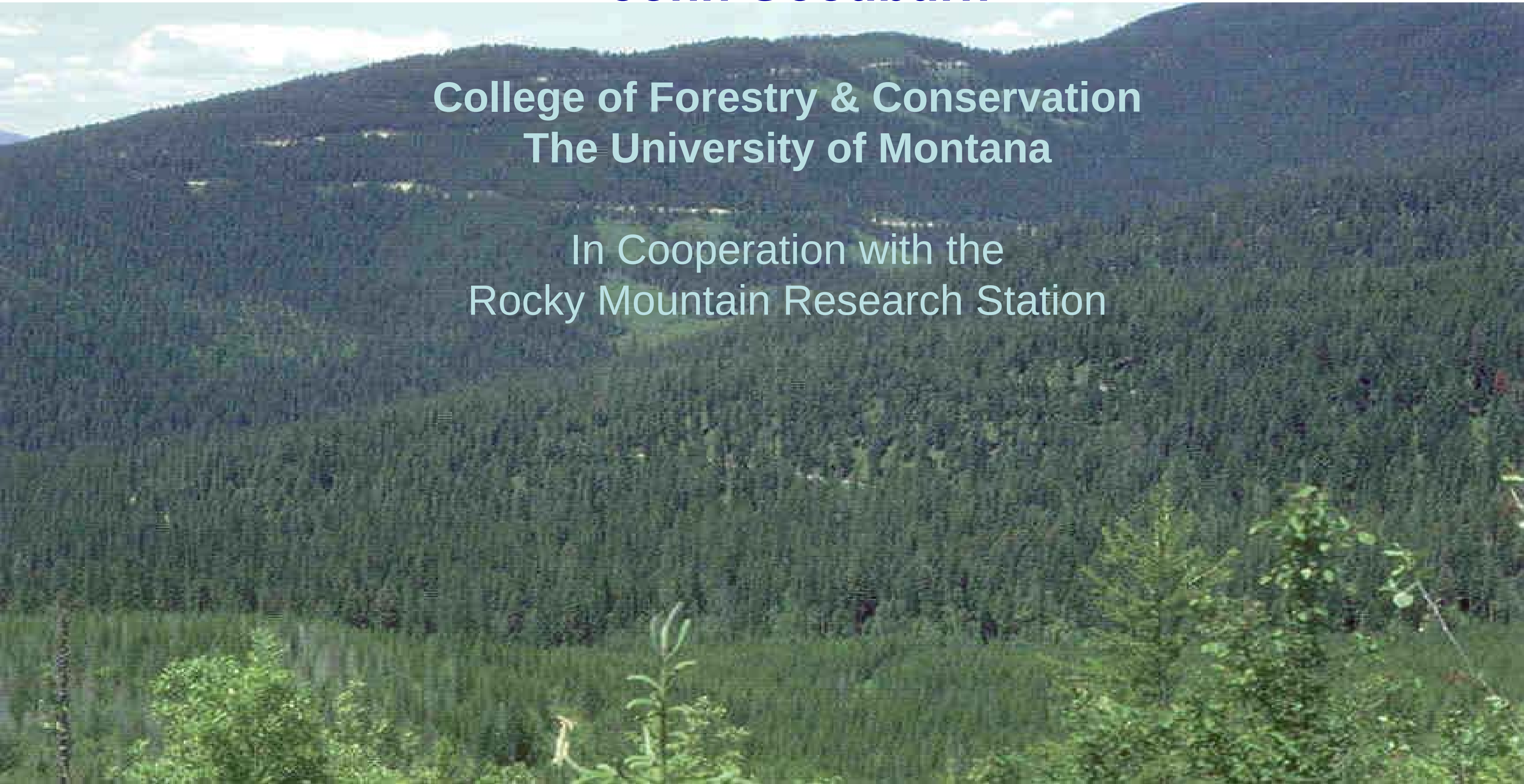
Forest productivity related to utilization treatment options on Coram Experimental Forest

John Goodburn



College of Forestry & Conservation
The University of Montana

In Cooperation with the
Rocky Mountain Research Station

Effects of harvest and residue treatments on natural regeneration and long-term sapling dynamics in larch-fir forests

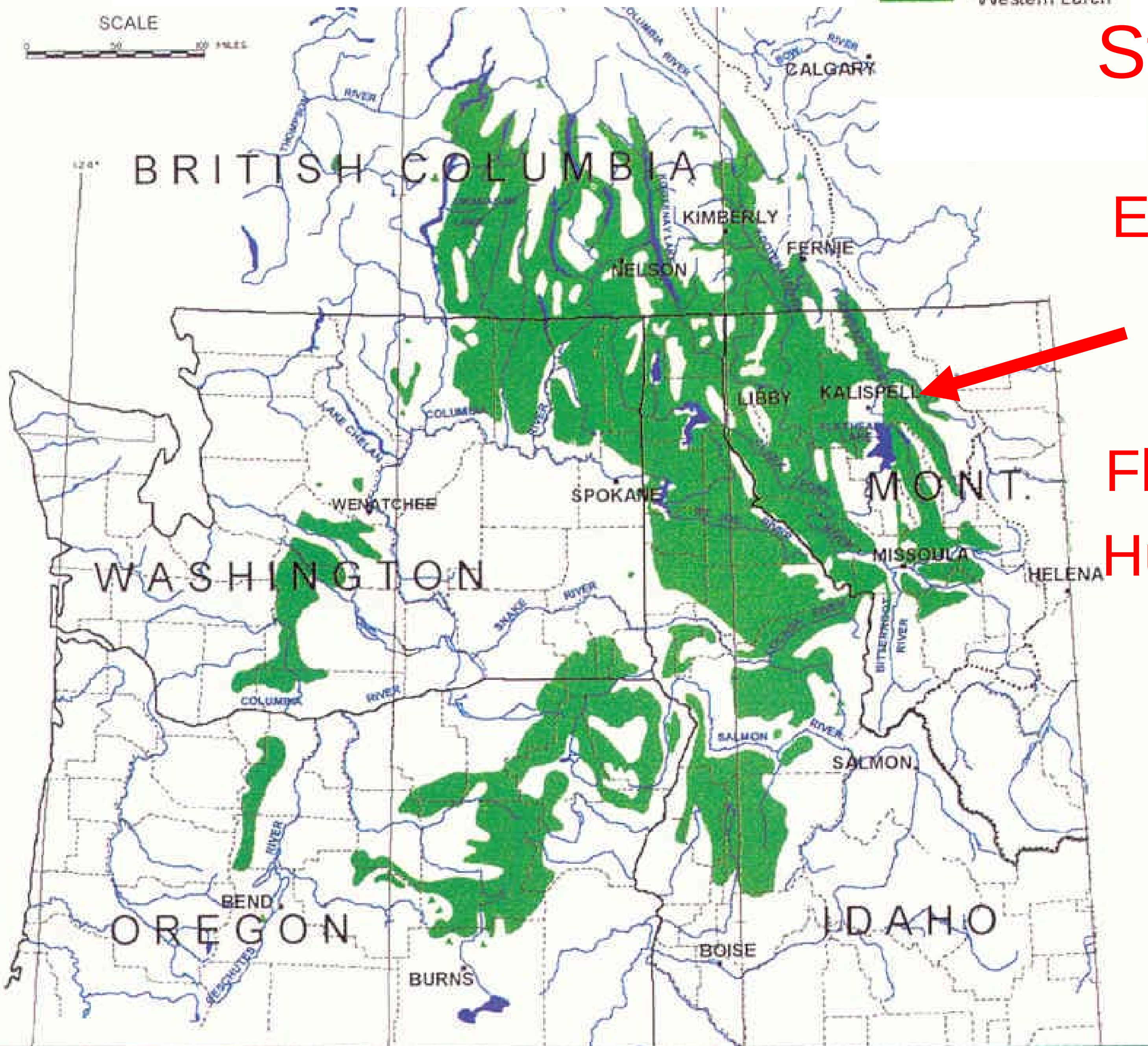
John Goodburn and Sarah Pierce

Research Joint Venture with the
Rocky Mountain Research Station
Ray Shearer: USFS Research Scientist

Overview

- **Provide background on the Harvest and Residues Study initiated at Coram in 1974;**
- **Consider some early results related to the impacts of utilization on Nutrient pools and cycling;**
- **Examine some findings gleaned from sapling growth comparisons across the utilization and harvest treatments.**

