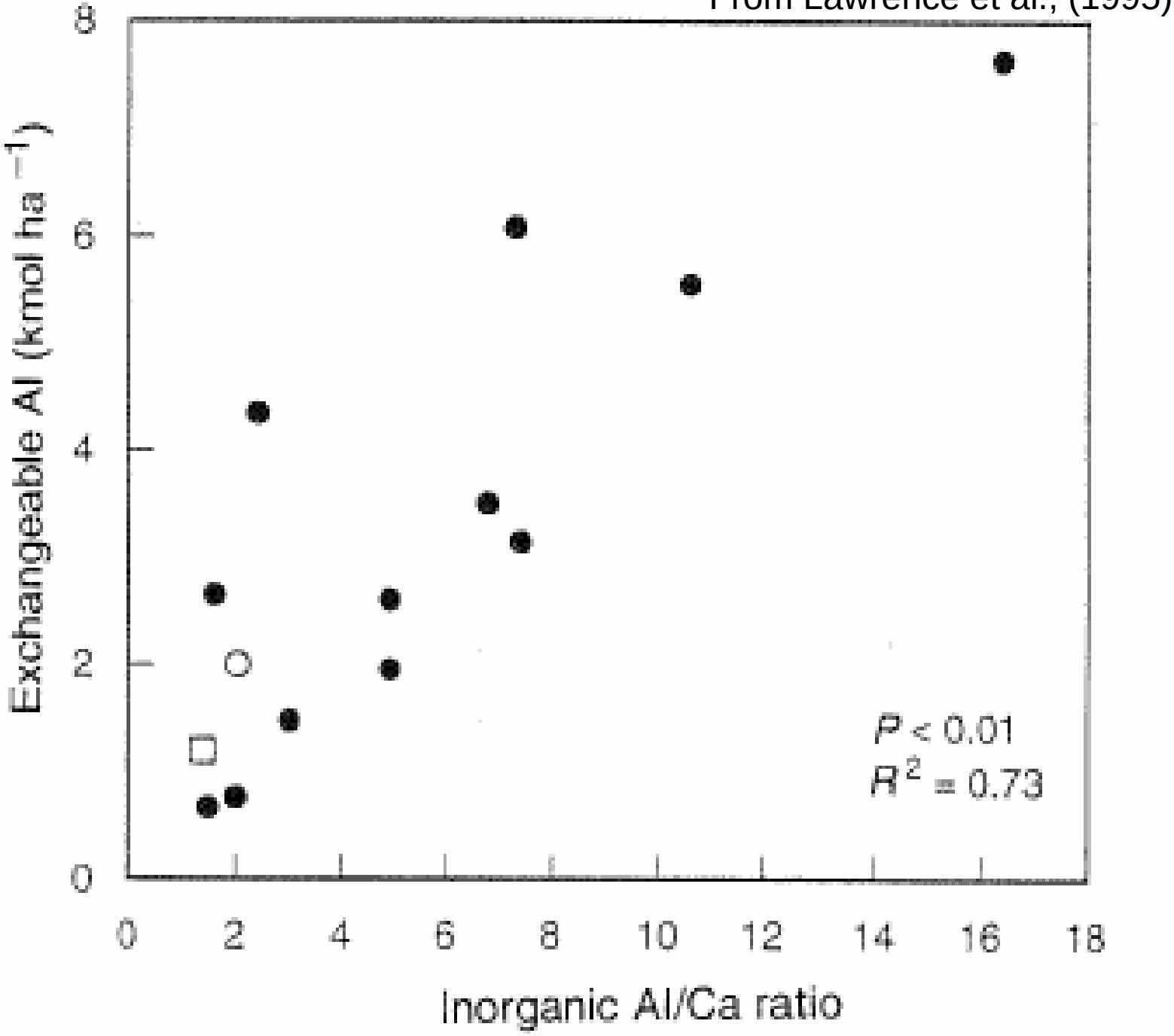
Did Soils in Northeastern Spruce Stands Change During the 1990's?

