

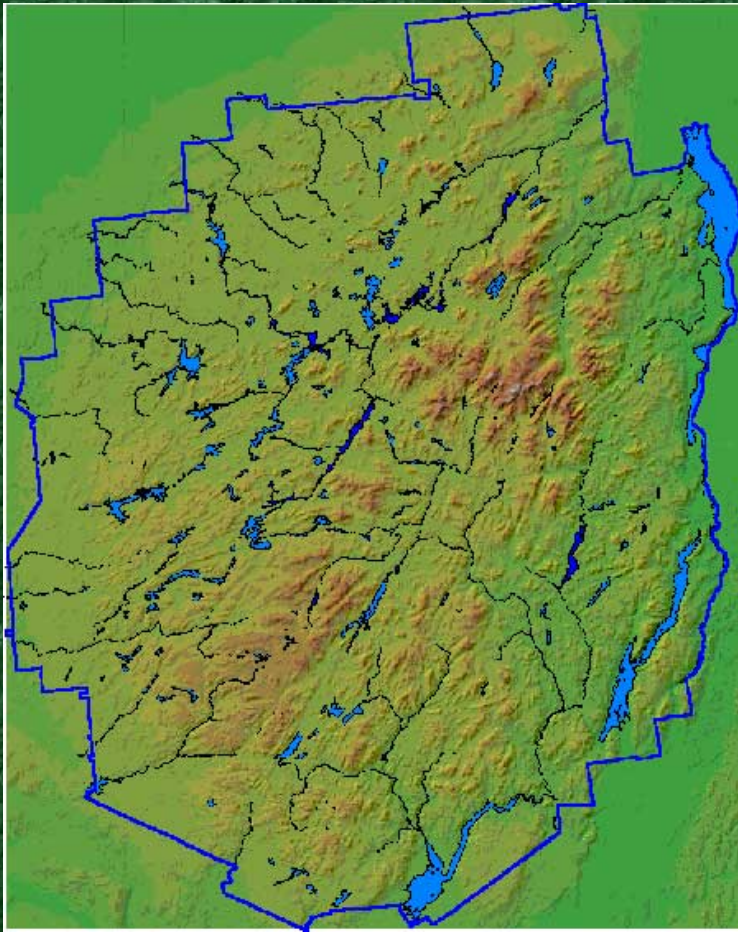
Apical Dieback of Red Spruce
(*Picea rubens*) Trees
of the Adirondack Mountains,
New York, USA

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- 6 million Acres (size of Vermont)
- 3x's size of Yellowstone Natl.
- largest Park in lower 48 states



- Red Spruce (*Picea rubens*)
- common in northeastern hardwood forests
 - longevity: 300-400 yrs.

Winter injury and healthy Tissue



- Apical dieback, is the initial death of stems and concomitant needles of first-year stems during their first over-wintering (Friedland et al., 1984; Evans, 1986)
- Ruptures epidermal cells destroying tissues ultimately killing stem (Evans and Biesemeyer, 1988).

Major Hypotheses

- **Hypothesis 1) Central new growth stems have significantly higher survival rate than lateral stems on branches.**

Hypothesis 2) 2004 and 2003 growth will differ in their incidence of dead/missing percentages

Hypothesis 3) Percentages of missing stems will differ from percentages of dead stems on branches

Methods

- Adirondack Mountains: 4 mountains
 - Algonquin Mtn (1573m)
 - Giant Mtn. (1423m)
 - Snowy Mtn. (1197 m)
 - Whiteface Mtn. (1498m)

Methods

4 elevations per mountain → 4 trees per elevation

Examinations of 2 branches every 45 degrees

→ start at magnetic north (0degrees)

