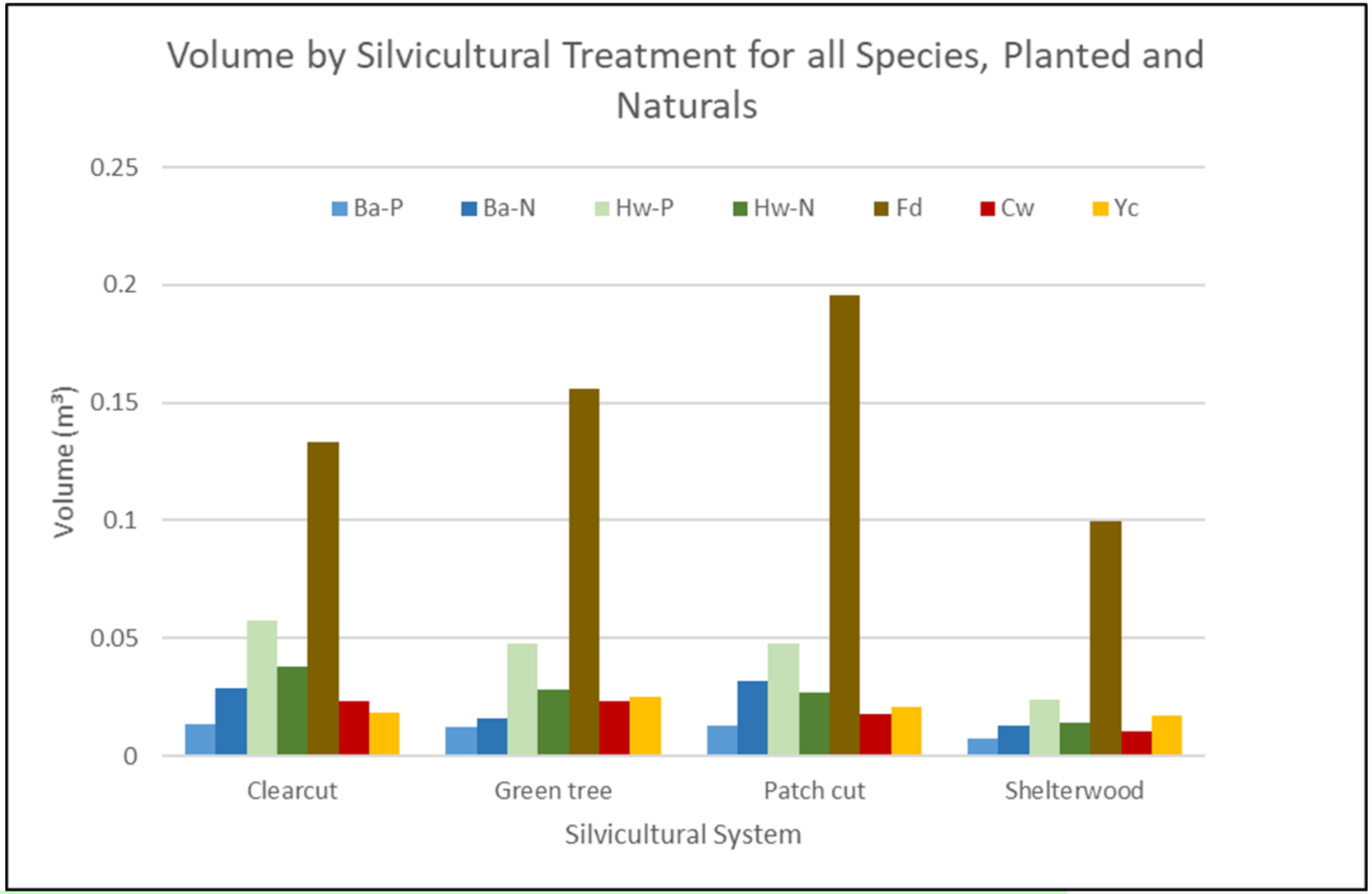


Results:

- Advance Ba & Hw regeneration 5 to 150+ years old, but capable of release
- Stocking of small conifers recovers after 5 seasons
- Seedling (<30cm) densities reduced by harvesting damage and mortality
- Germinant survival extremely poor
- Cw establishment improved with harvest

Study by Bill Beese and Jeff Sandford

Natural Regeneration – vs Planted Seedlings



Results (25 years):

- **Planted Douglas-fir volume growth was far superior to all other species, but it had the highest mortality and greatest snow breakage**
- **Growth was reduced in the Shelterwood compared to other systems**

Studies by Bill Beese, Jeff Sandford, Jim Arnott, Glen Dunsworth, Al Mitchell, Tom Bown, Graeme Goodmanson, Cosmin Filipescu

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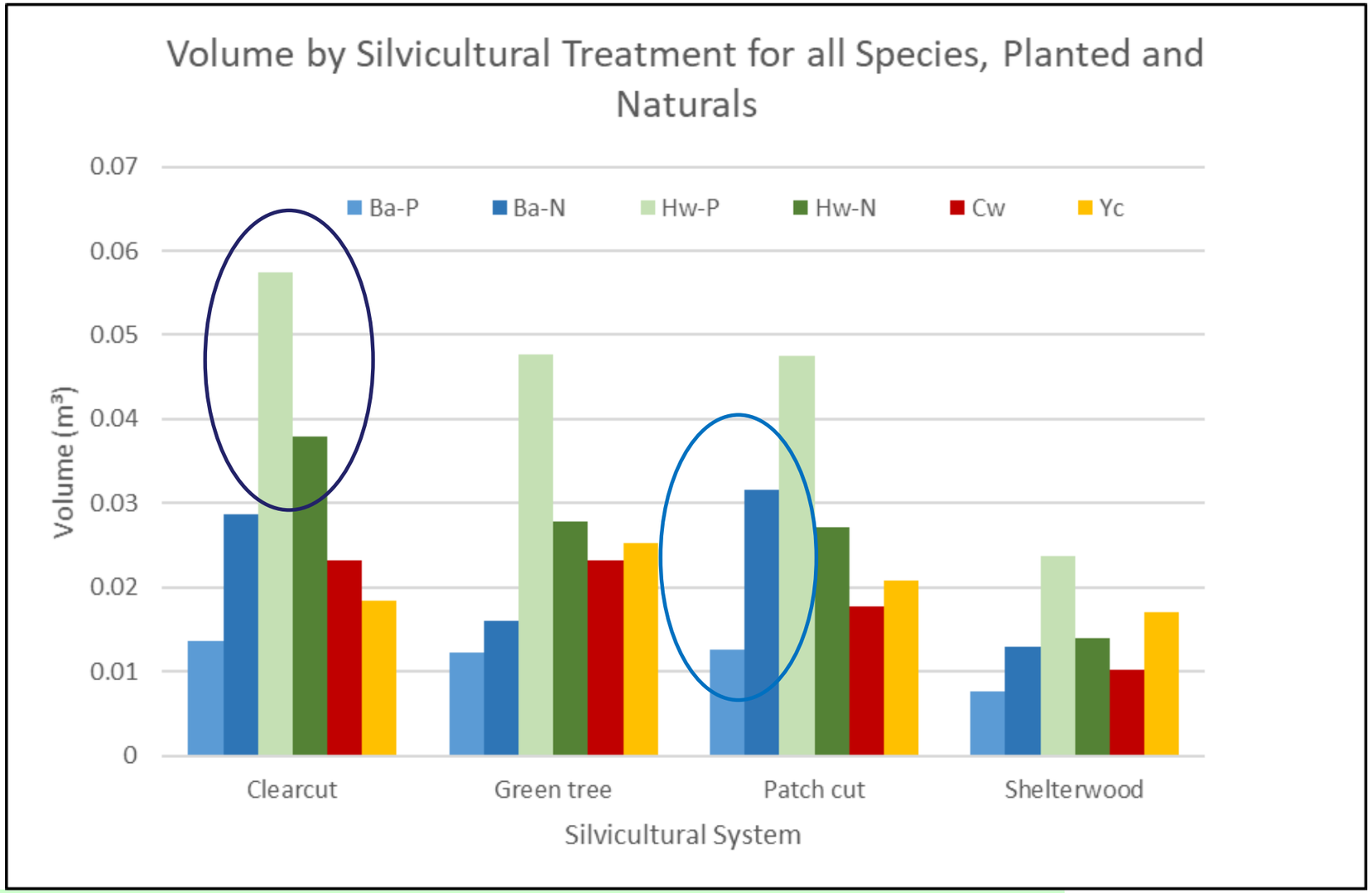
Natural Regeneration – vs Planted Seedlings



Results (25 years):

- **Planted western hemlock outperformed naturals, but natural amabilis fir had better growth than planted fir.**
- **We think it is due to slow fir root establishment**

Studies by Bill Beese, Jeff Sandford, Jim Arnott, Glen Dunsworth, Al Mitchell, Tom Bown, Graeme Goodmanson, Cosmin Filipescu

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Light Environment and Analysis