Range of Western Larch



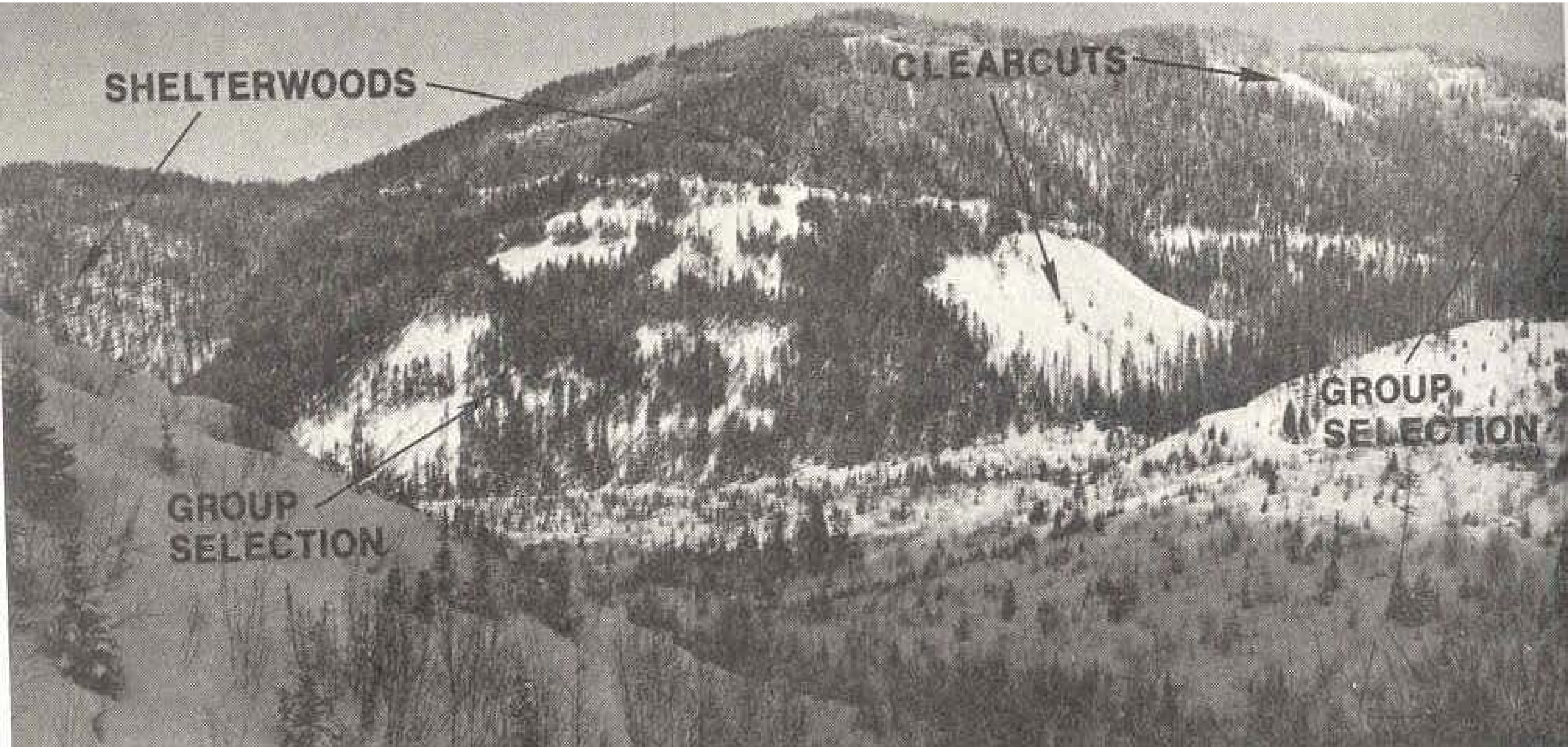
Study Area

Coram Experimental Forest,

Flathead N.F. Hungry Horse District

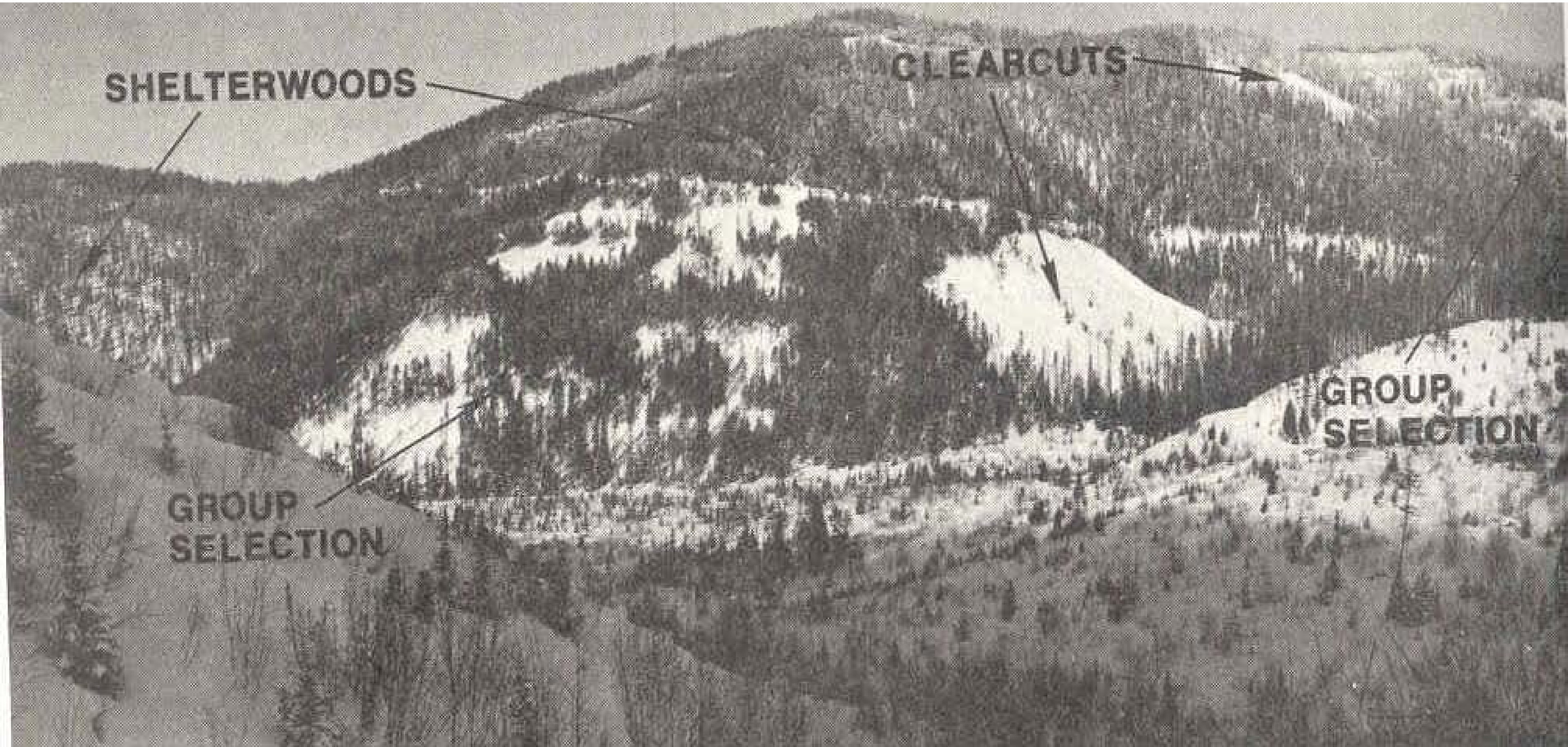
Forest Residues Utilization Study at Coram Exp. Forest

- Initiated 1974 to investigate alternative harvesting practices and more complete utilization standards that could help meet increasing wood demands, mitigate negative aesthetics of harvests, & reduce fuels build-up;



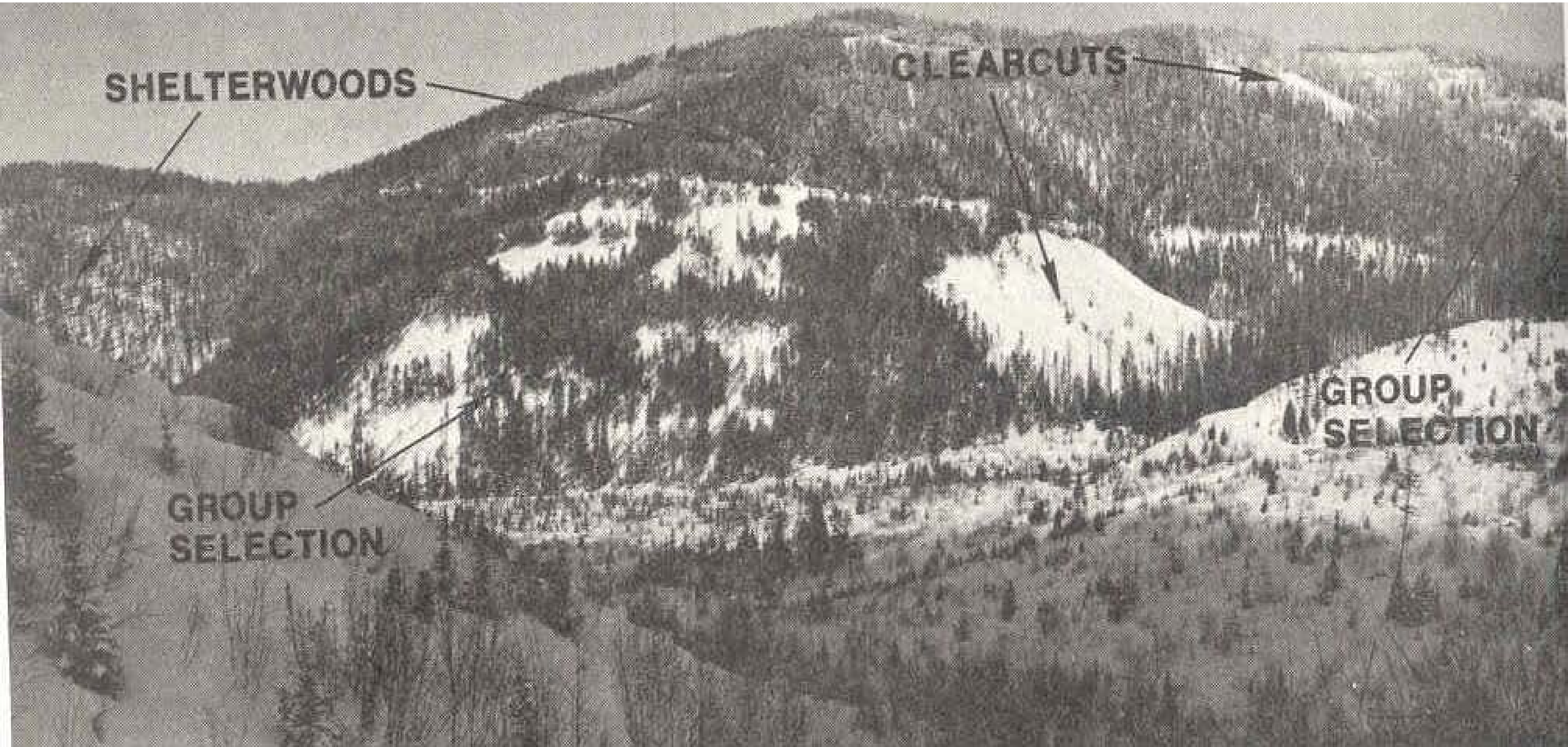
Forest Residues Utilization Study at Coram Exp. Forest

- Objectives:
  - Evaluate harvesting and utilization systems that can improve the feasibility of recovering more of the total wood resource;
  - Examine biological and environmental effects of residue reduction.



Forest Residues Utilization Study at Coram Exp. Forest

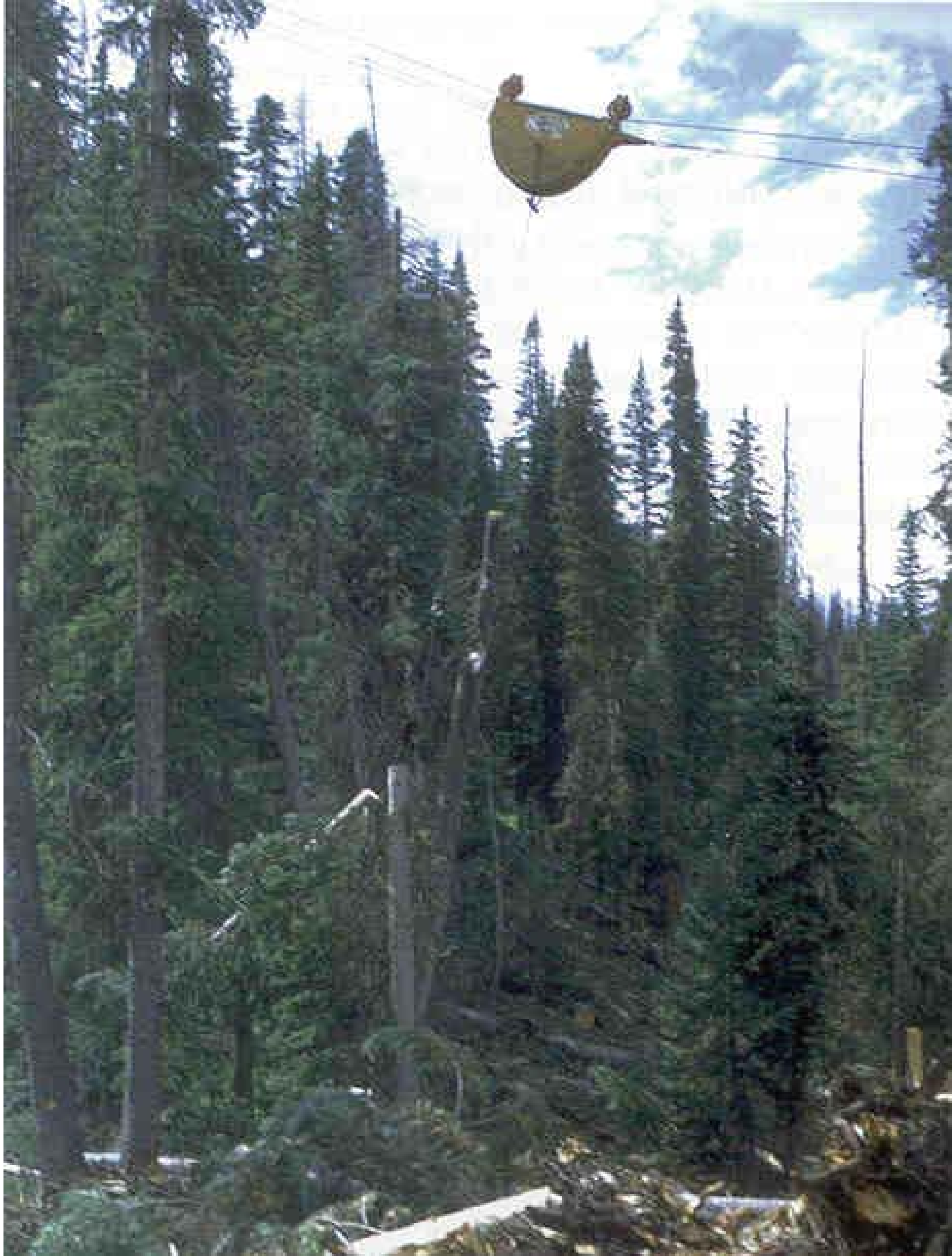
- Collaborative research effort included personnel with skills in engineering, wood technology, economics, microbiology, entomology, biometrics, but also silviculture, fire management, hydrology, and wildlife habitat