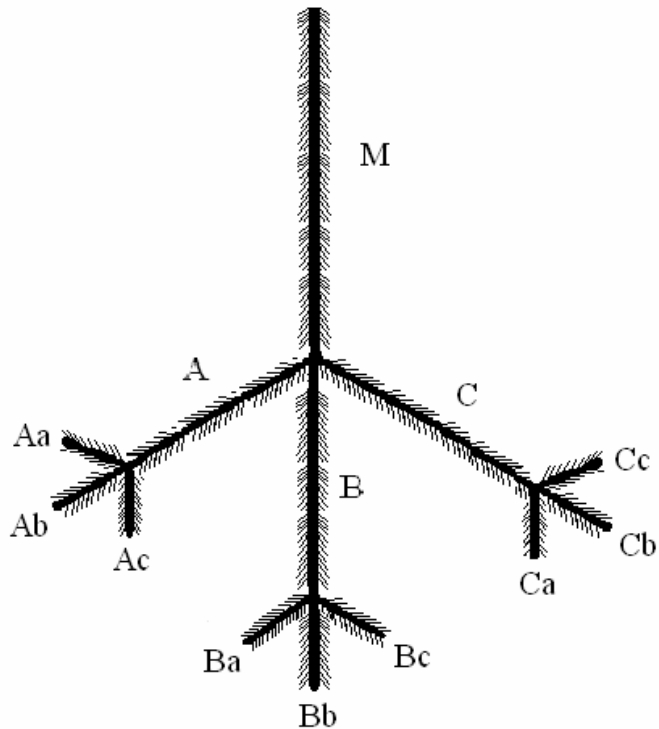
-Potential for examination of:

= 1024 of 2002 growth (actual 944)

= 3072 of 2003 growth (actual 2151)

= 9216 of 2004 growth (actual 5832)

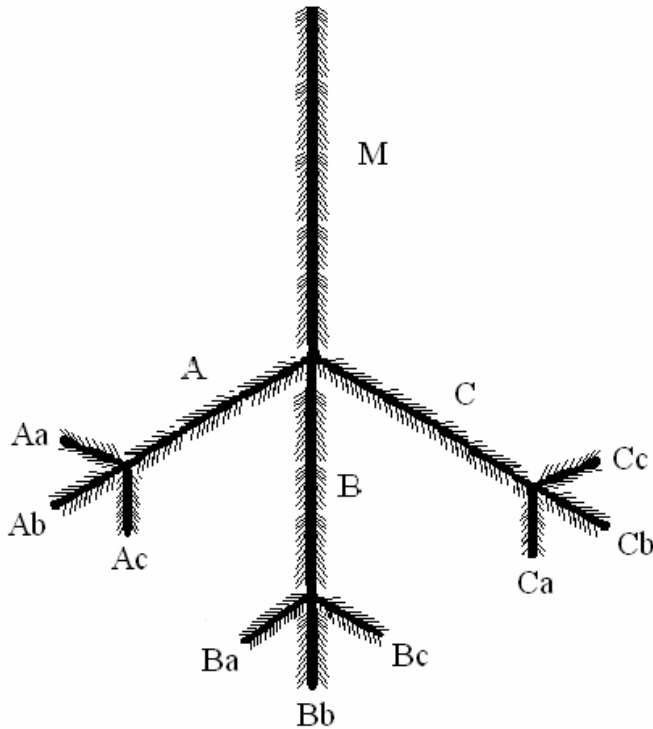
Stem injury evaluation scheme



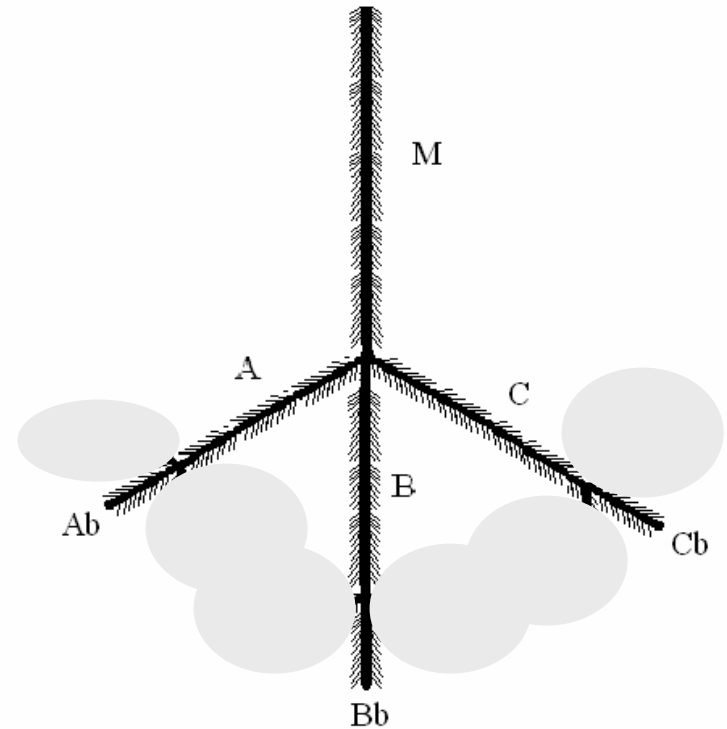
M= 2002 growth
A, B, C= 2003 growth
a,b,c= 2004 growth