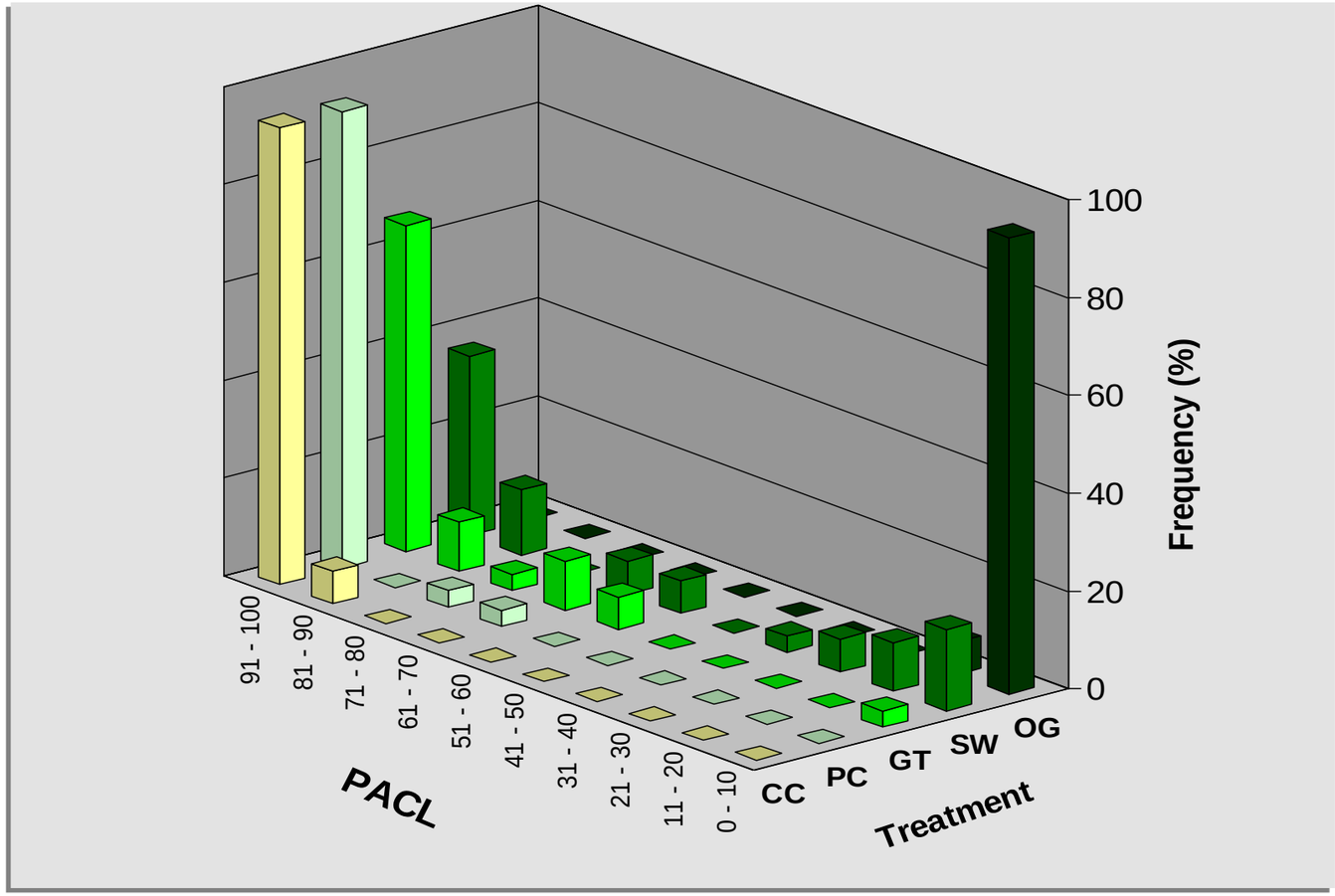
Total Site Factor = percentage of total direct + indirect solar radiation relative to above-canopy, integrated over the year.

Total Site Factors

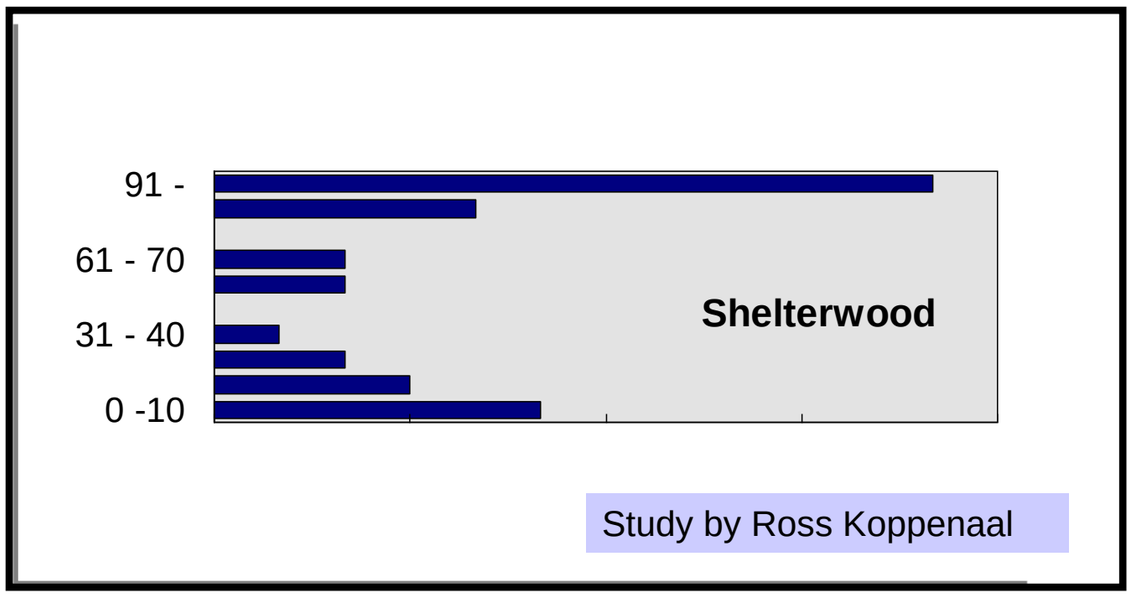
CC = 0.99

GT = 0.70

SW = 0.41



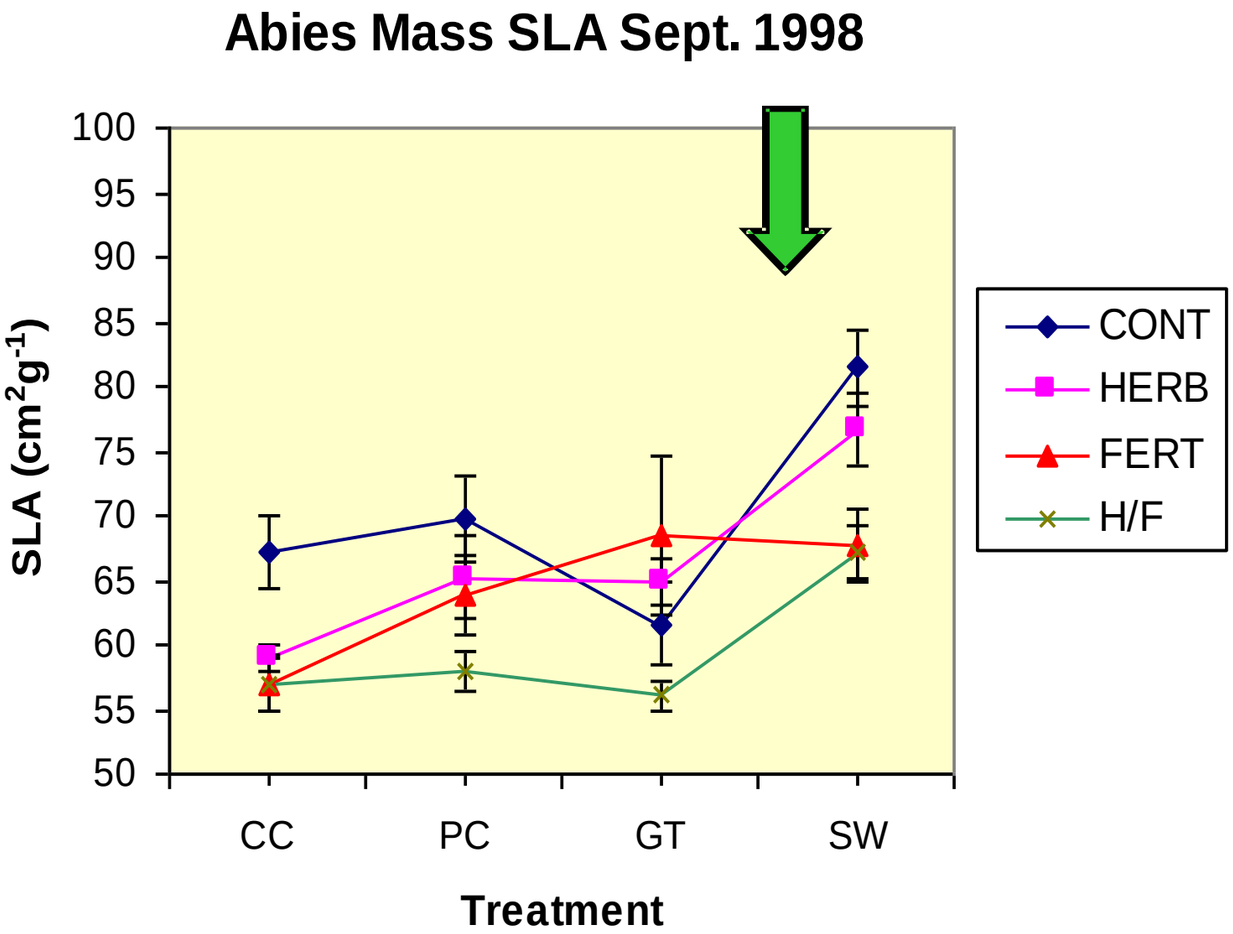
Canopy light transmittance under clear skies (% Above Canopy Light (PACL) vs. % frequency)