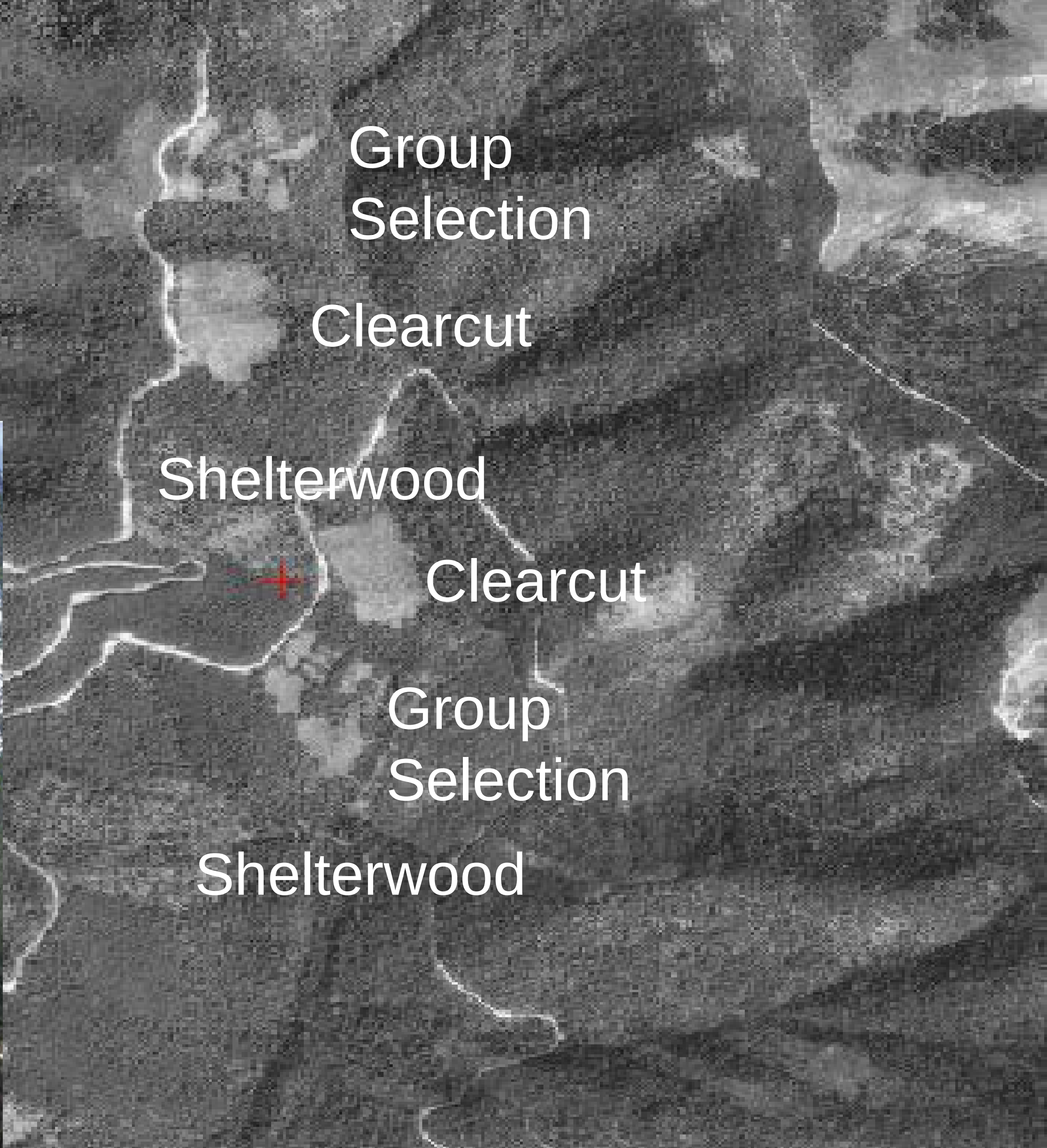
Coram Exp. Forest

Hungry Horse RD, Flathead NF

- 4000 to 5300 feet elevation
- Precipitation 30”- 35” annually
- ABLA/CLUN Habitat types
- Dominated by old western larch and Douglas-fir stands
- lesser amts of subalpine fir, Engl. spruce, w. hemlock, and birch
- steep slopes and operating constraints required use of cable yarding system (highline).



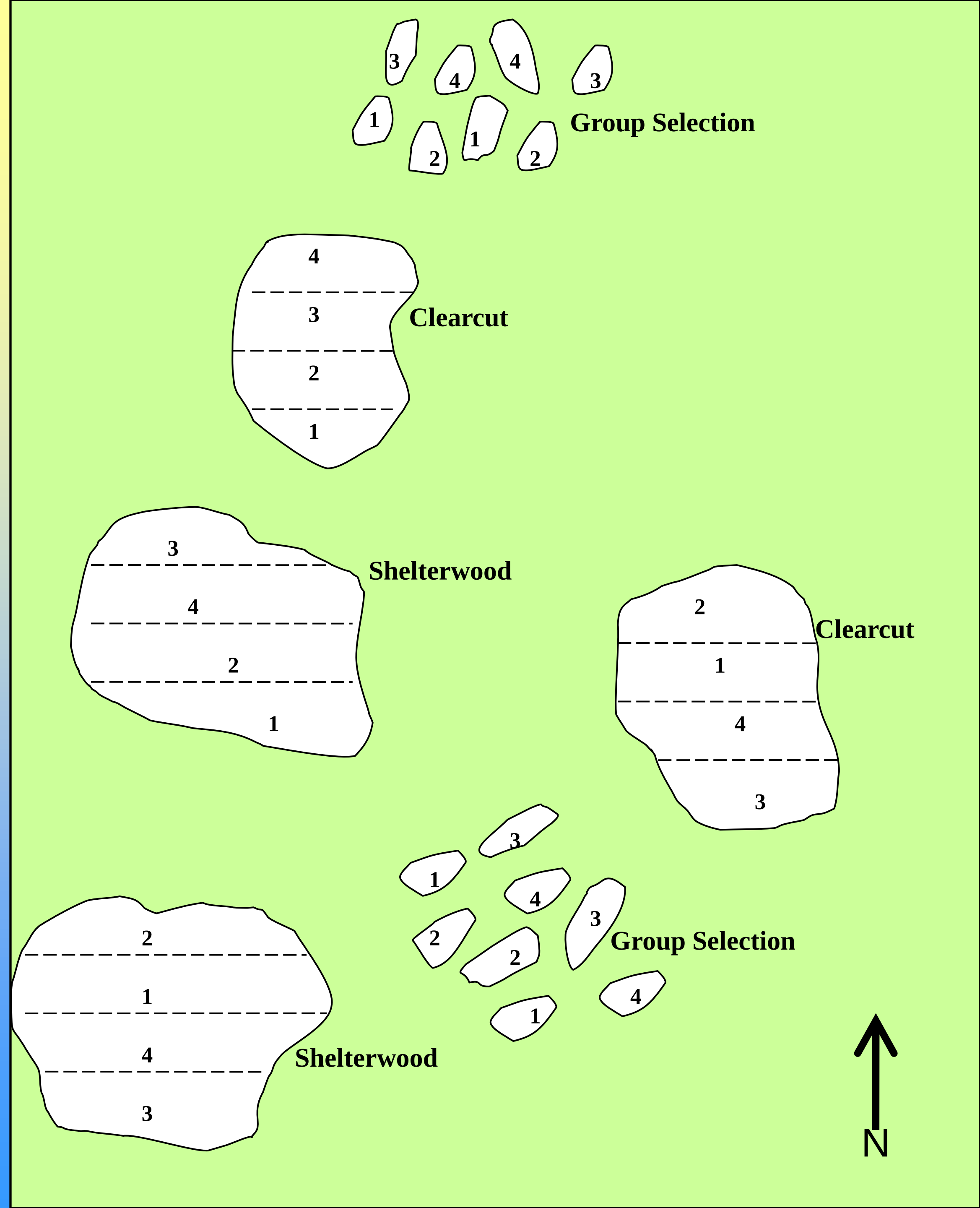
Harvest Treatment Blocks: 1974



Original Study Design

Harvest treatments:
- Two units each of clearcut,
- group selection, shelterwood, and no harvest (control)

Residue Treatments:
- Four residue treatments within each harvest treatment (burned



Residue Treatments

Trt	Utilization Standard	Fire Treatment
2	**Low Utilization:** Remove sawtimber material to 7” dbh, 8’ length, one-third sound	**Understory slashed & broadcast burned**
4	**Medium Utilization:** Remove all material to 3” diameter, 8’ length and one-third sound	**Unburned**
1	**Medium Utilization:** Remove all material to 3” diameter, 8’ length and one-third sound	**Slashed and Broadcast burned**
3	**High Utilization:** Remove all timber to 1” diameter-intensive fiber utilization	**Slashed and left unburned**