Hypothesis 1

Central stems of 2004 growth have higher survival rates than lateral stems on branches.



Control



experimental

Table 1: Numbers of missing/dead a, b, and c stems for 2004 stems of red spruce trees from four mountains in the Adirondack Mountains.

Mountain	2004 stems		
	a	b	c
Algonquin	241	117	245
Giant	179	74	183
Snowy	173	82	195
Whiteface	140	73	146

a and c (purple highlight) represents statistical similarity of growth on each mountain ($P < .05$). b (brown highlight) represents statistical difference from a and c growth on each mountain ($P > .05$).

Fig 1-4: 2004 a,b,c stem missing/dead numbers

Fig. 1: Algonquin

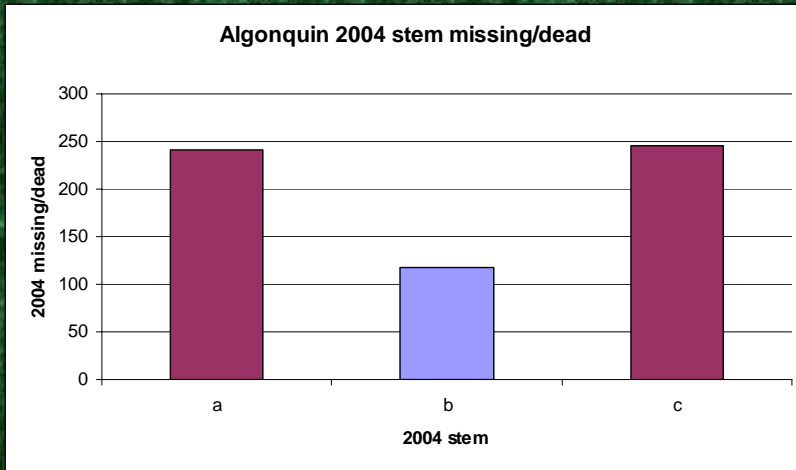


Fig. 2: Giant

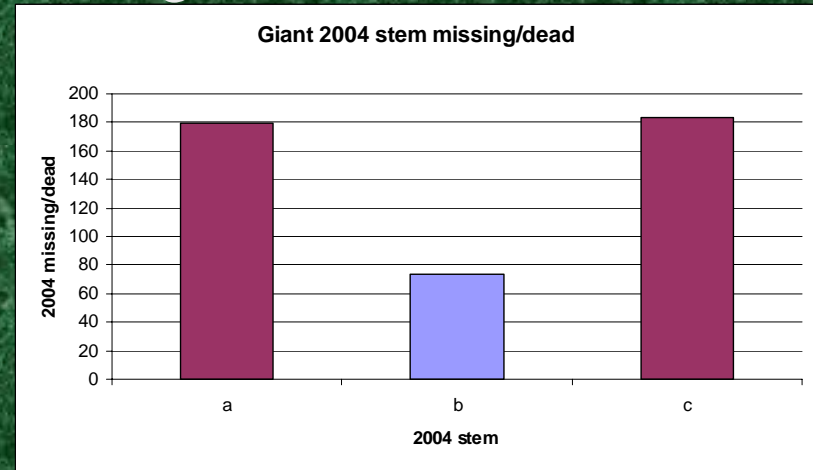