Spruce Stands, Hubbard Brook Experimental Forest, NH

From Lawrence et al., 1995

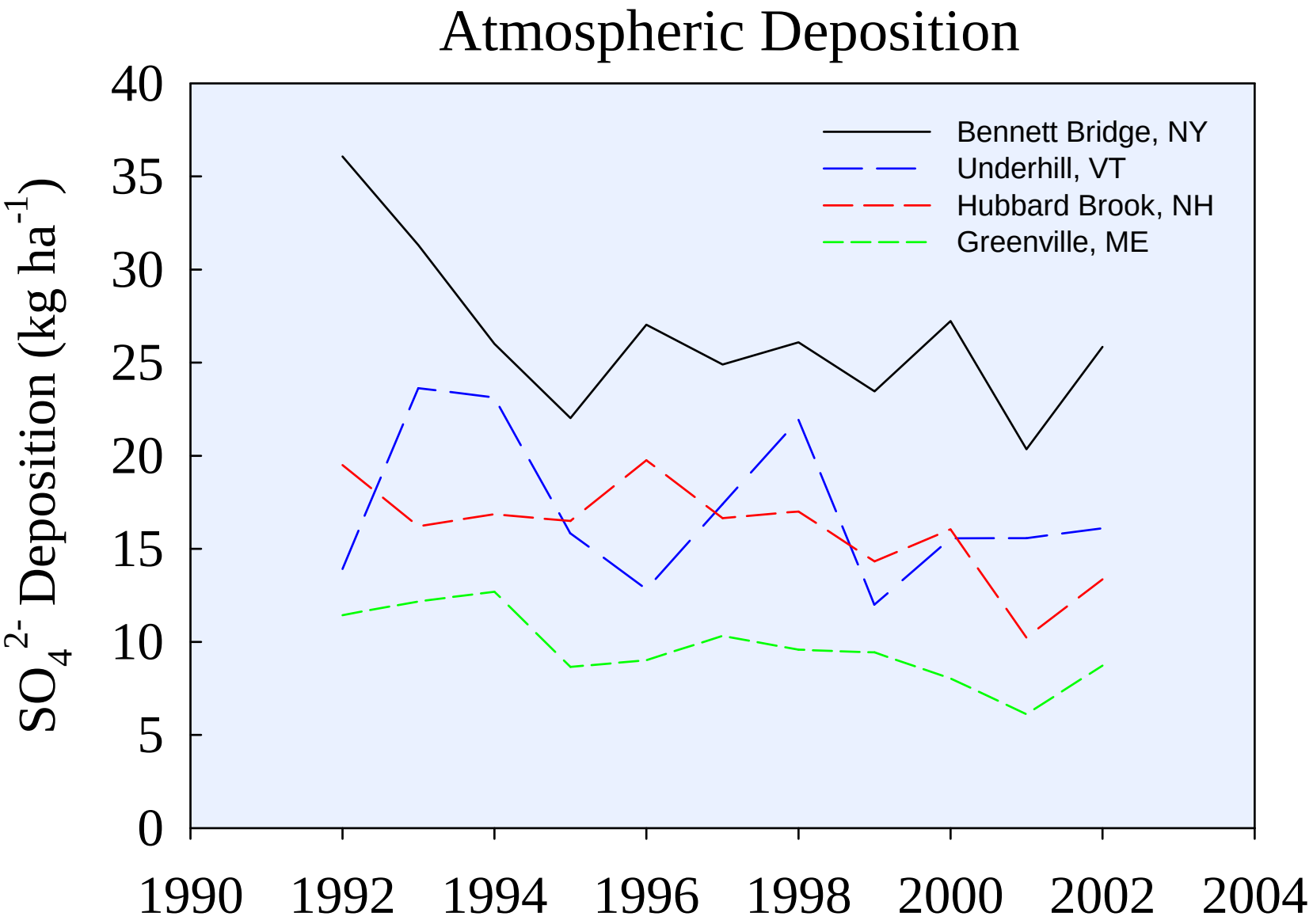
	Exchangeable ($cmol_c\ kg^{-1}$)		Extractable ($cmol_c\ kg^{-1}$)	
Sampling Period	Al	Ca	Al	Ca
1969-1970	2.5^a (1.1)	8.3^a (4.4)	19.3^a (10.2)	9.9^a (6.4)
1987,1992	3.7^a (2.9)	3.5^b (2.1)	37.0^b (21.6)	4.6^b (2.9)