* Moist Fuels limited duff reduction and mineral soil exposure

Duff reduction and mineral soil exposure

Mean duff reduction

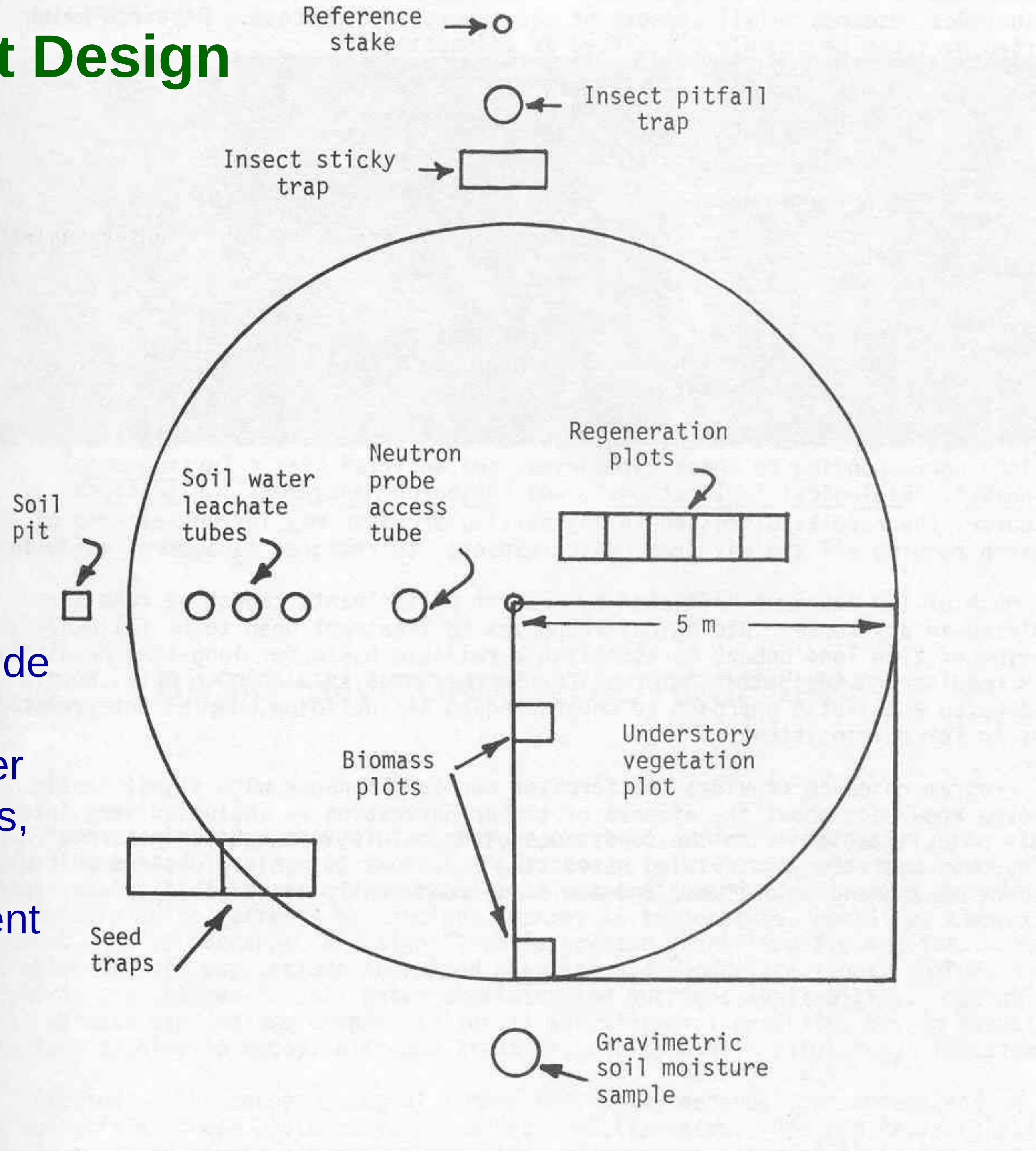
5 - 29%

Mineral soil exposed

7 - 22%

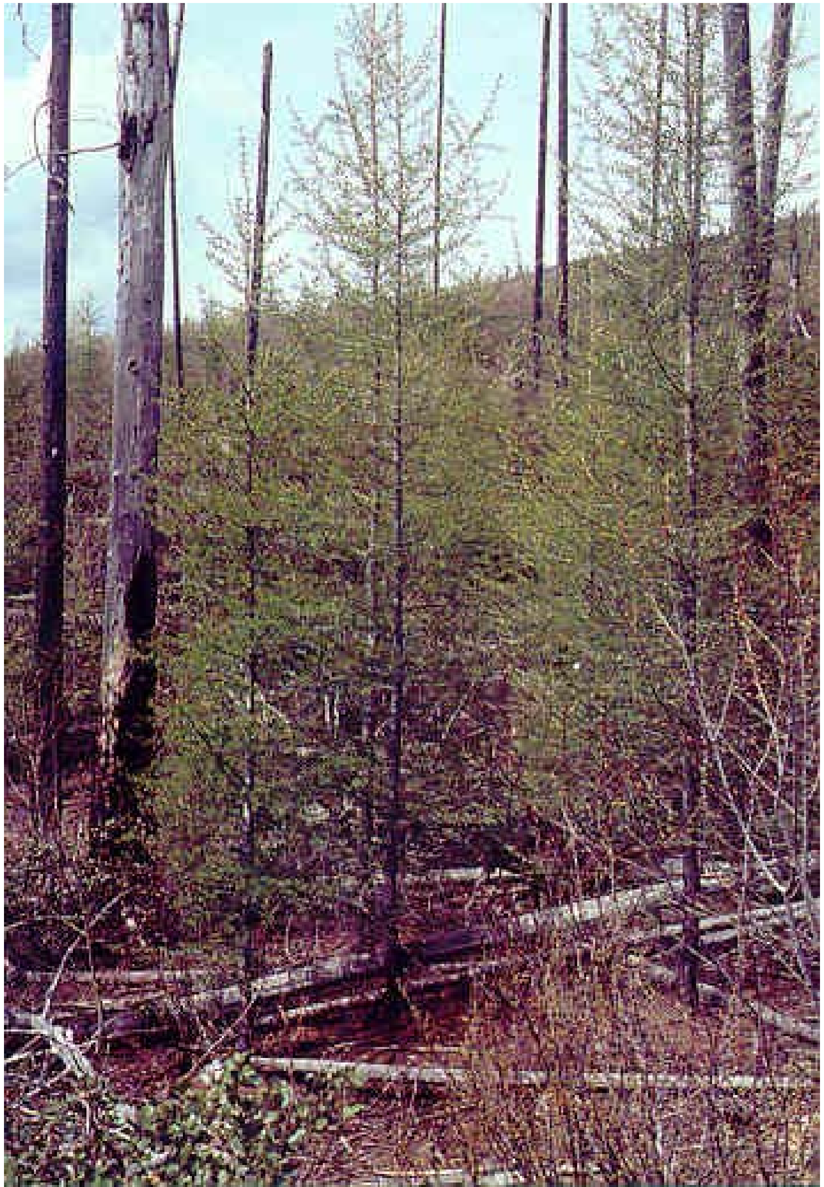
Coram Study Plot Design

- The layout of a typical sampling point on the Coram study site.
- Plot measures were coordinated to meet needs of various research disciplines.
- Typical plot might include insect traps, soil water access tubes, soil water solution sampling tubes, seed traps, and vegetation measurement sub-plots.



Impacts of Utilization on Nutrient Cycling

Nellie M. Stark, 1979



Examined loss of nutrients below the rooting zone (~ 20")

Nutrient losses of Ca and Mg accelerated by hot fires for 2-5 years. In controls, even these elements were replaced via precipitation within the year.

Losses of Nitrogen (as a percent of total N) were on the order of 2 - 4%, slightly higher in burned trts. but not consistent.

Extractable Phosphorus loss was on the order of 1 – 2 %, w/out clear trends related to utilization intensity or burning

Percent of total quantity (includes unavailable) of each element removed from a 1m^2 surface area on the basis of 0.5 m deep feeder root zone, relative to total root zone.

Percent of Available quantity of each element removed from a 1m^2 surface area on the basis of 0.5 m deep feeder root zone, relative to total root zone.

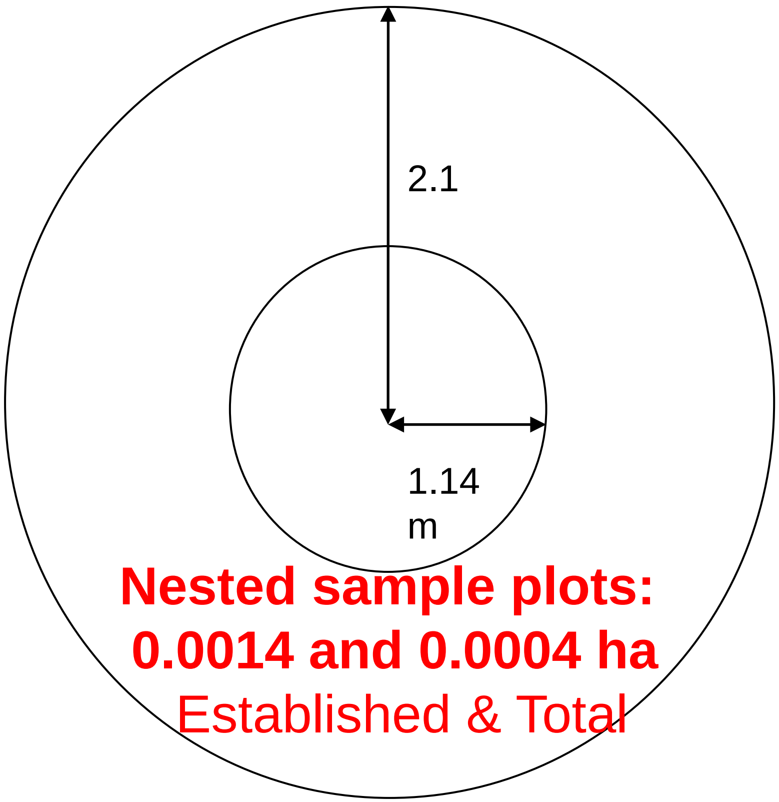
Silvicultural Practice[2]	Tr	Ca	Cu	Fe	K	Mg	Mn	Na	P	Zn	Equivalent % of Available Cations Removed
		Percent									
Shelterwood 1	2	8.6	13.5	4.7	14.1	11.6	9.9	5.7	1.25	62.7	9.5
	4	3.1	5.7	1.9	5.7	9.7	2.9	2.3	0.71	80.1	4.0
	1	6.3	11.5	6.6	7.0	6.5	5.1	8.3	0.41	62.6	6.4
	3	4.3	7.9	3.4	6.9	4.6	3.9	3.1	0.96	40.3	4.6
Group Selection 1	2	7.8	12.8	1.4	16.1	10.5	6.9	5.3	1.98	64.7	9.0
	4	3.9	9.2	2.4	9.3	5.9	4.9	3.8	1.03	33.6	4.9
	1	3.9	6.9	2.0	6.8	4.4	3.4	3.0	0.88	29.6	4.3
	3	6.1	10.5	3.0	11.0	6.9	5.6	4.3	1.10	39.6	6.8
Clearcut 1	2	2.7	5.3	1.2	5.2	3.2	2.9	2.1	0.34	19.1	3.0
	4	9.1	23.5	4.7	10.5	15.8	12.8	7.9	0.94	84.3	10.1
	1	12.1	17.3	3.9	27.4	11.2	9.2	6.8	2.01	91.7	13.9
	3	5.8	13.9	2.8	9.8	8.8	7.5	5.5	0.58	48.2	6.6
Shelterwood 2	2	1.7	2.9	1.1	2.6	1.6	1.6	1.21	0.43	15.3	1.9
	4	2.5	4.1	1.5	3.9	2.4	2.4	1.7	0.63	20.7	2.8
	1	2.6	4.5	1.6	4.1	2.5	2.6	1.9	0.71	24.7	2.9
	3	2.3	3.6	1.7	3.7	2.3	2.5	1.9	0.59	14.8	2.6
Group Selection 2	2	8.3	14.2	4.0	11.4	8.2	7.9	5.6	1.43	65.4	8.9
	4	5.4	8.9	2.5	8.2	5.6	4.9	3.8	1.16	35.9	5.9
	1	11.7	34.2	5.9	13.4	9.3	7.7	9.2	1.57	59.0	11.8
	3	5.2	8.0	2.3	7.8	5.3	1.1	3.3	0.96	29.8	5.5
Clearcut 2	2	6.3	9.6	2.6	10.1	6.1	4.4	3.9	0.82	38.4	6.9
	4	4.6	8.1	2.4	8.1	4.6	4.9	3.4	0.86	31.9	5.2
	1	8.0	11.2	3.1	10.8	6.3	6.5	4.6	1.21	44.4	8.3
	3	4.3	16.5	1.8	6.6	3.8	3.9	2.8	0.68	23.2	4.6

Trt 2 = Conventional/Burned; 4 = Med Utilization/Unburned; 1 = Med/Burned; 3 = Intensive Util./Unburned

Natural Regeneration Study

- Eighty permanent sample plots installed in each cutting unit, and divided among four residue treatments