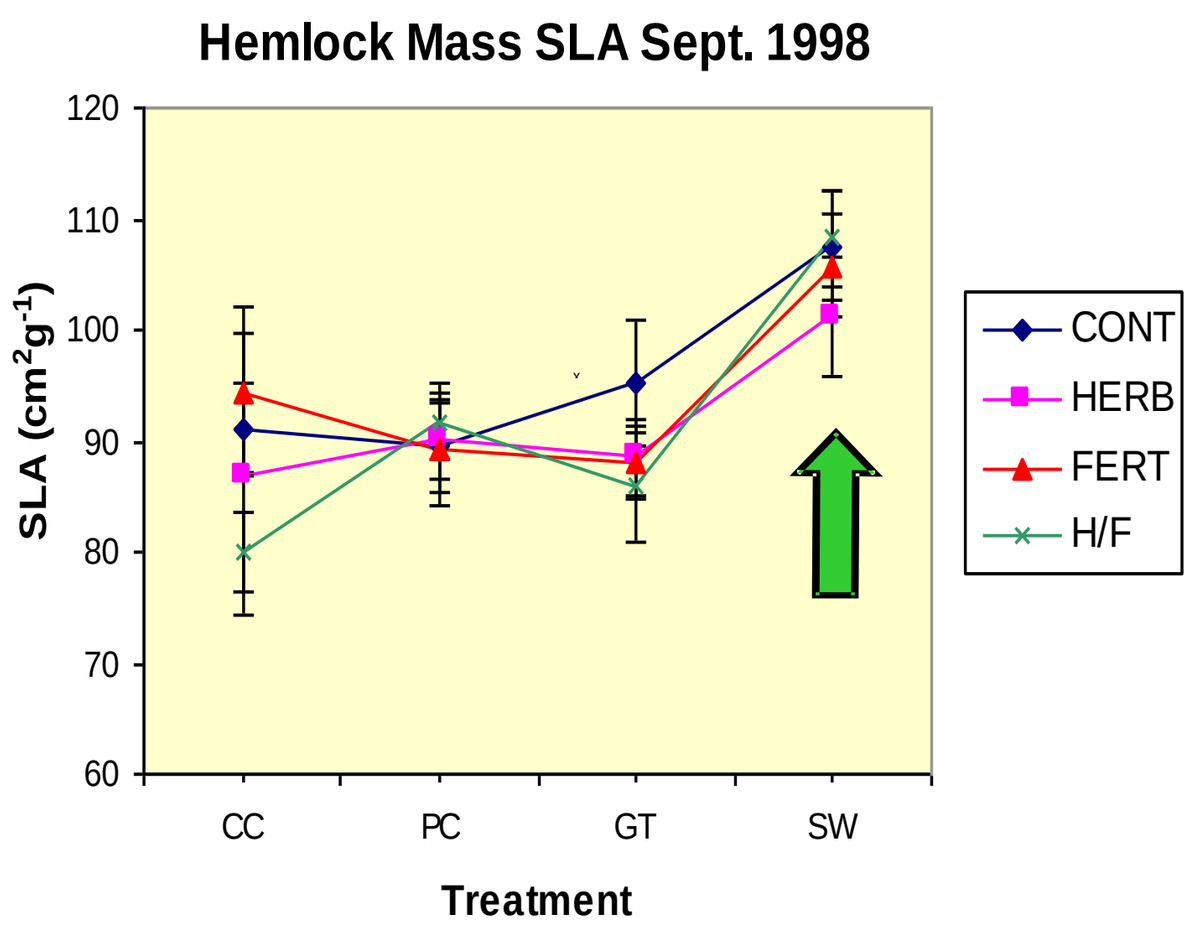


Study by Ross Koppenaal

Planted Seedlings - Shade Limitations

Specific leaf area ($cm^2\ g^{-1}$) of planted Western hemlock and Amabilis fir seedlings (year 5).





Results:

- Increased specific leaf area in the Shelterwood indicated shade limitations on growth.
- Post planting treatments did not affect specific leaf area in any of the silviculture systems.
- Growth limitations could arise from both overstory and understory shade.

Study by Al Mitchell, Tom Bown and Graeme Goodmanson

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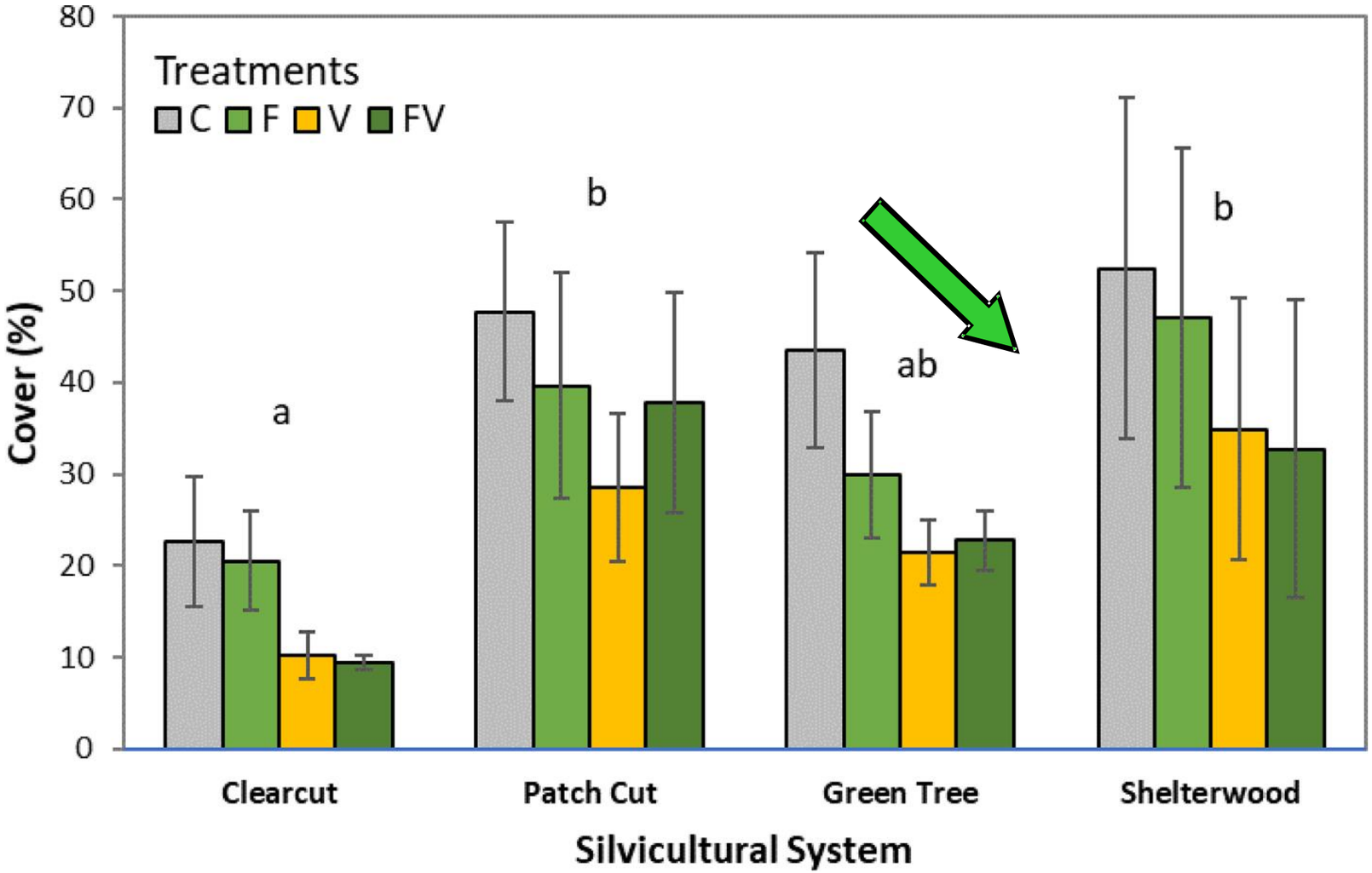
Sub-treatments on Planted Trees – Shrub at 26 years



Treatments

C=Control (no treatment)

F=Fertilization

V=Vegetation control (manual and herbicide)