Fig. 3: Whiteface

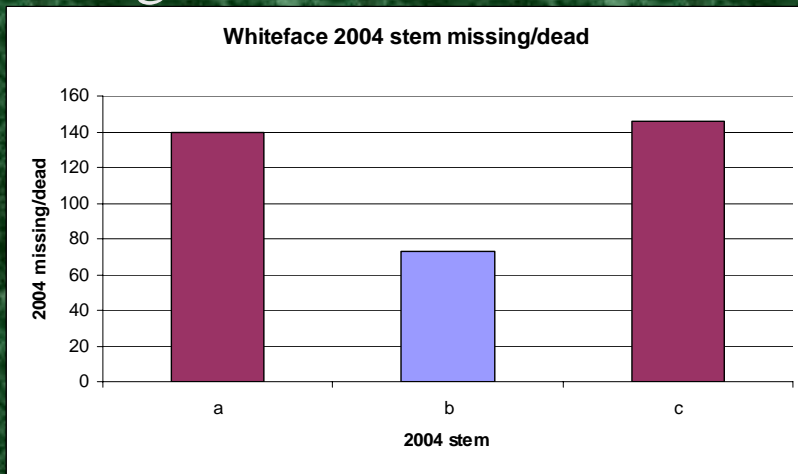


Fig. 4: Snowy



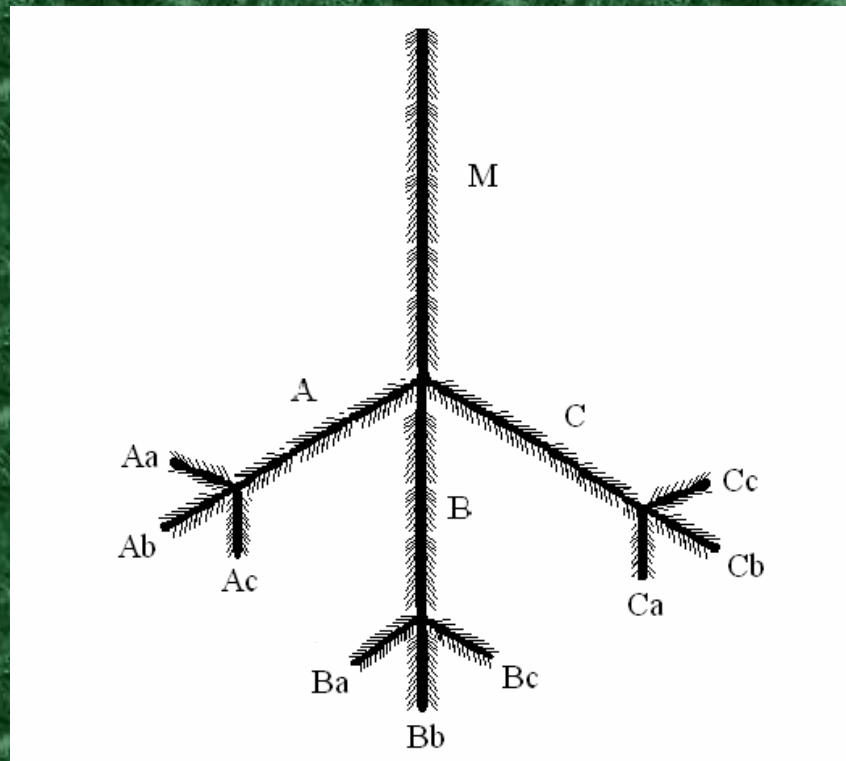
Fig.1-4: Display relationships between 2004 a,b, and c growth.
Purple highlighted represents statistically significant relationships

Hypothesis 1: Conclusions

- Incidence of dead/missing stems for lateral 2004 stems (a and c growth) was higher than central growth (b).
- 32% (1851/5832) of 2004 growth stems had exhibited apical dieback on 4 mountains in the Adirondacks.

Hypothesis 2

2004 and 2003 growth will differ in their incidence of dead/missing percentages



2003 dead/missing < 2004 dead/missing

Table 3.
Numbers of missing/dead stems of red spruce trees of four mountains of the Adirondacks.