- Initial Measure1979
- Remeasured: 1987 1992,   2001



25 years after treatments applied

Clearcut

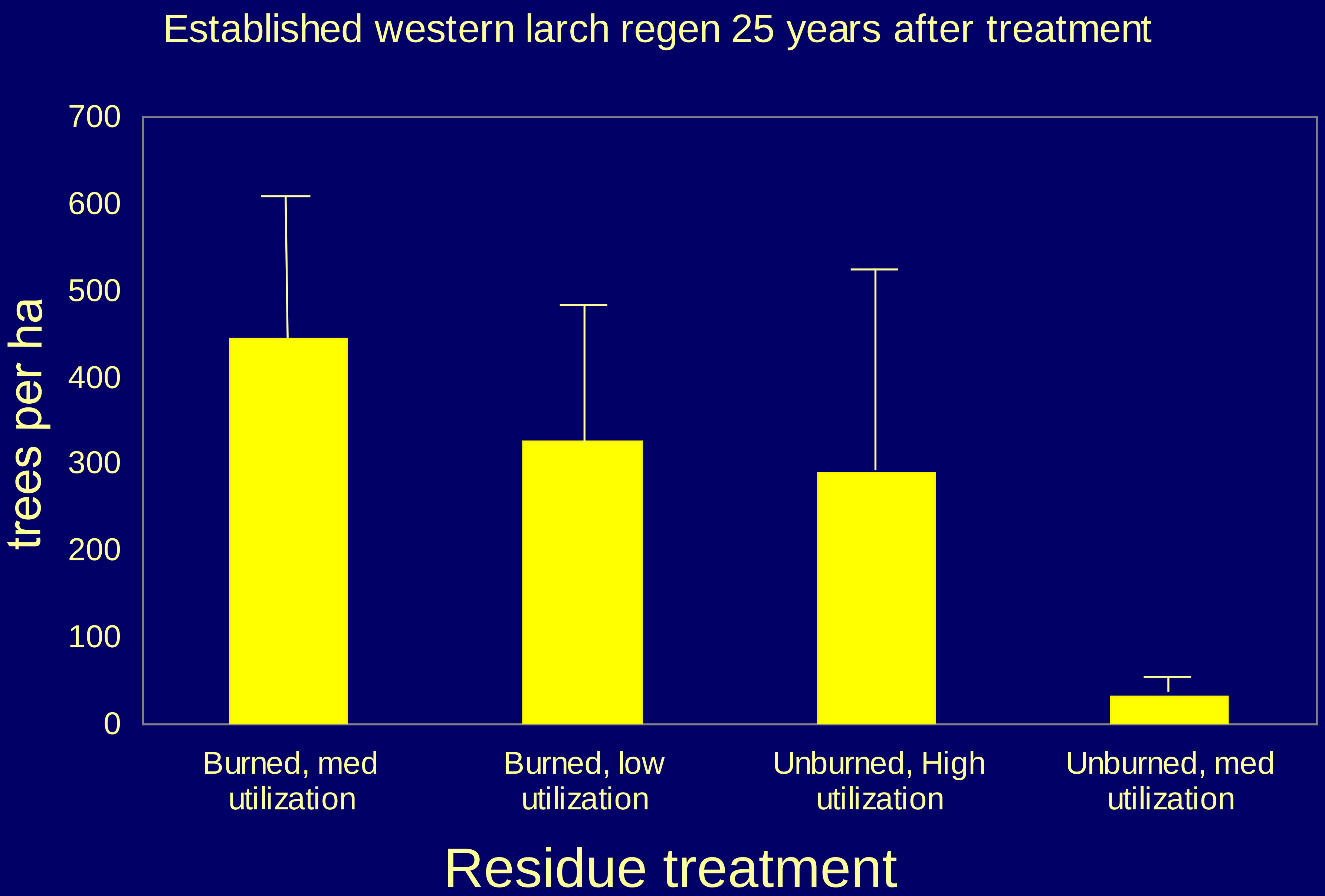
Shelterwood

Germination and establishment of western larch in the Coram study was limited to the first 5-6 years following harvest.

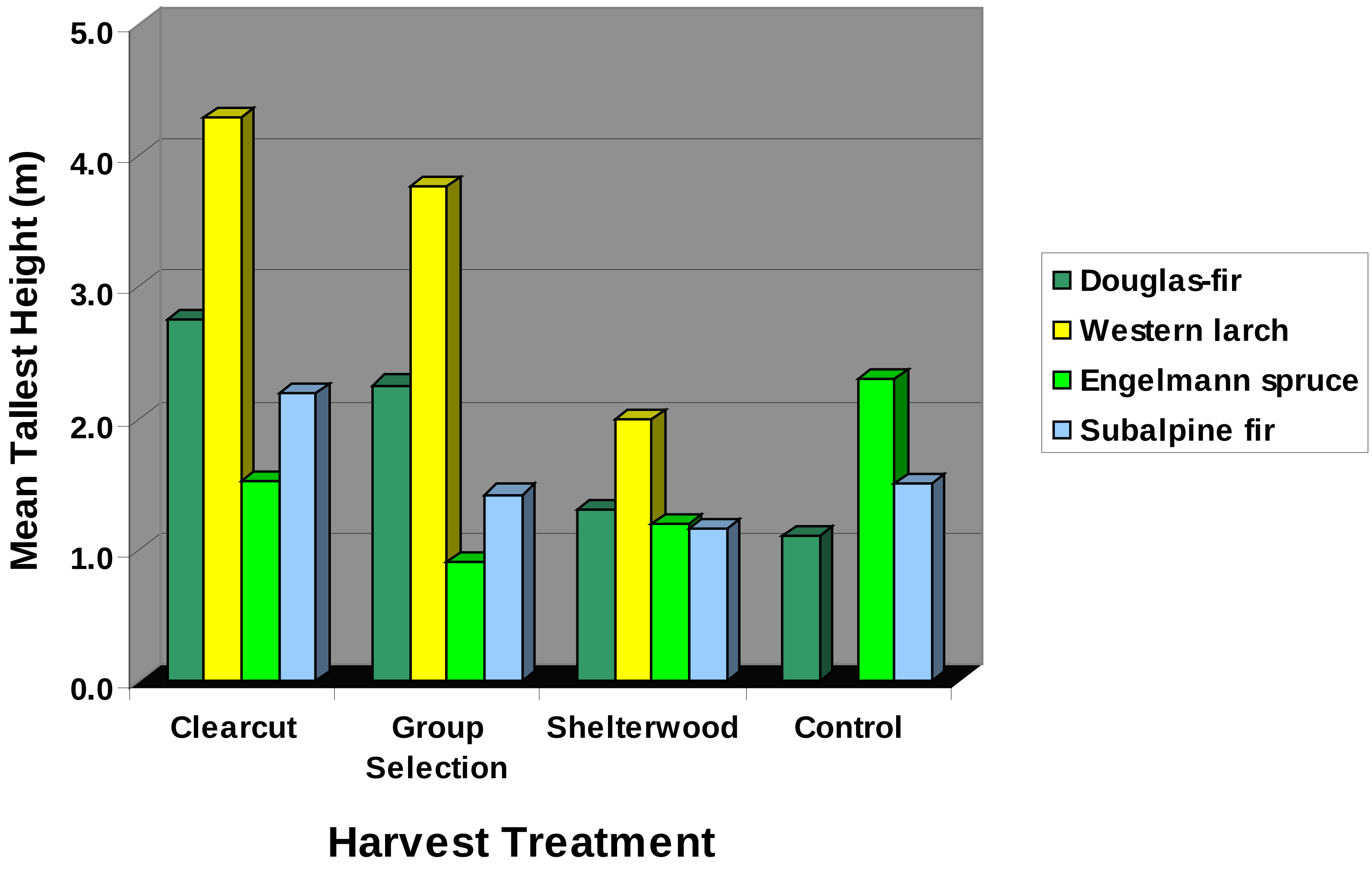
55% 1st year

20% 3rd yr, 22% 5th

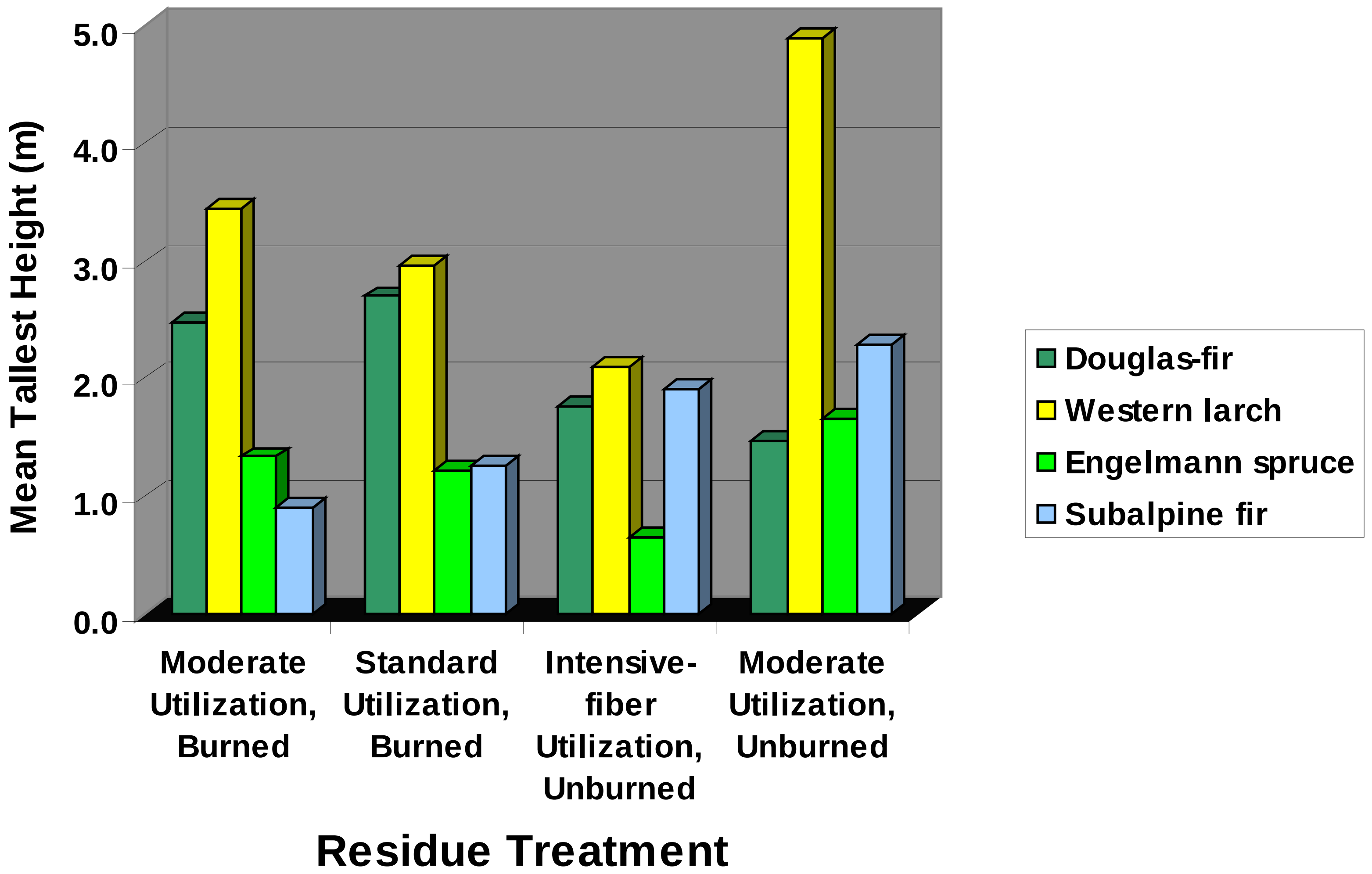
Western larch seedling recruitment was closely tied to site preparation and residues treatments had a significant effect on regeneration stocking and composition.