FV=Fertilization + Vegetation control

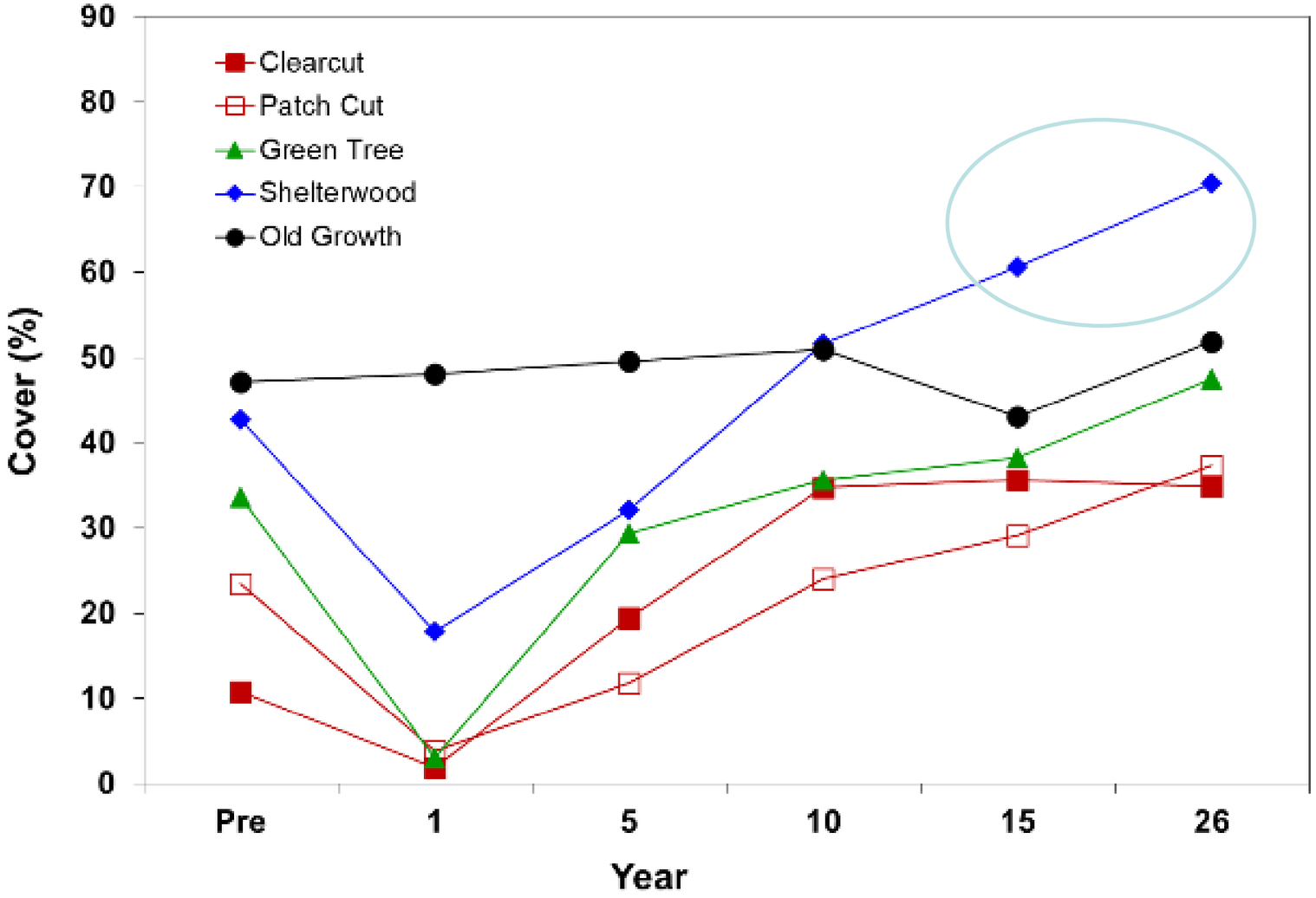
Error bars are +/- 1 SE.

Results:

- Trends suggest lower cover with vegetation control, but NSD among treatments
- The Clearcut had significantly less shrub cover than the Patch Cut and Shelterwood

Study by Jim Arnott, Glen Dunsworth, Al Mitchell, Tom Bown, Graeme Goodmanson, Cosmin Filipescu

Understory Shrubs - Percent Cover



Results:

- The sheltwerwood maintained more shrub cover after harvesting and produced the highest shrub cover after 26 years.

Study by Bill Beese, Jeff Sandford, Megan Harrison, Cosmin Filipescu

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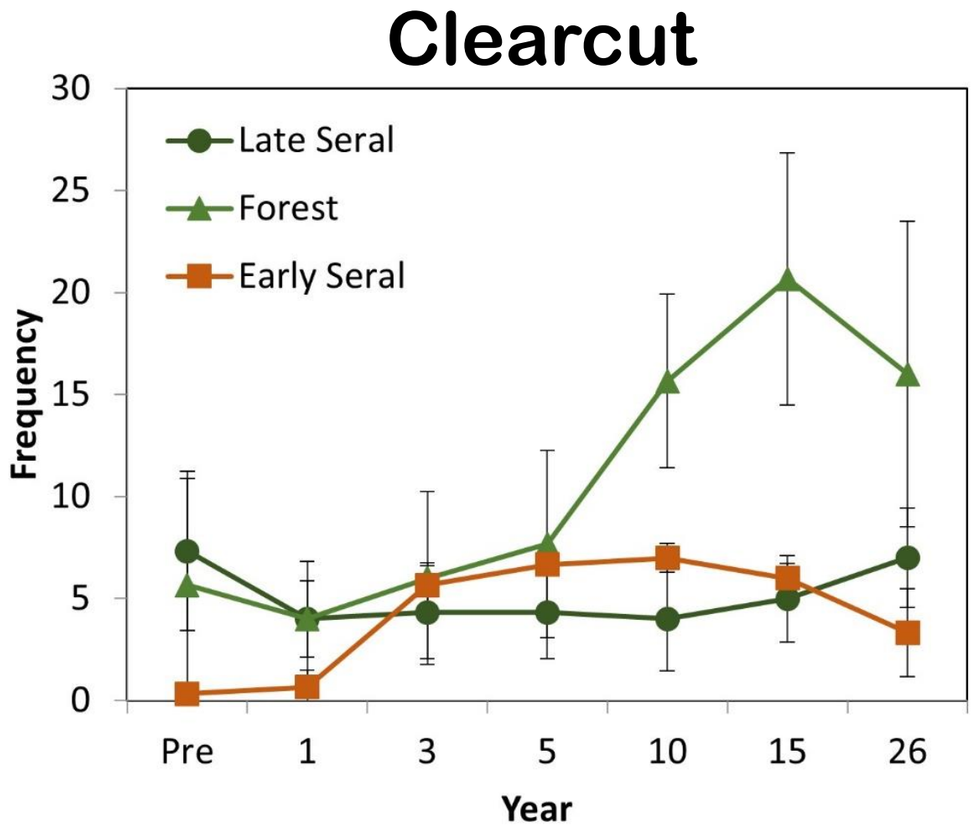
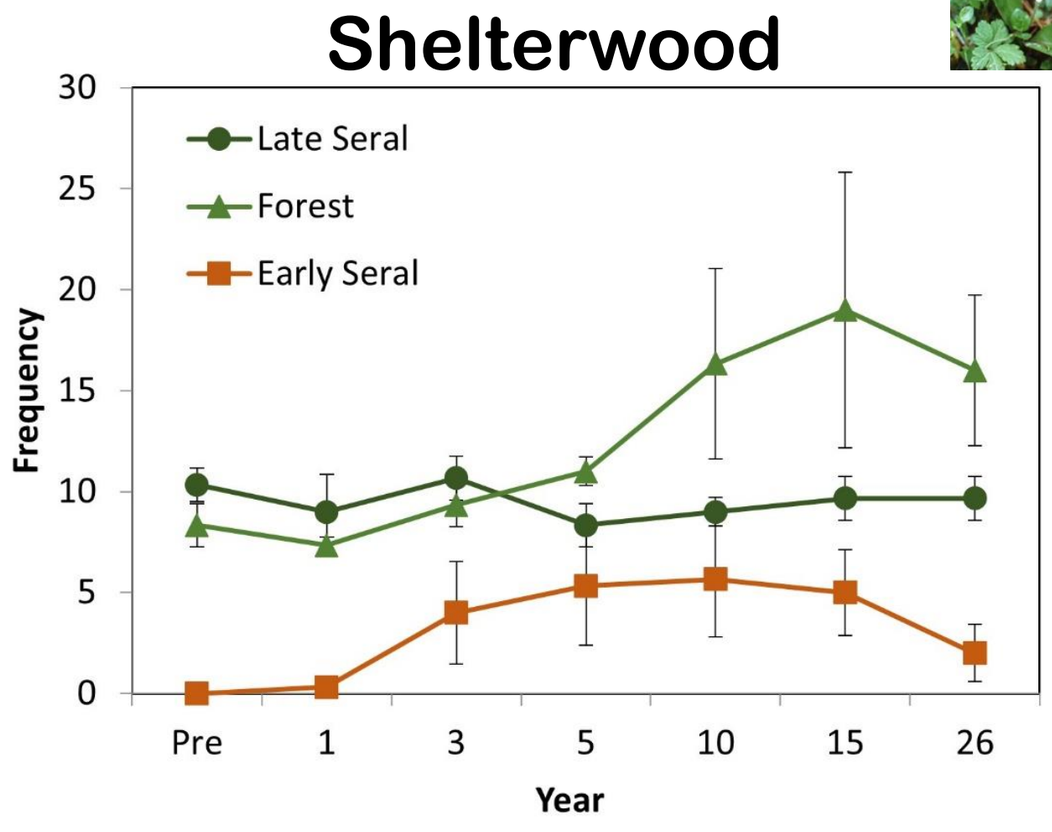
Understory – Herb Frequency by Seral Groups