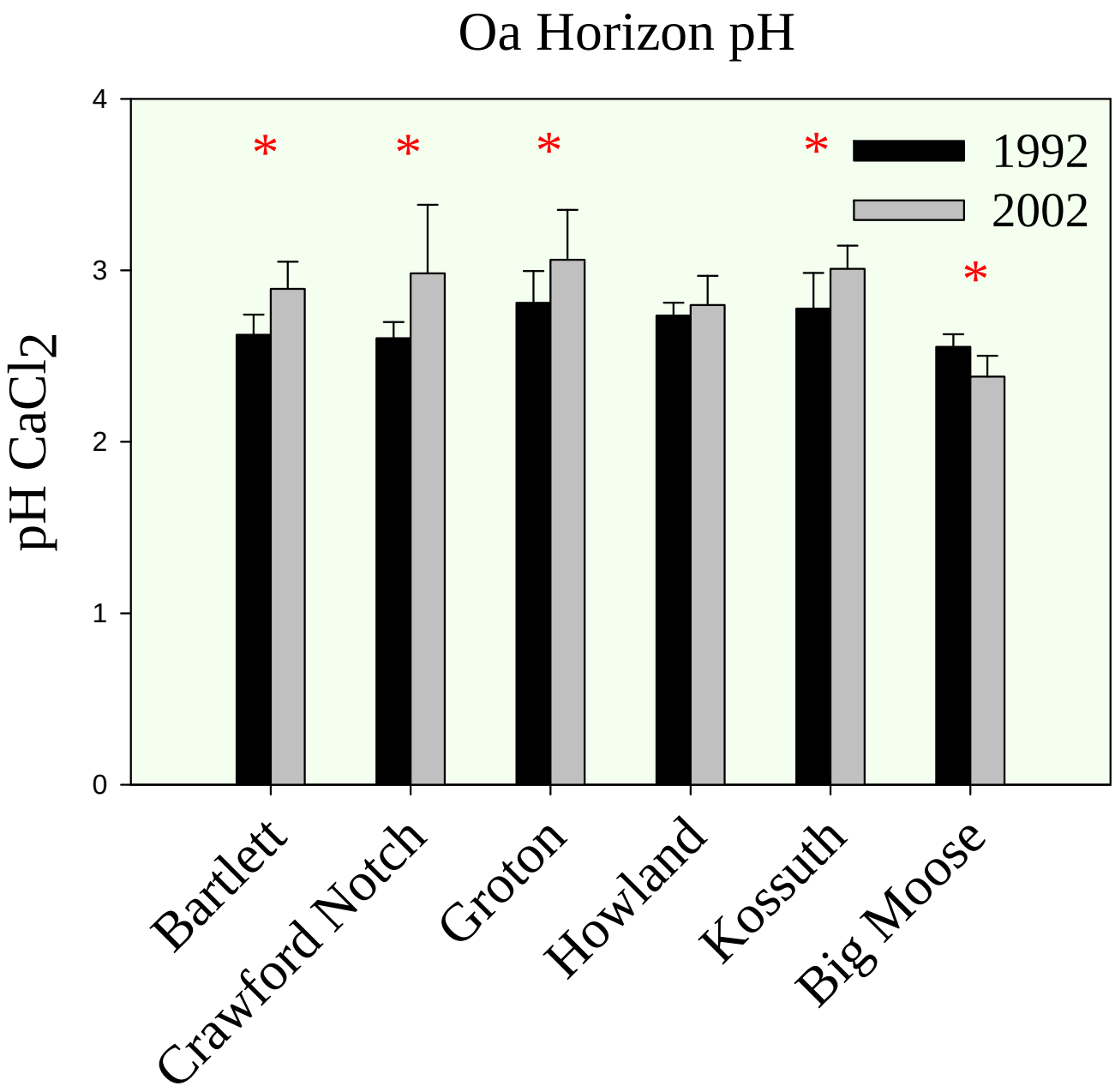
From Lawrence et al., (1995)