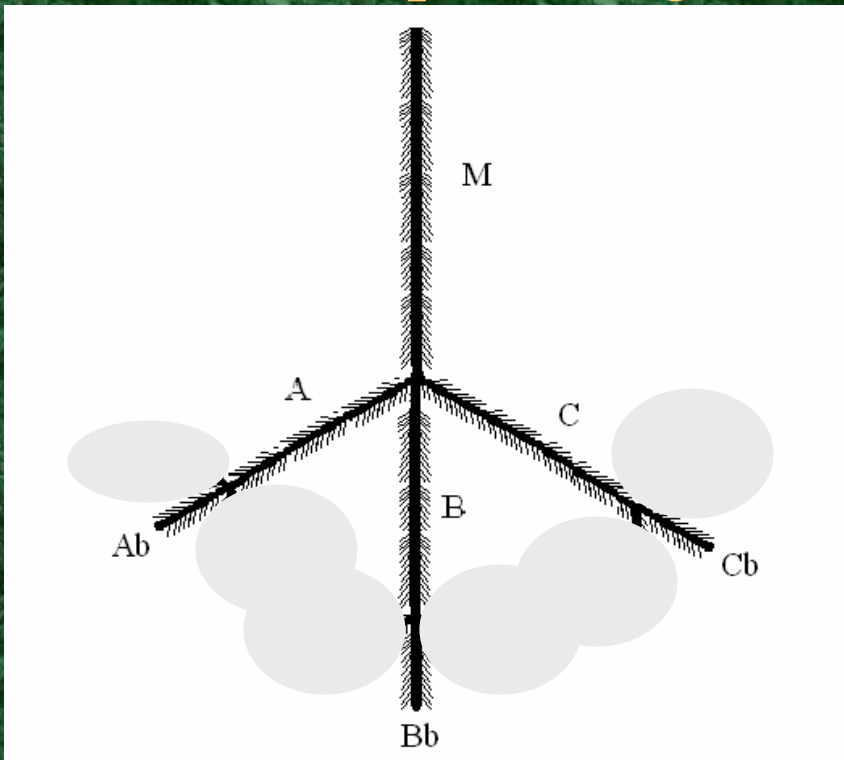
Mountain	possible 2003 branches total	2003 branches missing/dead	possible 2004 branches total	2004 branches missing/dead
Algonquin	549	55	1482	607
Giant	510	46	1389	435
Snowy	519	47	1416	450
Whiteface	573	58	1545	359
	2151	206	5832	1851
Percentages		10%		32%

Hypothesis 2: Conclusions

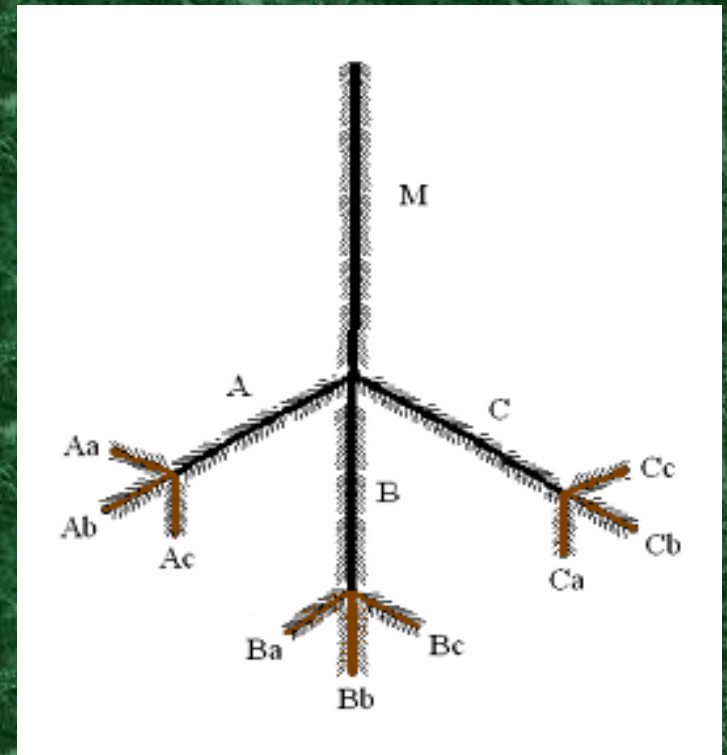
- 2003 growth displayed 90% survival rates while 2004 only exhibited 68% survival. Higher incidence of death/missing stems in new growth.
 - 10% death/missing for 2003 growth
 - 32% death/missing for 2004 growth
- 2004 dead/missing percentages were statistically larger than 2003 numbers.