Results:

- Early seral herbs increased in the first 10 years, then dropped off from crown shading
- Forest generalist herbs peaked in year 15, with the largest increase among the 3 groups
- **Late seral** herbs did not show much change overall, but some species decreased

Study by Bill Beese, Jeff Sandford, Megan Harrison, Cosmin Filipescu

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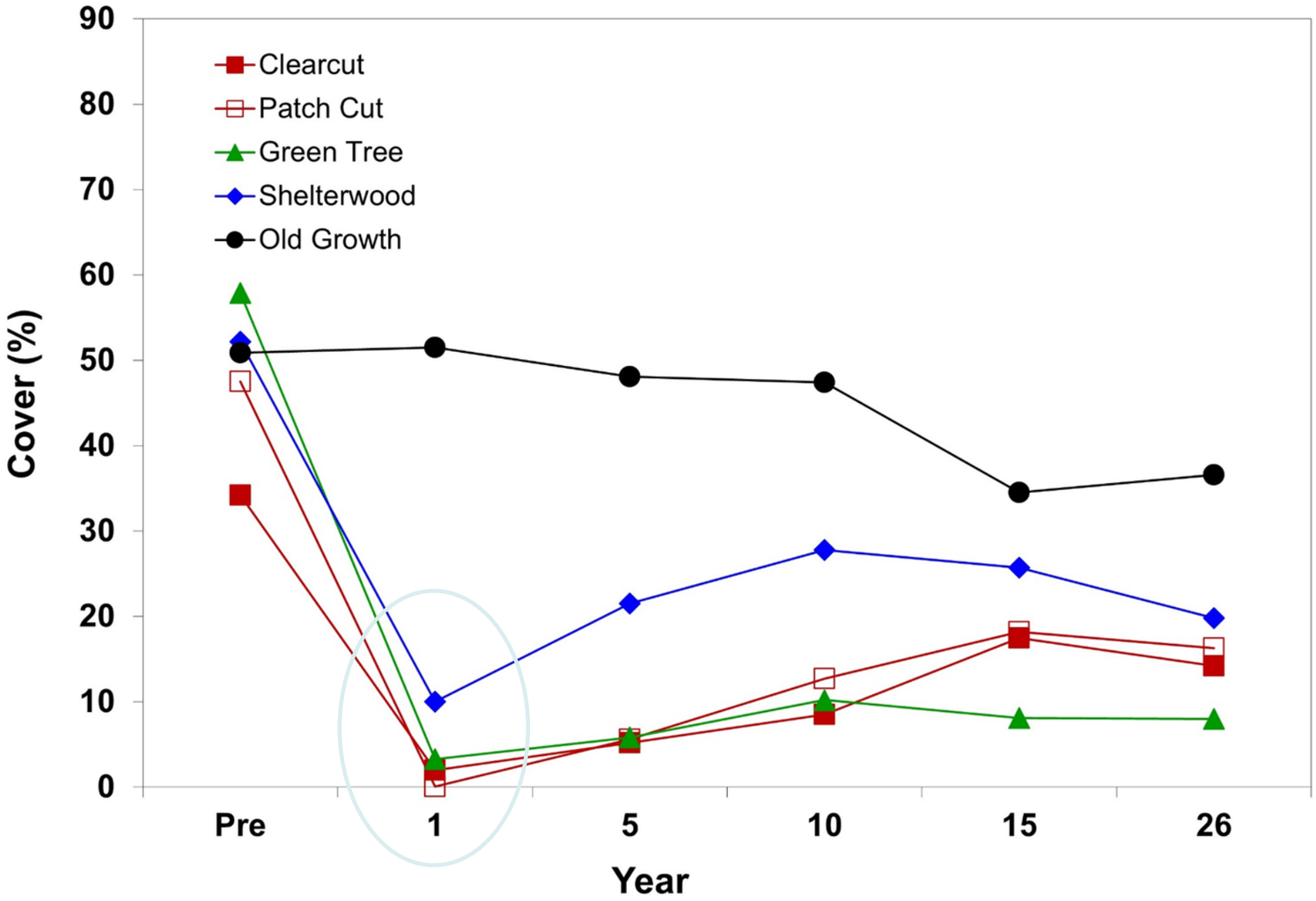
Bryophytes - Percent Cover



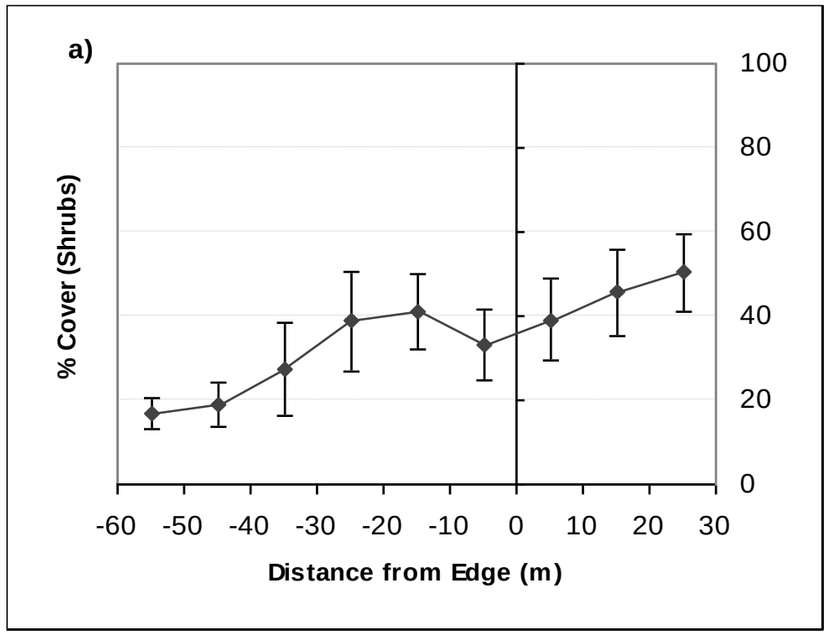
Results:

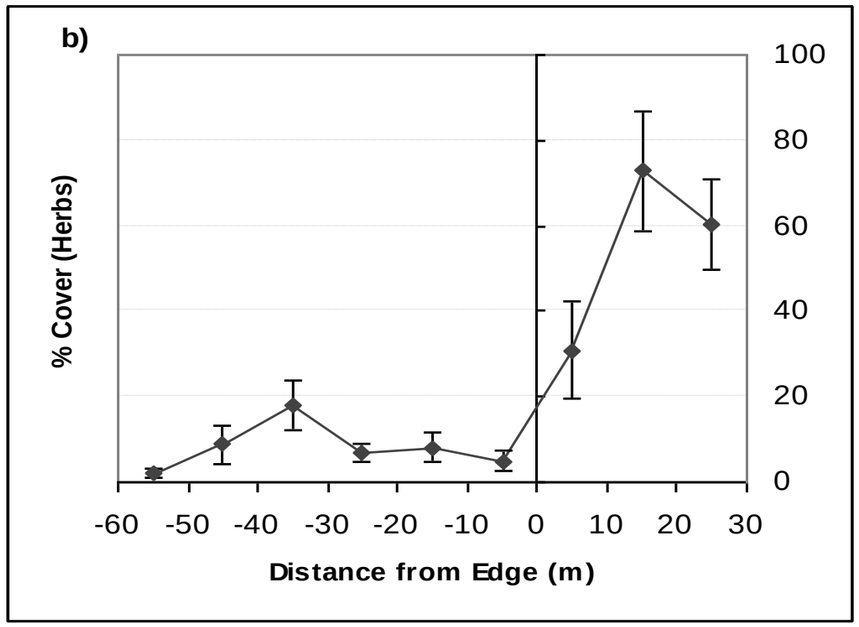
- Bryophytes (mostly mosses) did not recover to pre-harvest cover

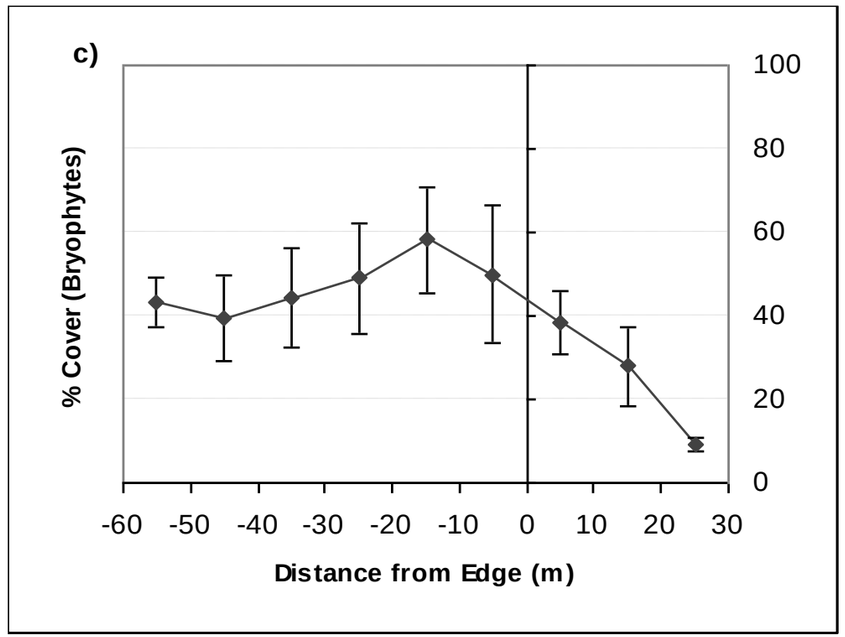
Study by Bill Beese, Jeff Sandford, Megan Harrison, Cosmin Filipescu