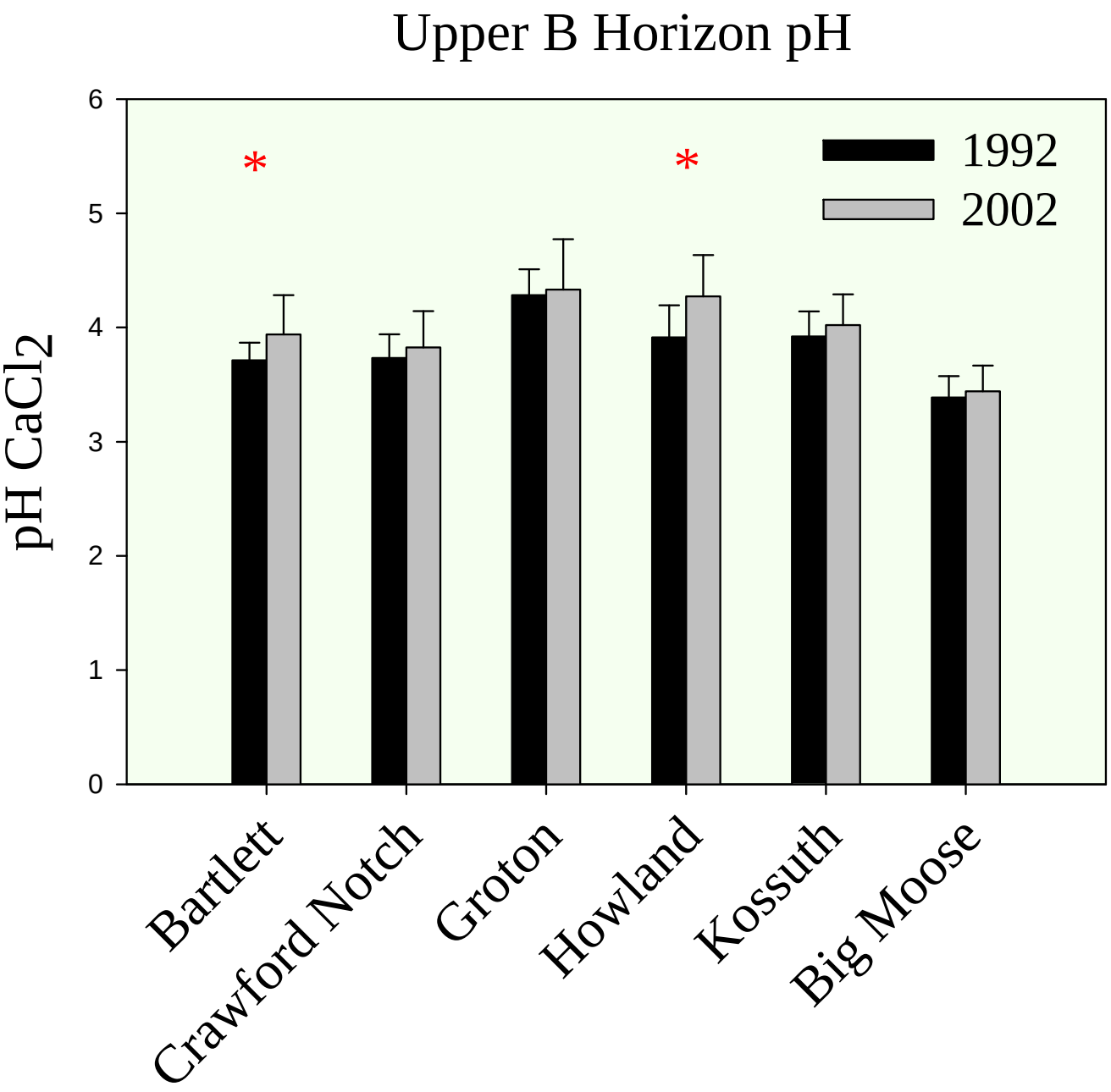


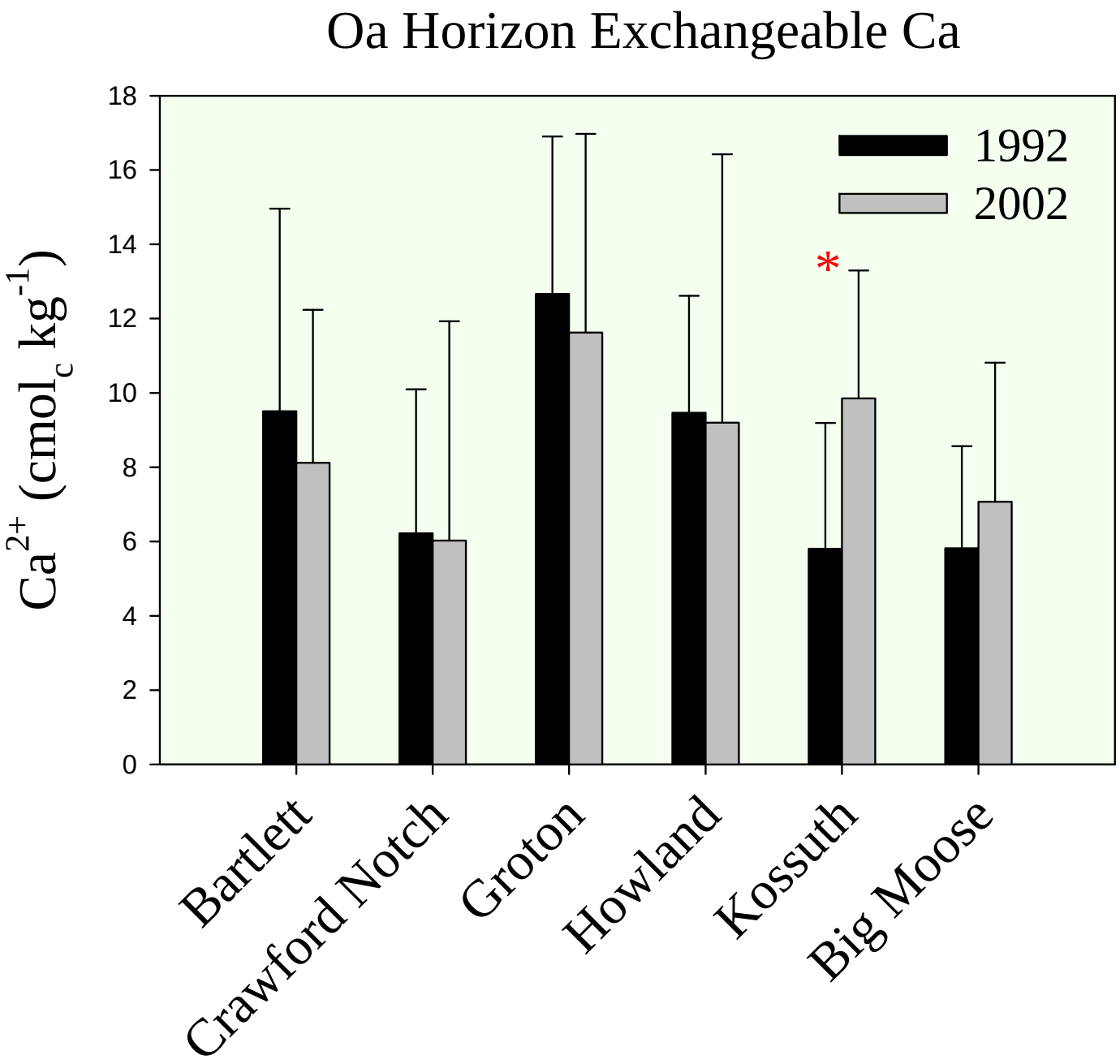
Interpretation: Al mobilized in the mineral soil by acidic deposition is transported into the forest floor by upward movement of water through:

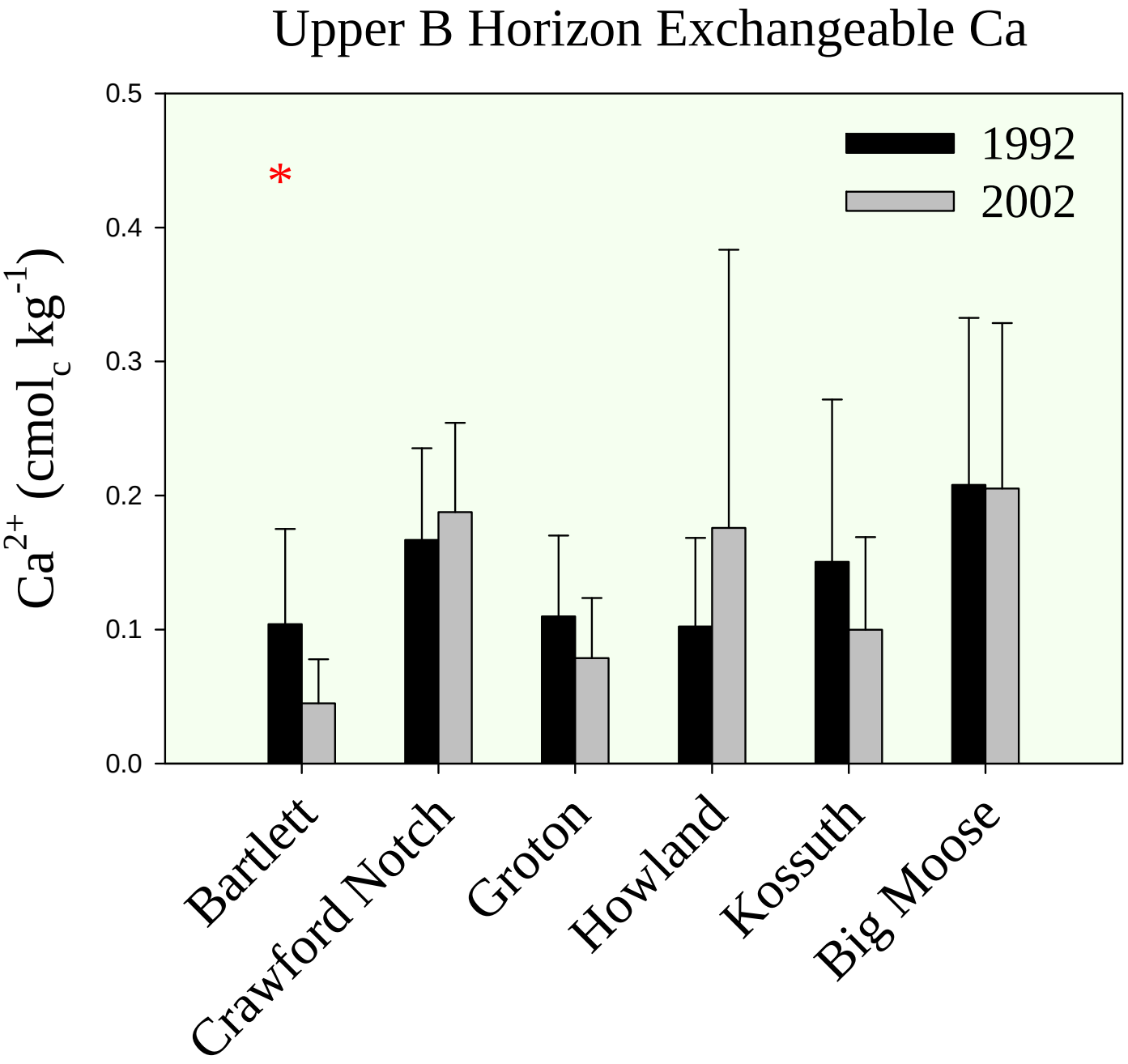
a. a rising water table, and
b. capillary rise from evapotranspiration.