Hypothesis 3

Percentages of missing stems will differ significantly from percentages of dead stems on branches



Missing growth



Dead growth

Table 4: Percentage of Missing and Dead for 2003 and 2004 stems on Algonquin

Table 4.
Percentages of missing and dead stems on Algonquin Mountain

Elevation	2003			2004		
	Missing (%)	Dead (%)	TTest (Probability)	Missing (%)	Dead (%)	Ttest (Probability)
840m						
Mean	3.65	13.0	0.294	35.8	12.7	0.008
S.D.	2.0	14.8		17.5	9.7	
1050m						
Mean	4.0	0.55	0.015	34.1	0.53	0.001
S.D.	1.11	1.11		13.2	0.79	
1250m						
Mean	6.8	2.6	0.89	50.6	0	0.0097
S.D.	3.8	4.0		17.2	0	
1434m						
Mean	3.3	5.0	0.81	44.0	0	0.039
S.D.	4.7	7.0		13.8	0	

Purple highlight represents statistically significant relationships (P<.05).

Hypothesis 3: Conclusions

- 2004 stems showed significantly higher incidence of missing than dead stems.
- 2003 data showed no consistent statistical relationship between dead and missing stems

Overall Conclusions

Hypothesis 1: Central new growth stems have higher survival rates than lateral stems on branches

→ Incidence of dead/missing stems for lateral 2004 stems (a and c growth) was higher than central growth (b).

→ 39%, 22%, 39% for a,b,c dead/ missing respectively

→ 32% (1851/5832) of 2004 growth stems

had exhibited apical dieback on 4 mountains in the Adirondacks.

Hypothesis 2: 2004 and 2003 growth will differ in their incidence of dead/missing percentages

→ 2003 growth displayed 90% survival rates while 2004 only exhibited 68% survival.

Higher incidence of death/missing stems in new growth

→ 2004 dead/missing percentages were consistently larger than 2003 numbers.

Hypothesis 3: Percentages of missing stems will differ significantly from percentages of dead stems on branches

→ 2004 stems showed significantly higher incidence of missing than dead stems.

→ 2003 data showed no consistent statistical relationship between dead and missing stems

References

Evans, L.S., Biesemeyer, P.T., 1988. Initial twig injury to high elevation *Picea rubens* in eastern North America caused by inadequate periderm formation. *Amer. J. Bot.* 75: 1378-1386.

Evans, L.S., Cocchiara, J., Jaklitsch, P., Feliciano, J., Biesemeyer, P.T., 1999. Needle and stem injuries of *Picea rubens* (Pinaceae) in the Adirondack Mountains, USA. *Environ. Exp. Botany.* 41: 267-280.

Richardson, A.D., Berlyn, G.P. Gregoire, T.G., 2001. Spectral reflectance of *Picea rubens* (Pinaceae) and *Abies balsamea* (Pinaceae) needles along an elevational gradient, Mt. Moosilauke, New Hampshire, USA. *Am. J. Botany* 88: 667-676.

Scott, J.T., Siccama, T.G., Johnson, A.H., Breish, R.A., 1984. Decline of red spruce in the Adirondacks. *Bull. Torrey Bot. Club* 111: 438-444.

Siccama, T.G., Bliss, M., Vogelmann, H.W., 1982. Decline of red spruce in the Green Mountains of Vermont. *Bull. Torrey Bot. Club* 109: 162-168.

Vogelmann, A.F., Rock, B.N., 1988. Anatomy of red spruce needles from forest decline sites in Vermont. *Environ. Exp. Botany* 28: 19-26.

Zar, J.H., 1974. *Biostatistical Analysis*. Prentice-Hall, Englewood Cliffs, NJ.