Established western larch regen 25 years after treatment
trees per ha
700
600
500
400
300
200
100
0
Burned, med utilization
Burned, low utilization
Unburned, High utilization
Unburned, med utilization
Residue treatment

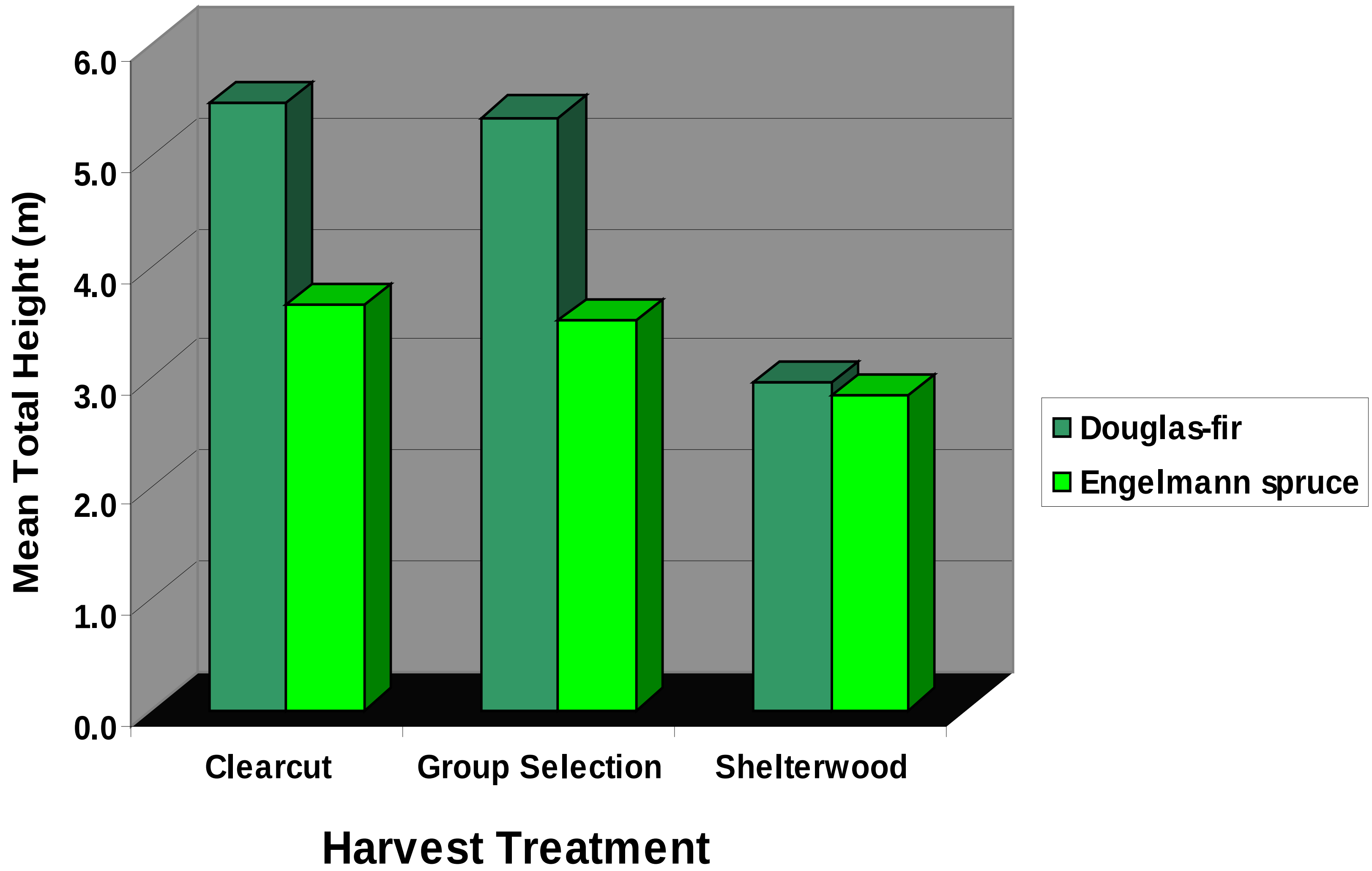
Mean Heights of Tallest Established Regeneration in 2001 by Harvest Treatment



Mean Heights of Tallest Established Regeneration in 2001 by Residue Treatment



Mean Heights of Planted Regeneration in 2001 by Harvest Treatment



Mean Heights of Planted Regeneration in 2001 by Residue Treatment

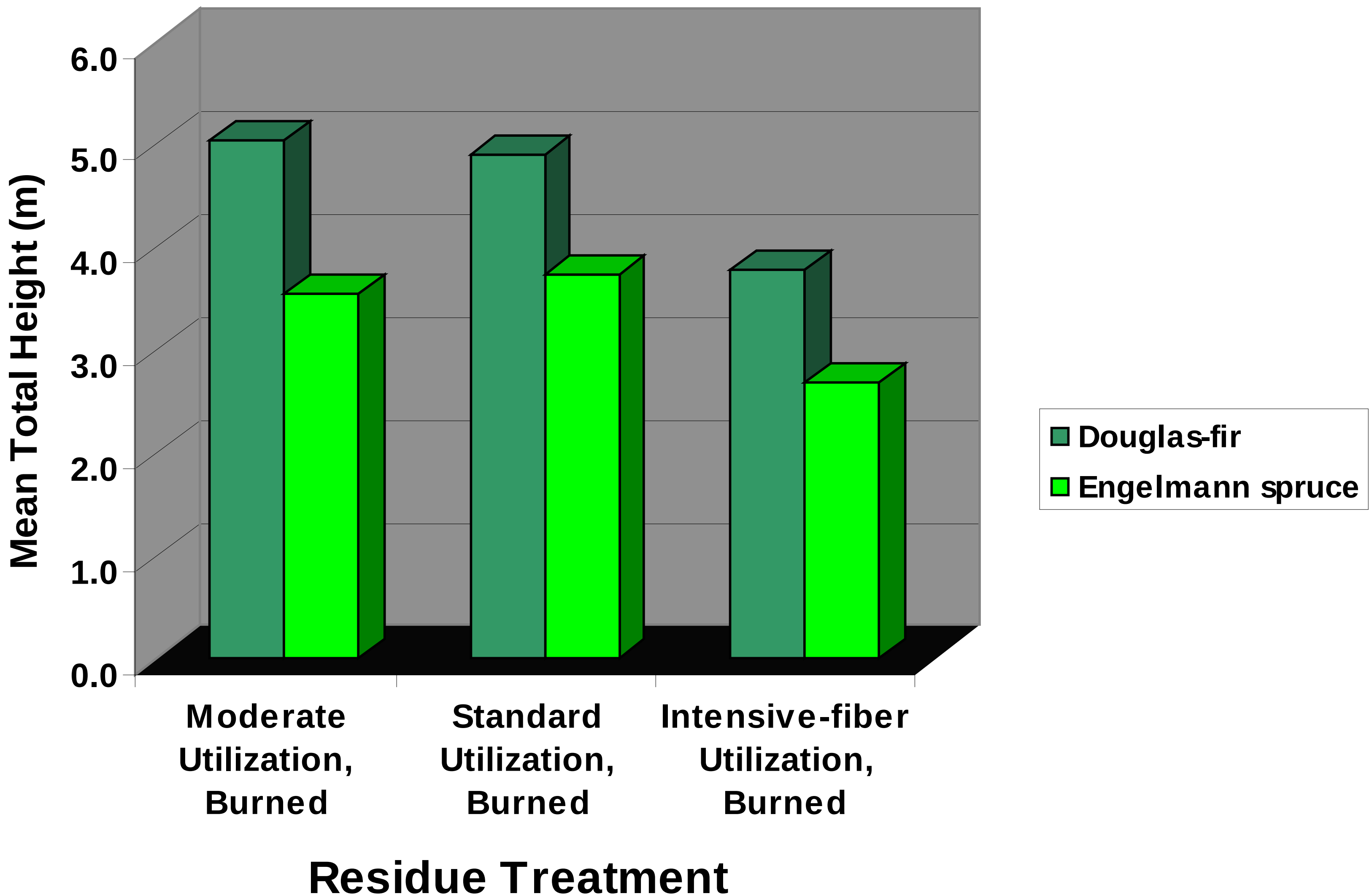


Table 1: Average total heights (m) of planted Douglas-fir and Engelmann spruce by harvest and residue treatments

	Species	Clearcut	Group Selection	Shelterwood
Moderate Utilization, Burned	Douglas-fir	5.7	5.4	4.0
	Engelmann spruce	3.9	3.6	3.2
Standard Utilization, Burned	Douglas-fir	6.0	6.1	2.7
	Engelmann spruce	4.2	4.2	2.8
Intensive-fiber Utilization, Unburned	Douglas-fir	4.7	4.5	2.2
	Engelmann spruce	2.8	2.8	2.5

Average total height growth of planted conifers was lower in the Intensive utilization / unburned treatment across all harvest regimes.

Average tallest heights (m) of established natural regeneration in 2001 by harvest and residue treatments, Coram Experimental Forest, Montana.

	Species	Clearcut	Group Selection	Shelterwood
Low Utilization/ Burned	Western larch	2.1	4.0	2.7
	Douglas-fir	3.3	3.4	1.5
Moderate Utilization, Unburned	Western larch	8.5	5.7	0.5
	Douglas-fir	$\boxed{1.8}$	1.6	1.0
Moderate Utilization, Burned	Western larch	4.9	2.8	2.7
	Douglas-fir	3.7	2.5	1.2
Intensive-Utilization, Unburned	Western larch	1.7	2.6	2.1
	Douglas-fir	$\boxed{2.2}$	1.6	1.5

Average total height of natural regen Douglas-fir highest in the two utilization treatments that were broadcast burned.

Residue Treatments

Trt	Utilization Standard	Fire Treatment
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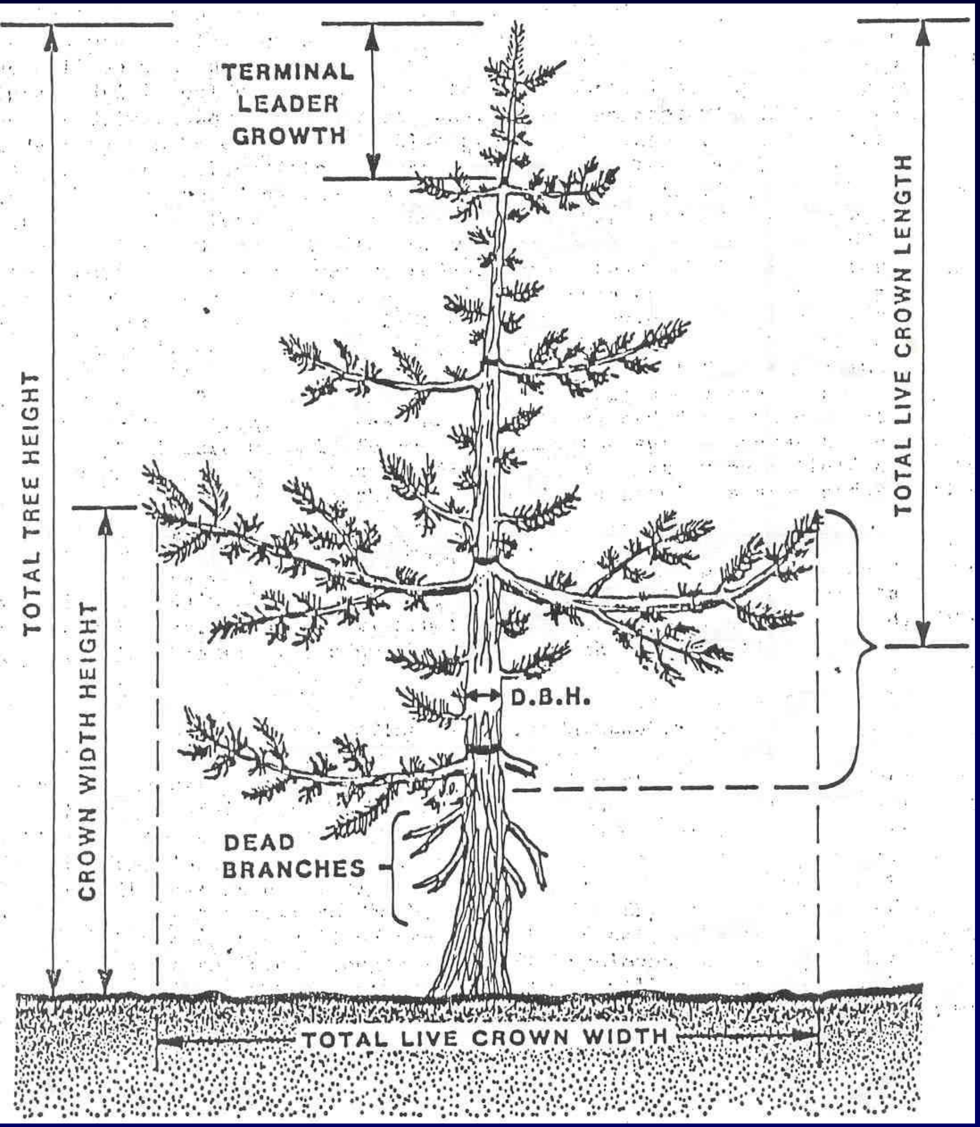
Summary comments:

- Trends in Nutrient availability/loss are not clearly associated with utilization options.
- Growth response of saplings across all harvest treatments was somewhat lower on Intensive utilization/Unburned treatment.
- Heights of saplings 25 years after treatment are not correlated with residue utilization treatment.
- May be confounded by variation in early establishment and reduced competition.

Discussion / Questions?

Individual Tree Study

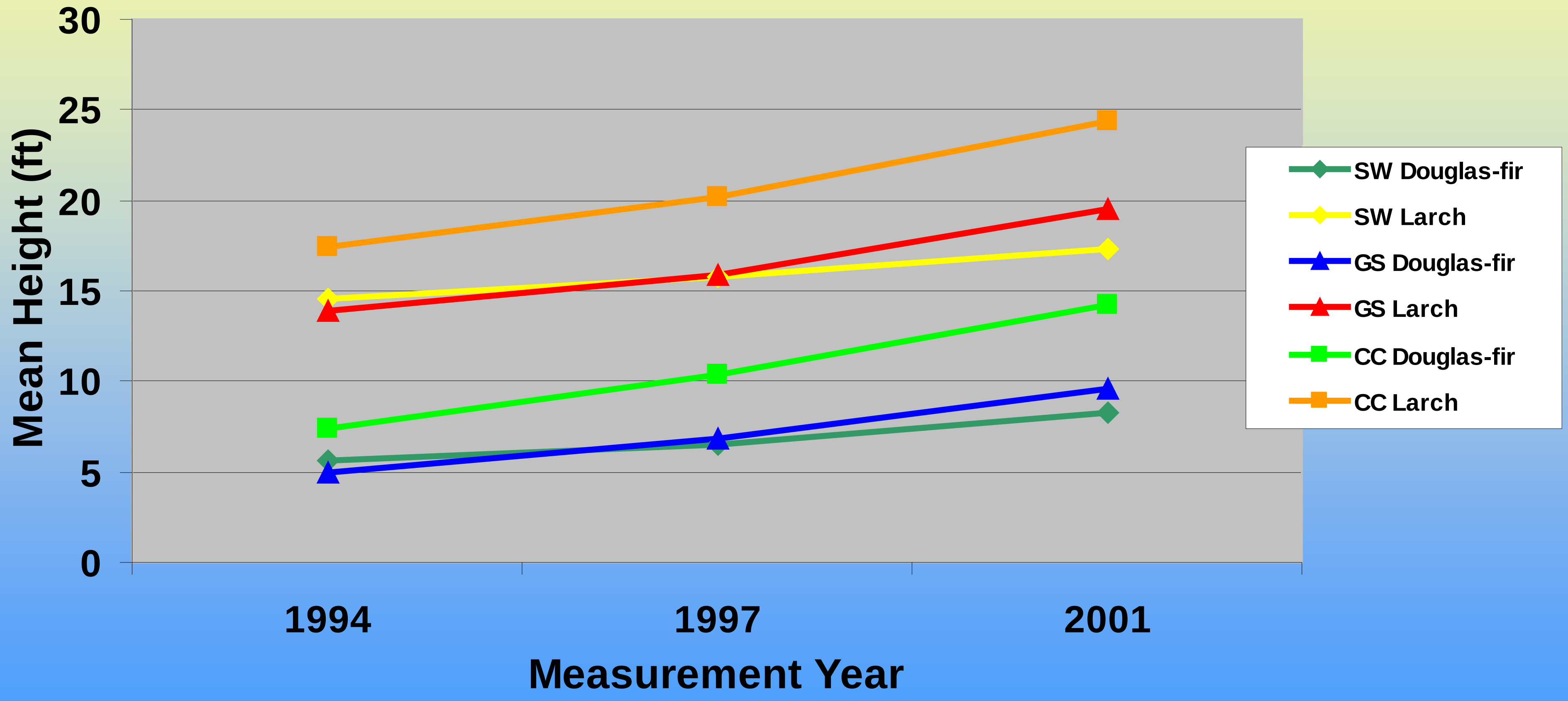


- 30 Western larch and 30 Douglas-fir were randomly selected and permanently tagged in each of the six cutting units in late 1994.
- Measured: 1994, 1997, 2001 for height, dbh, crown characteristics, vigor, and damage.

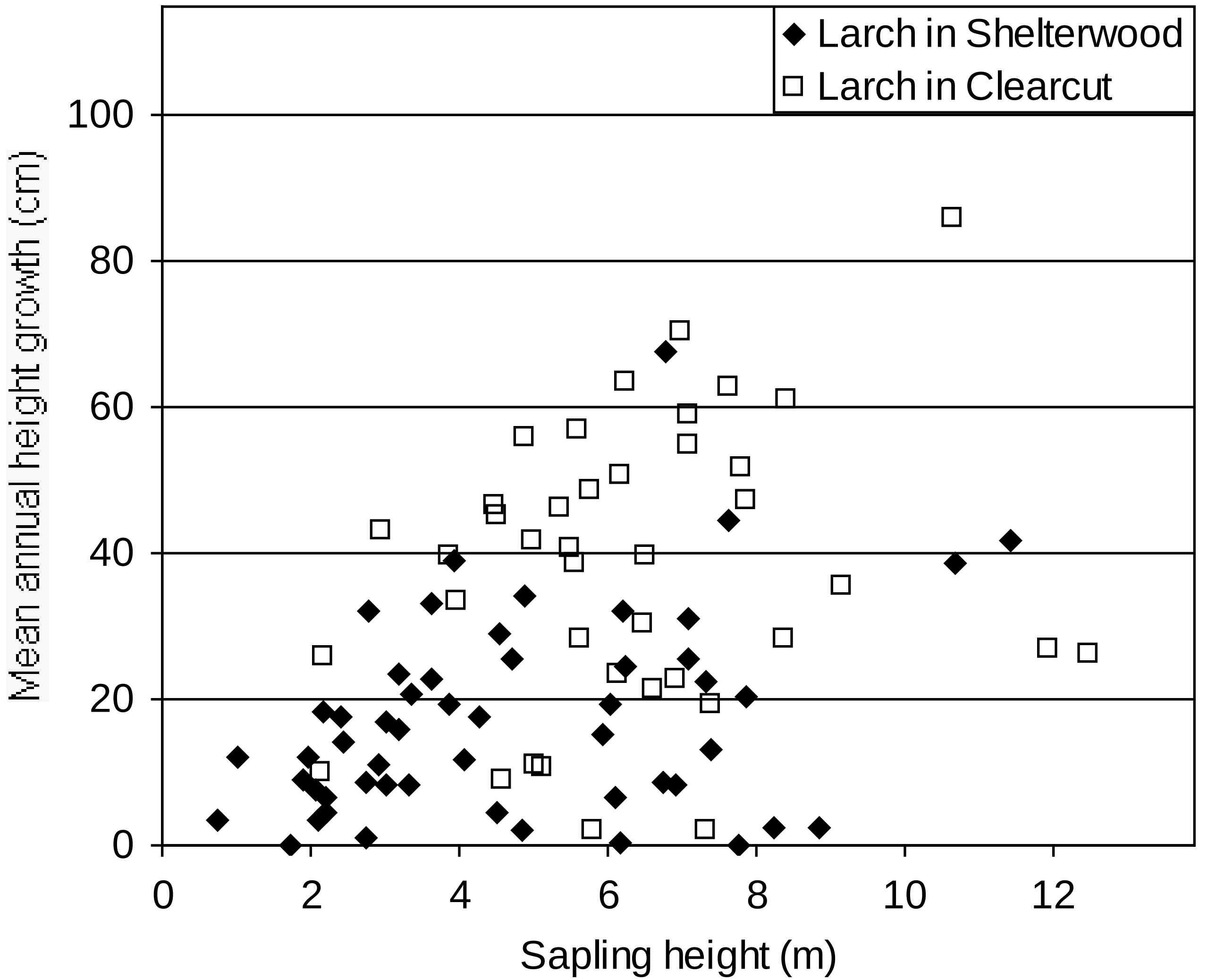
Remeasurement data for larch and Douglas-fir saplings ~25 years after harvest

	W. Larch	W. Larch	Doug-fir	Doug-fir
	Shelterwood	Clearcut	Shelterwood	Clearcut
Survival (%)	85	68	80	97
Mean height (m)	5.2	7.6	2.5	4.3
Height growth (cm)	21	45	17	40
Mean DBH (cm)	4.8	9.5	2.1	5.4
Diameter growth (cm)	0.3	0.7	0.3	0.7