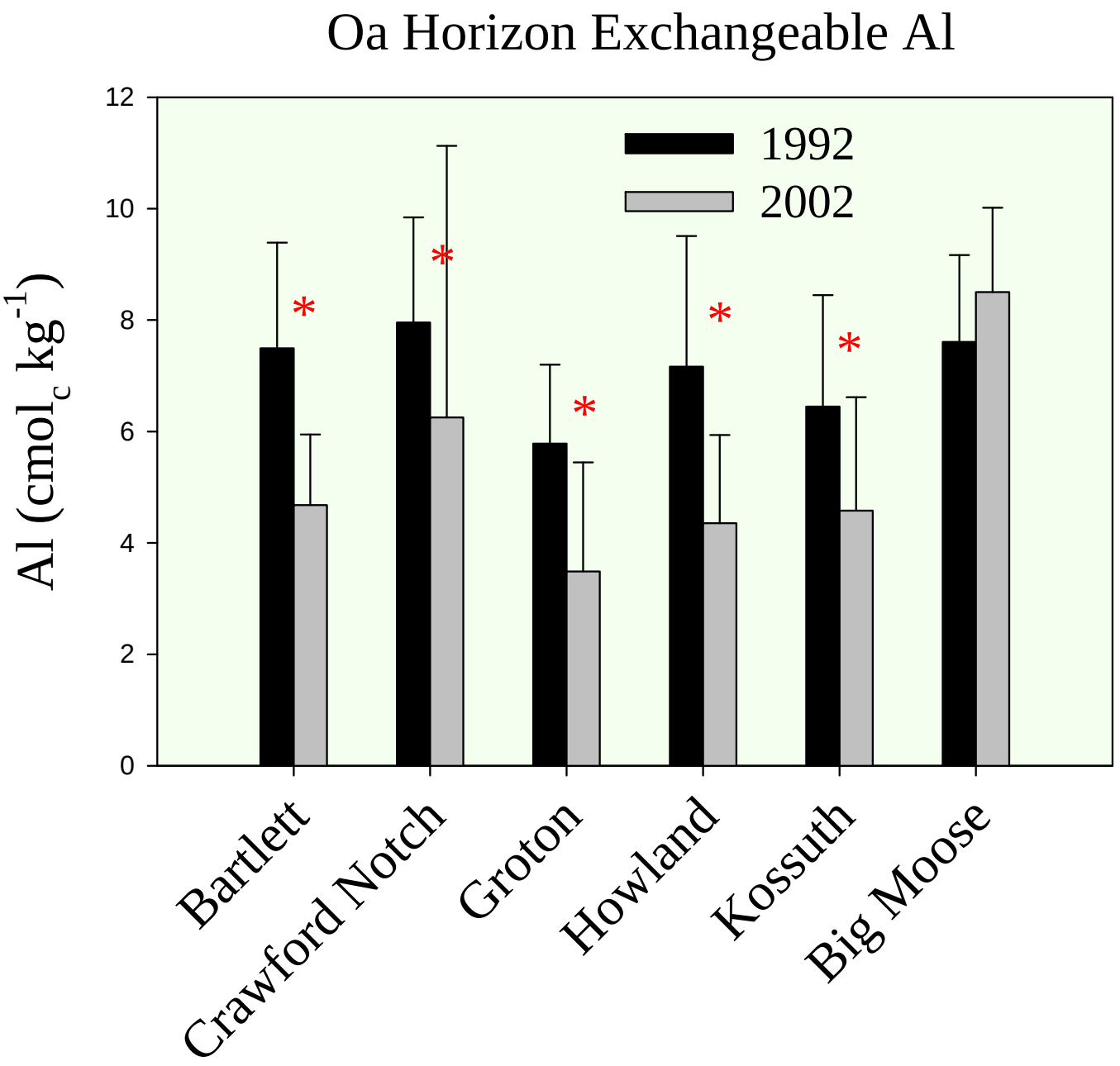

Atmospheric Deposition
SO_4^{2-} Deposition (kg ha^{-1})
40
35
30
25
20
15
10
5
0
1990
1992
1994
1996
1998
2000
2002
2004
Bennett Bridge, NY
Underhill, VT
Hubbard Brook, NH
Greenville, ME