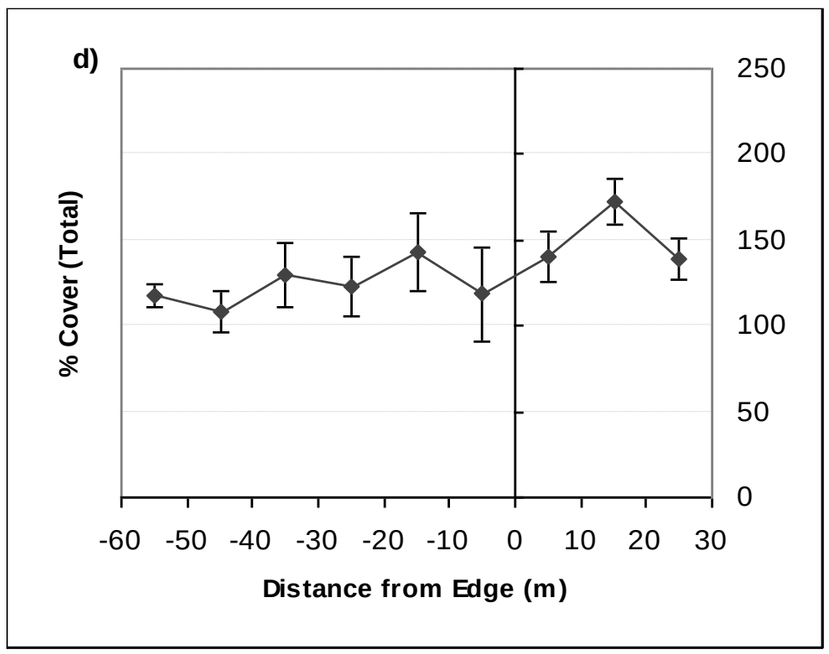
Understory - Patch Cut Edge Effects

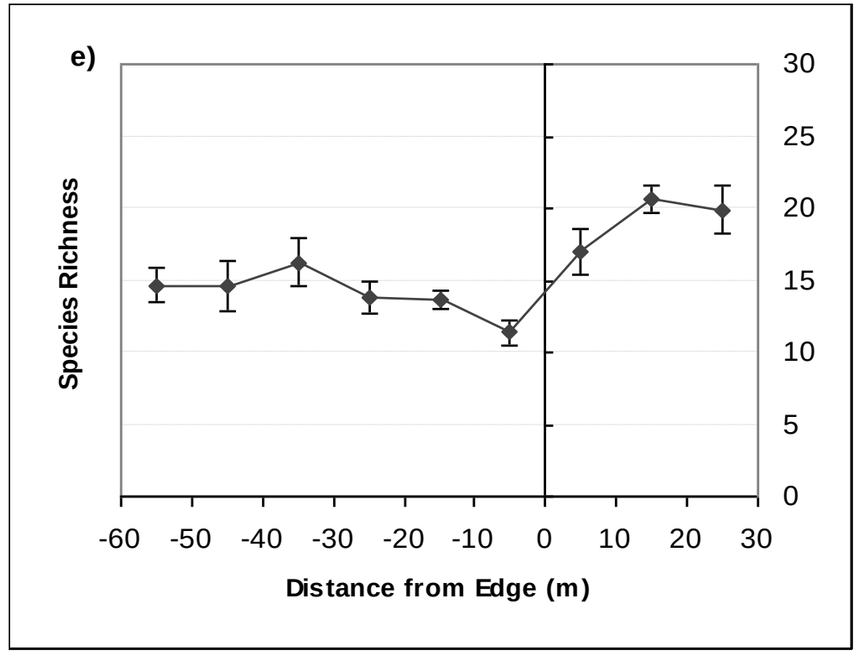
Study by Bill Beese, Jeff Sandford and Megan Harrison

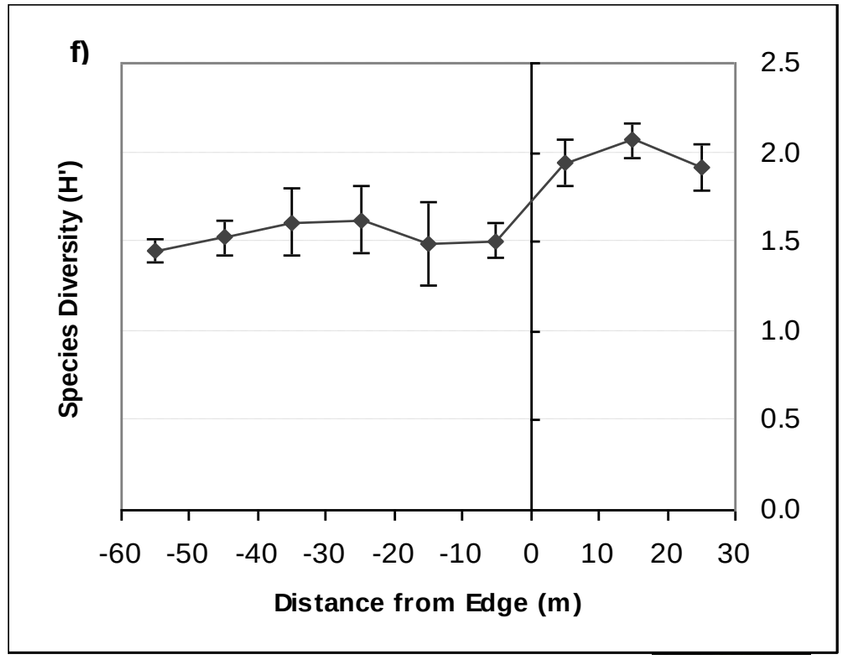












Wind Damage

Wind Damage	Treatment			
	GT	SW	PC	CC
% stems	29.4 a	10.3 b	2.3 b	7.7 b
Stems ha^{-1}	8.3 a	20.9 b	4.0 a	7.2 a
% basal area	29.6 a	18.3 ab	2.2 c	10.4 b
Basal area ha^{-1}	1.4 a	3.1 b	0.6 a	1.3 a

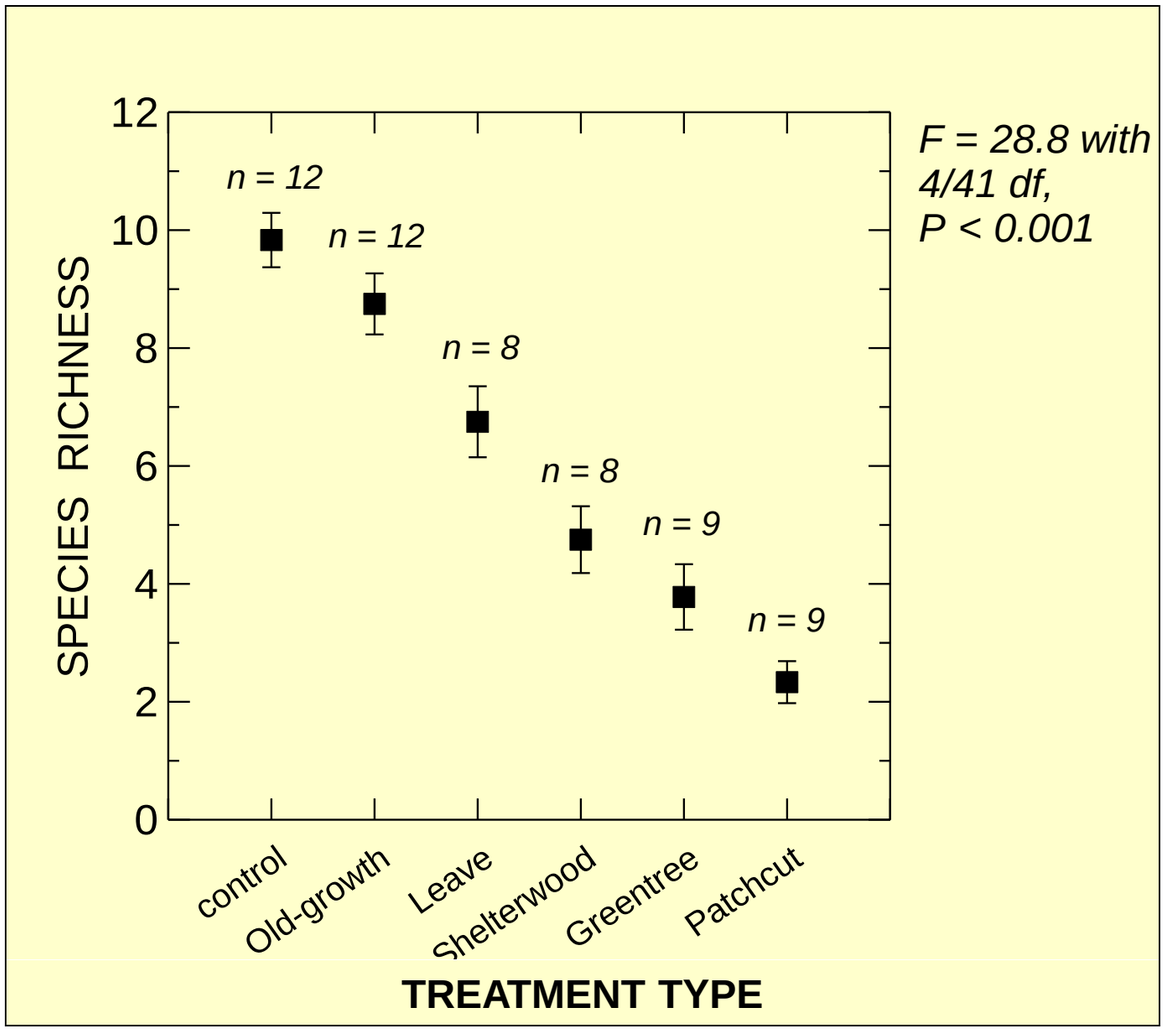
Attribute	Clearcut	Green Tree	Patch Cut	Shelterwood
	%	%	%	%
Wind Damage Type				
Uprooted	89	90	83	85
Broken	9	8	16	11
Leaning	2	2	1	4
Contributing Factors				
Wet soil	20	14	13	10
Shallow roots	6	2	10	3
Small root mass	15	14	20	7
Rooting in decayed wood	4	6	8	3
Damaged roots	0	5	0	6
Hit by another tree	45	5	24	28
Decayed wood (stem)	3	12	4	12
Unknown	24	43	37	33