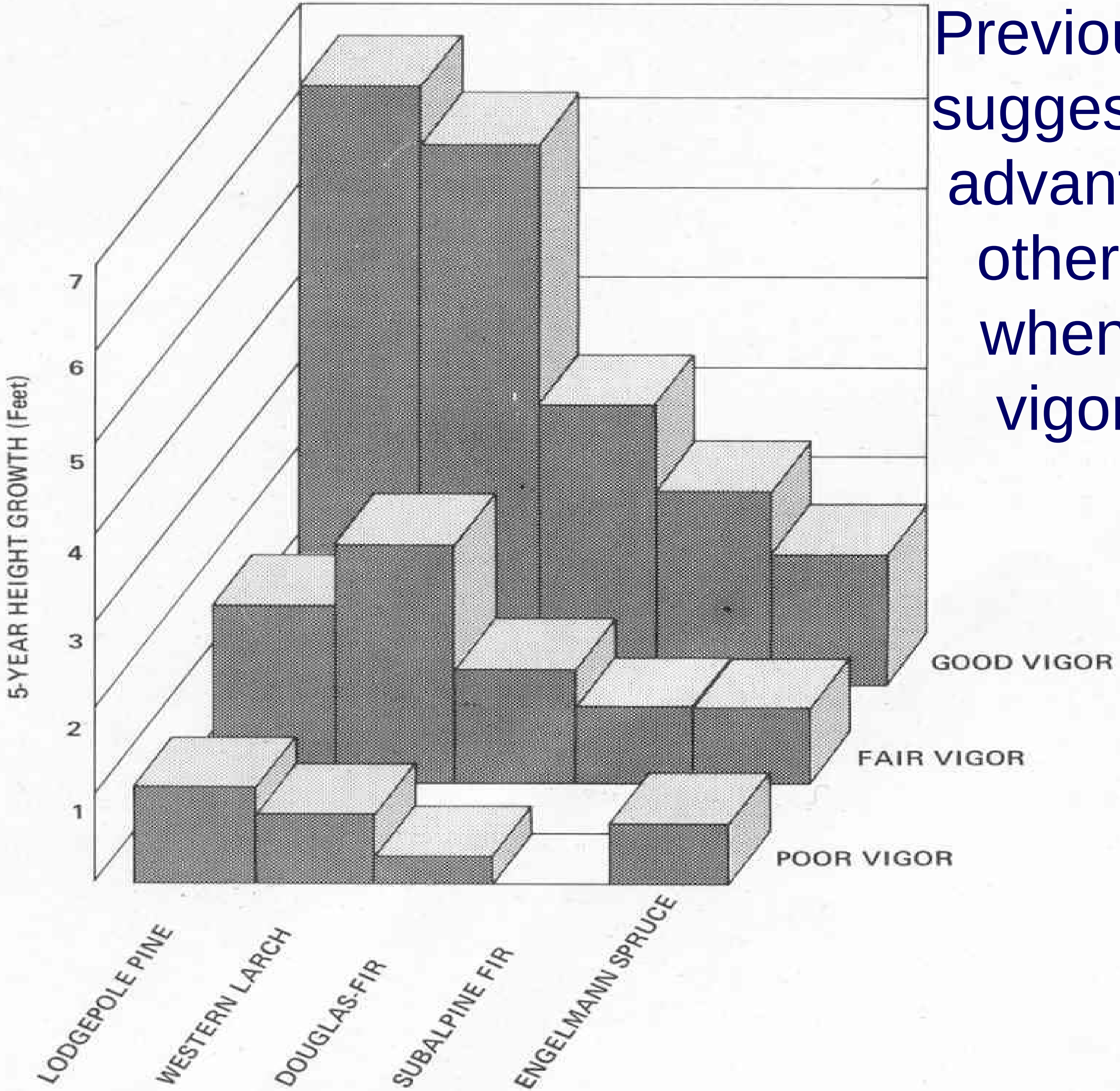
Individual Trees: Mean Heights over Time



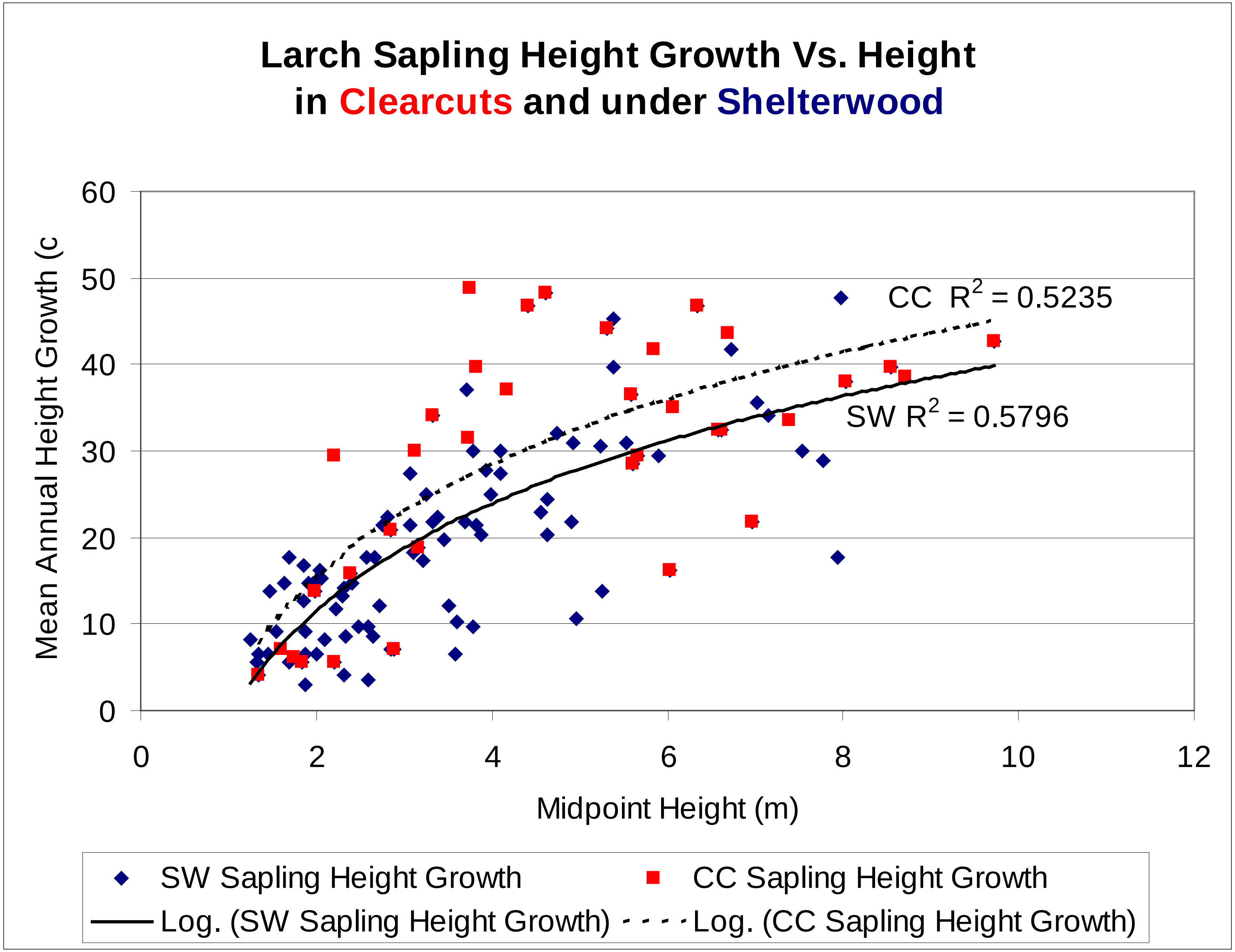
Larch sapling height growth variation in shelterwood and clearcut units



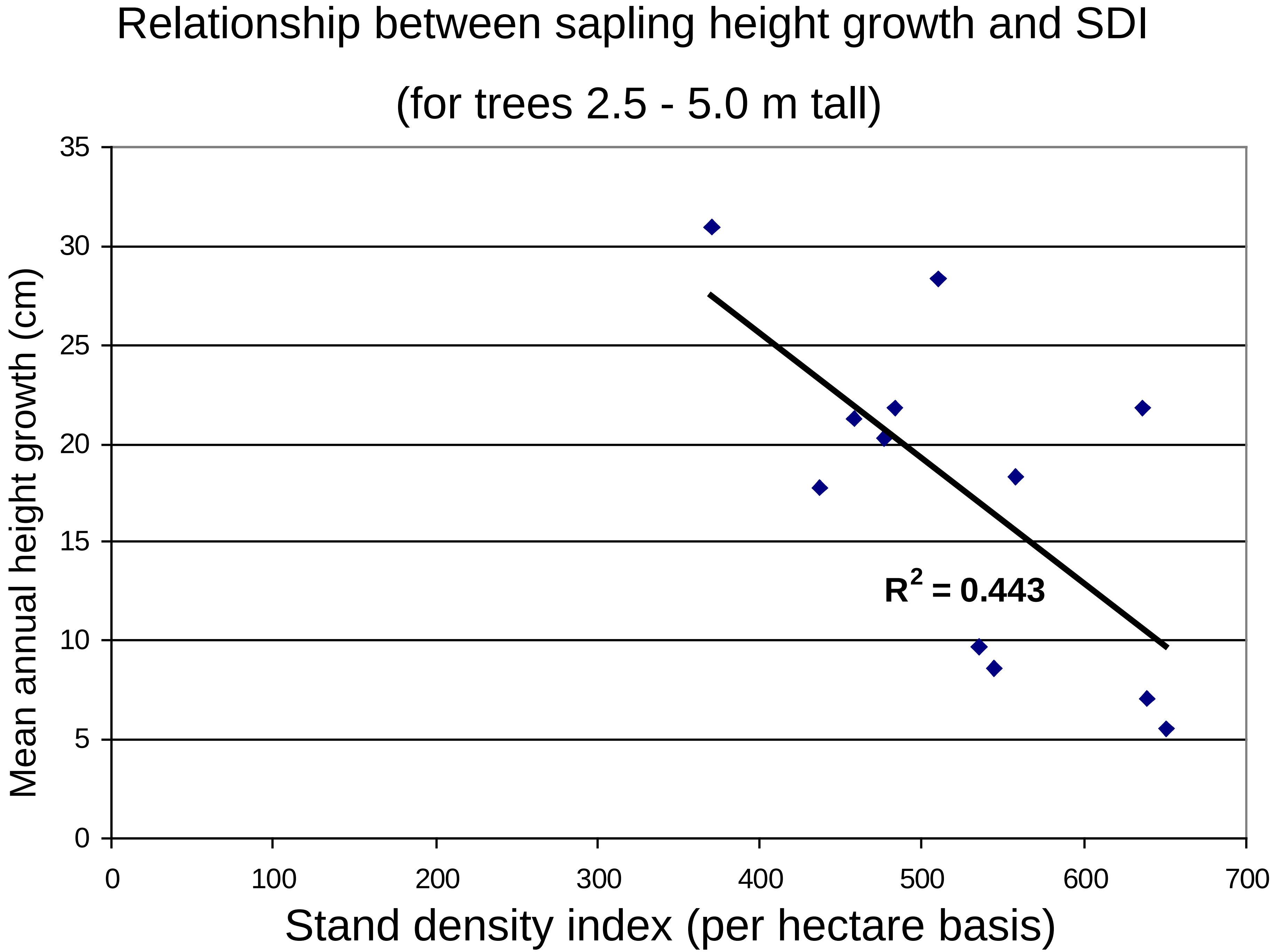
Previous studies suggest greatest advantage over other species when sapling vigor is high



- To what extent can variation in larch growth rates be explained by local competition measures?
- Sapling height growth as a function of local overstory (BA, Canopy cover, SDI, % sunlight) and understory (e.g. shrub cover) competition ?



Larch Sapling Height Growth Vs. Height
in Clearcuts and under Shelterwood
60
50
40
30
20
10
0
Mean Annual Height Growth (c
0
2
4
6
8
10
12
Midpoint Height (m)
CC R^2 = 0.5235
SW R^2 = 0.5796
SW Sapling Height Growth
CC Sapling Height Growth
Log. (SW Sapling Height Growth)
Log. (CC Sapling Height Growth)


Relationship between sapling height growth and SDI
(for trees 2.5 - 5.0 m tall)
Mean annual height growth (cm)
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
Stand density index (per hectare basis)
R2 = 0.443

Summary comments:

- After 25 years, shelterwood retention has not led to decreased survival and composition of larch.
- Larch sapling growth rates vary dramatically under heterogenous shelterwood in relation to neighborhood competition; changing over time.
- Treatment level means for larch height growth were substantially lower in shelterwoods than in clearcuts.
- However, results indicate that vigorous growth of some seral larch is possible under variable retention, i.e, as component of stand.

Next steps

- Better characterization of light and neighborhood competition.
- Broader range of sites for examining long-term dynamics of seral species under various retention levels.
- Analysis of sapling growth rates as a function of overstory spatial pattern.
- Relate heterogenous overstory retention patterns to field-based prescriptions and to incorporation of clumpiness in growth models.

Better characterization of light and neighborhood competition