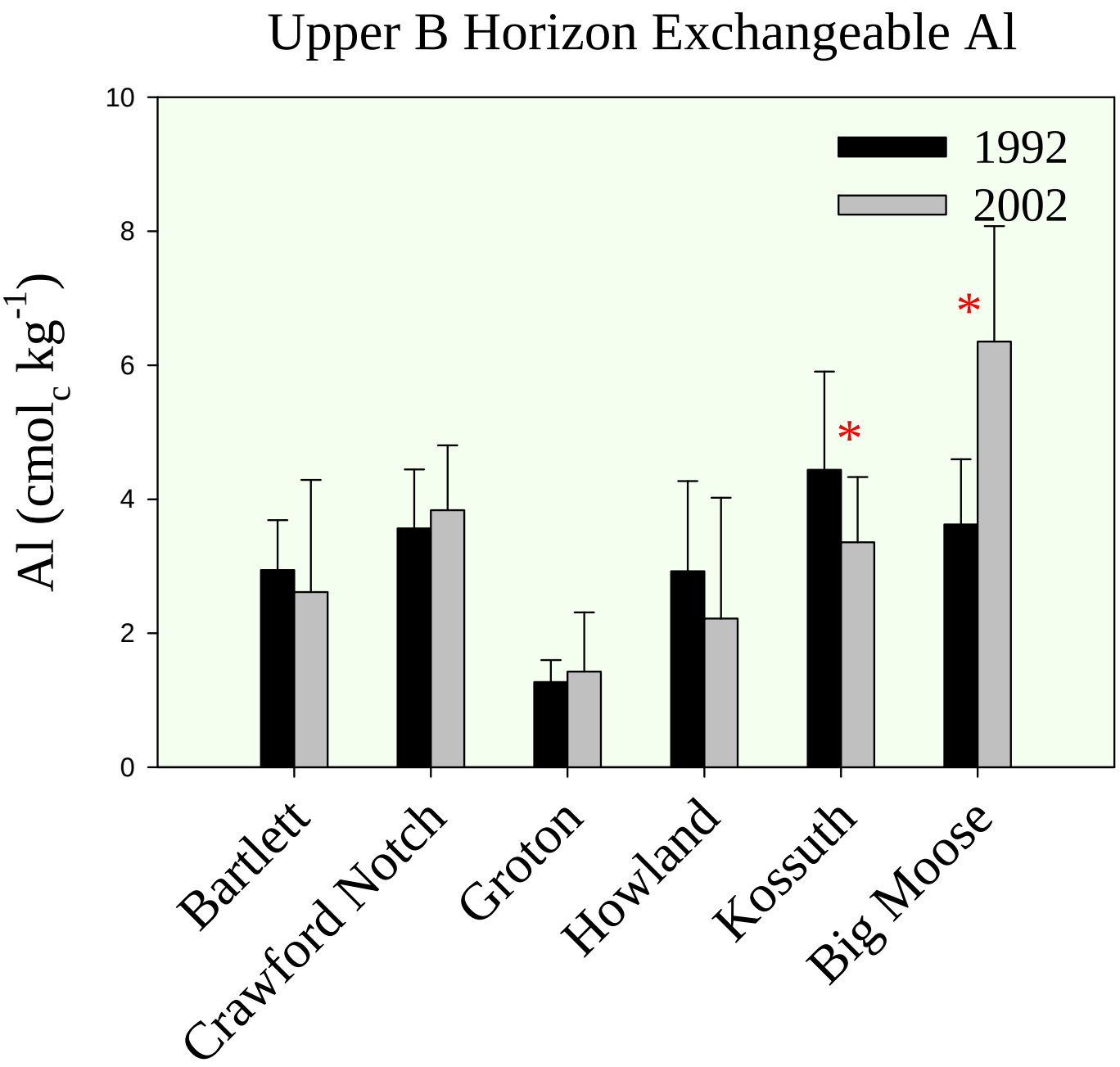

Oa Horizon pH
pH CaCl2
4
3
2
1
0
1992
2002
*
*
*
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

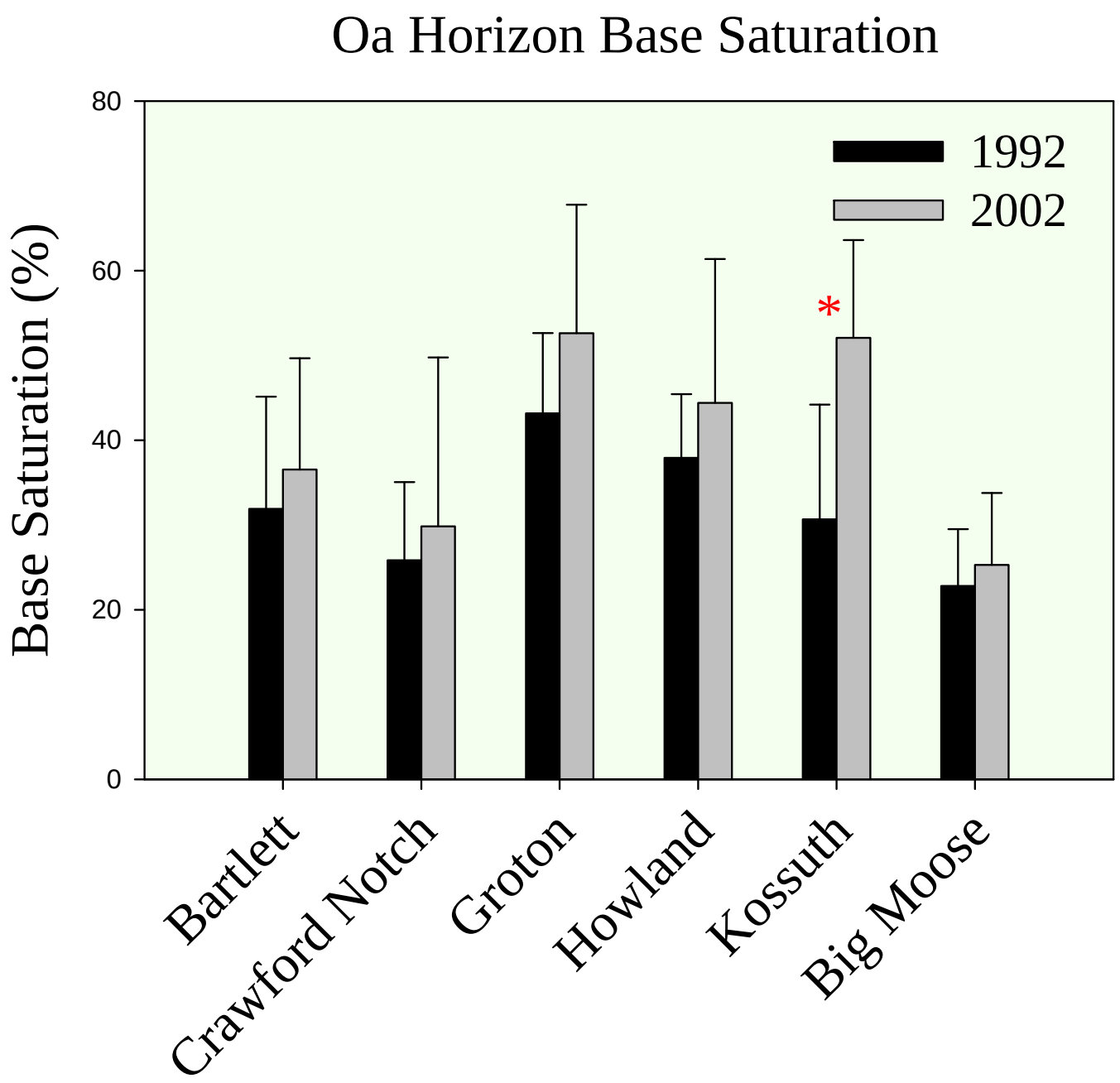

Upper B Horizon pH
pH CaCl2
6
5
4
3
2
1
0
*
*
1992
2002
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