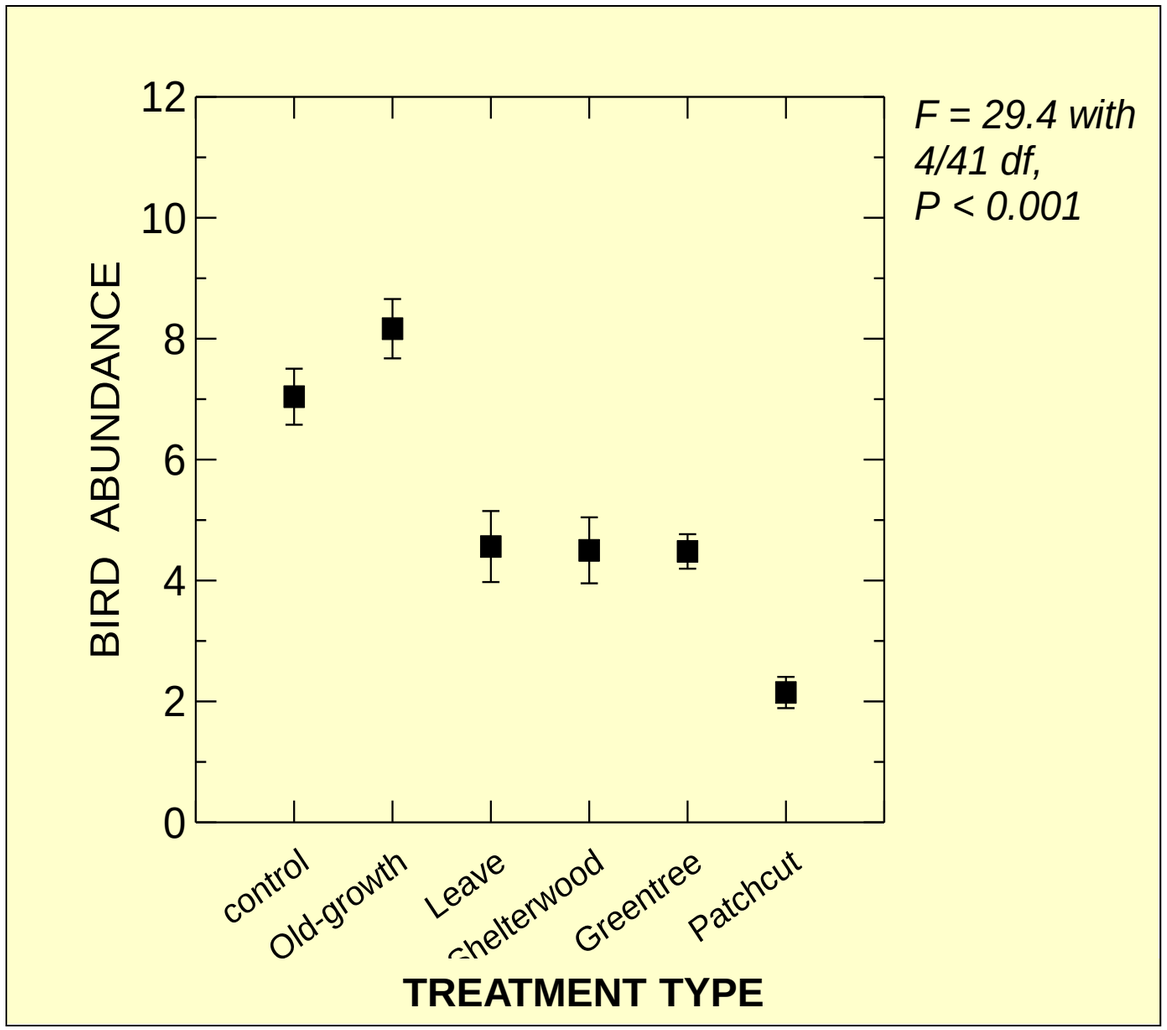
Summary for 6 years post-harvest

Study by Bill Beese, Tine McLennan, Judith Toms, Colin Peters, Jeff Sandford

MASS

Post-harvest - Bird Species Abundance and Richness



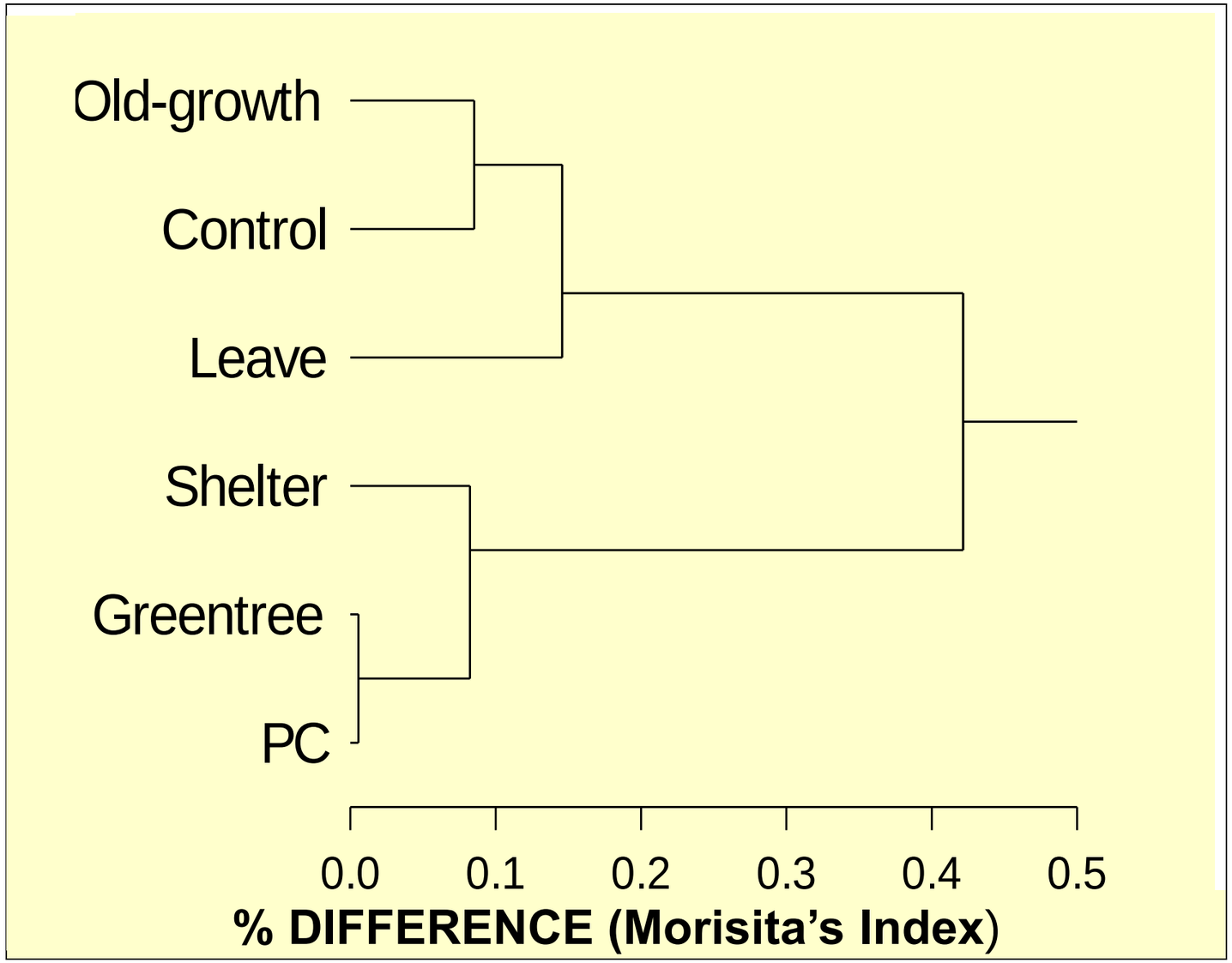


Pre-Harvest (1992) findings:

- MASS differs from other old-growth forests: low richness (4 spp. = 2/3 detections)
- More resident than migratory species, many cavity nesters

Study by Andrew Bryant

Bird Community Similarity



RESULTS:

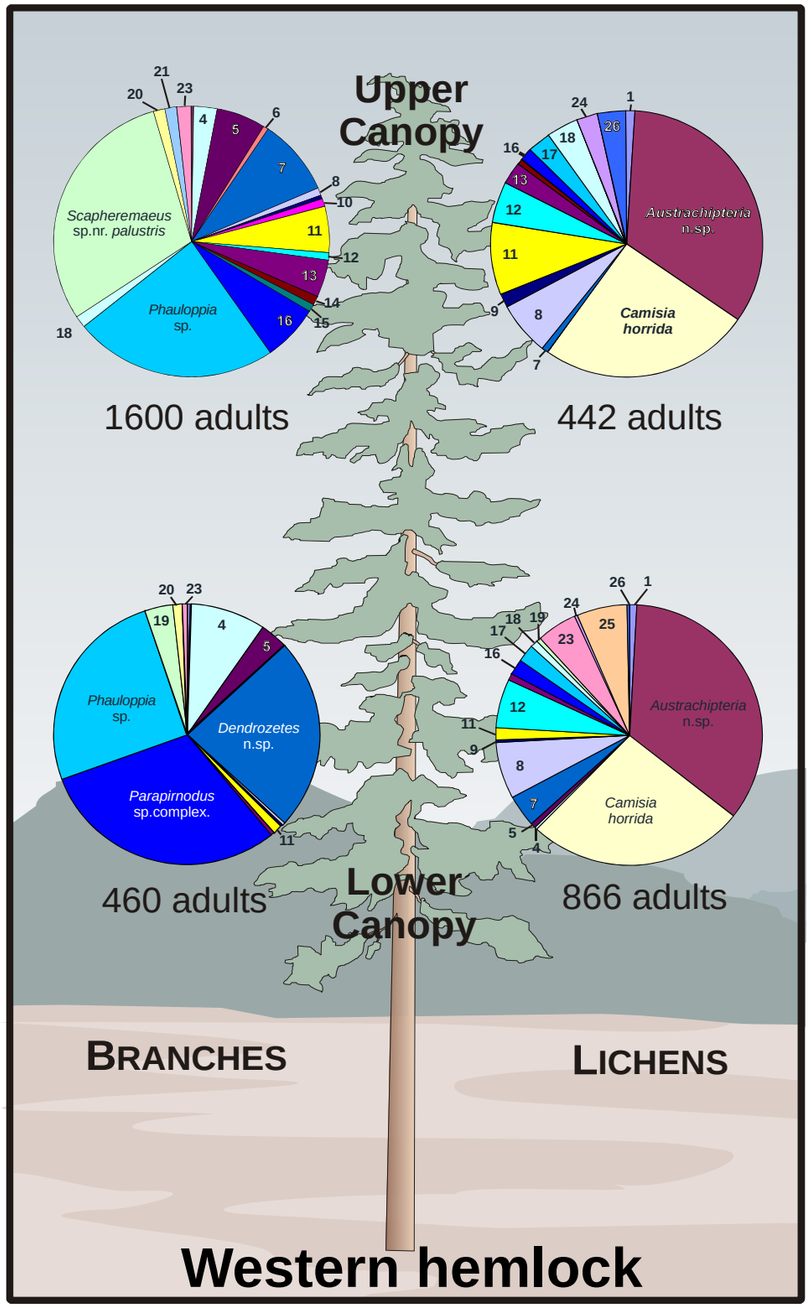
- < 60% overlap between treated and untreated stands
- Breeding bird community significantly altered

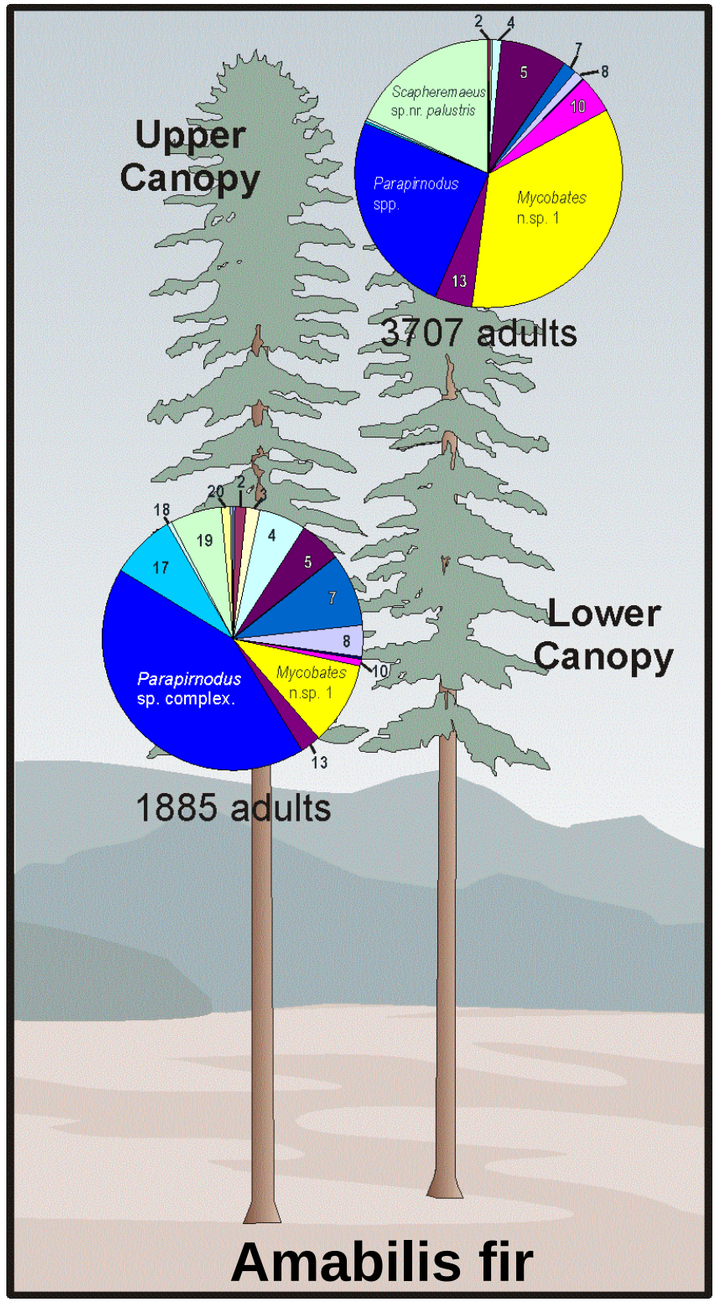
Photo: Mike Preston

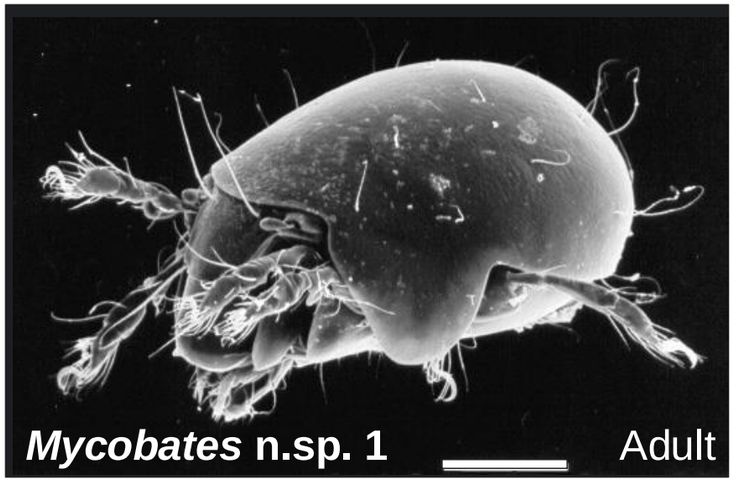
Chestnut-backed Chickadee

Study by Andrew Bryant

Canopy Oribatid Mite Diversity







RESULTS:

- Adult Oribatida were twice as abundant in the upper canopy of Amabilis fir and almost four times as abundant in the upper canopy of Western hemlock than in the corresponding lower canopies.
- Oribatid species richness of the branch micro-habitat is similar between tree species.
- Upper canopy supports a more abundant fauna than the lower.

Study by M. Clayton, L. M. Humble , V. Behan-Pelletier & N. N. Winchester

MASS

Silvicultural Implications

- Small patch cuts and low levels of retention do not affect early tree growth significantly.
- Planted western hemlock (Hw) had better height and volume growth under partial canopies vs. planted amabilis fir (Ba) or naturals, but advance Ba surpassed natural Hw. Douglas-fir outperformed all species.
- Modified shelterwood design (lower uniform density, strips, groups) could improve early growth compared to the shelterwood at MASS.
- GT and PC can be implemented on coastal montane sites without reducing early plantation performance.
- Vegetation control treatment generally reduced the time to free growing height for Ba and Hw.
- Vegetation control with fertilizer had an additive effect for Ba.

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