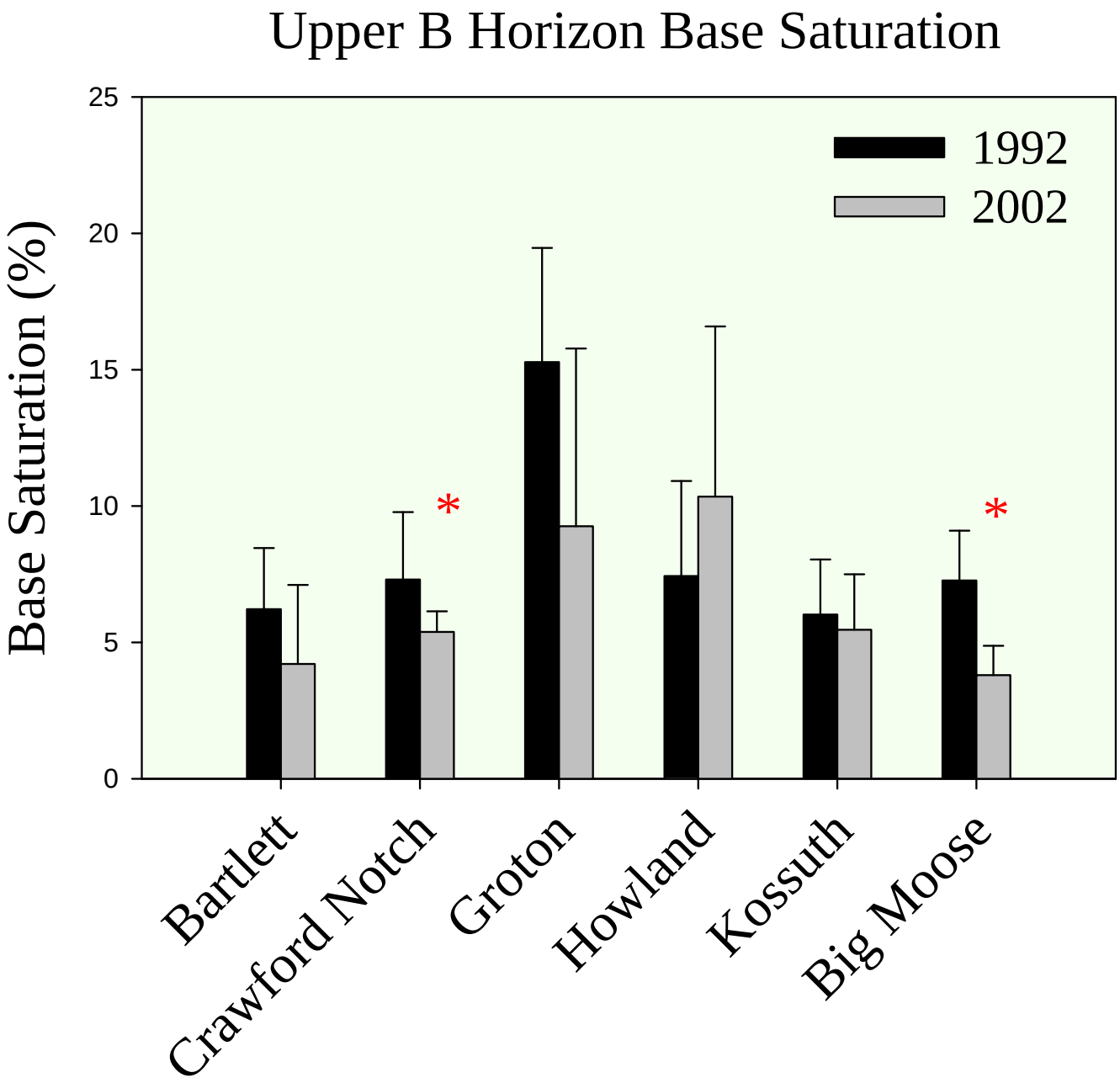

Oa Horizon Exchangeable Ca
1992
2002
*
Ca^{2+} ($cmol_c$ kg^{-1})
0
2
4
6
8
10
12
14
16
18
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Upper B Horizon Exchangeable Ca
0.5
0.4
0.3
0.2
0.1
0.0
*
1992
2002
Ca2+ (cmolc kg-1)
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Oa Horizon Exchangeable Al
1992
2002
Al (cmol$_c$ kg^{-1})
0
2
4
6
8
10
12
*
*
*
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Upper B Horizon Exchangeable Al
Al (cmol$_c$ kg^{-1})
10
8
6
4
2
0
1992
2002
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Oa Horizon Base Saturation
Base Saturation (%)
80
60
40
20
0
1992
2002
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

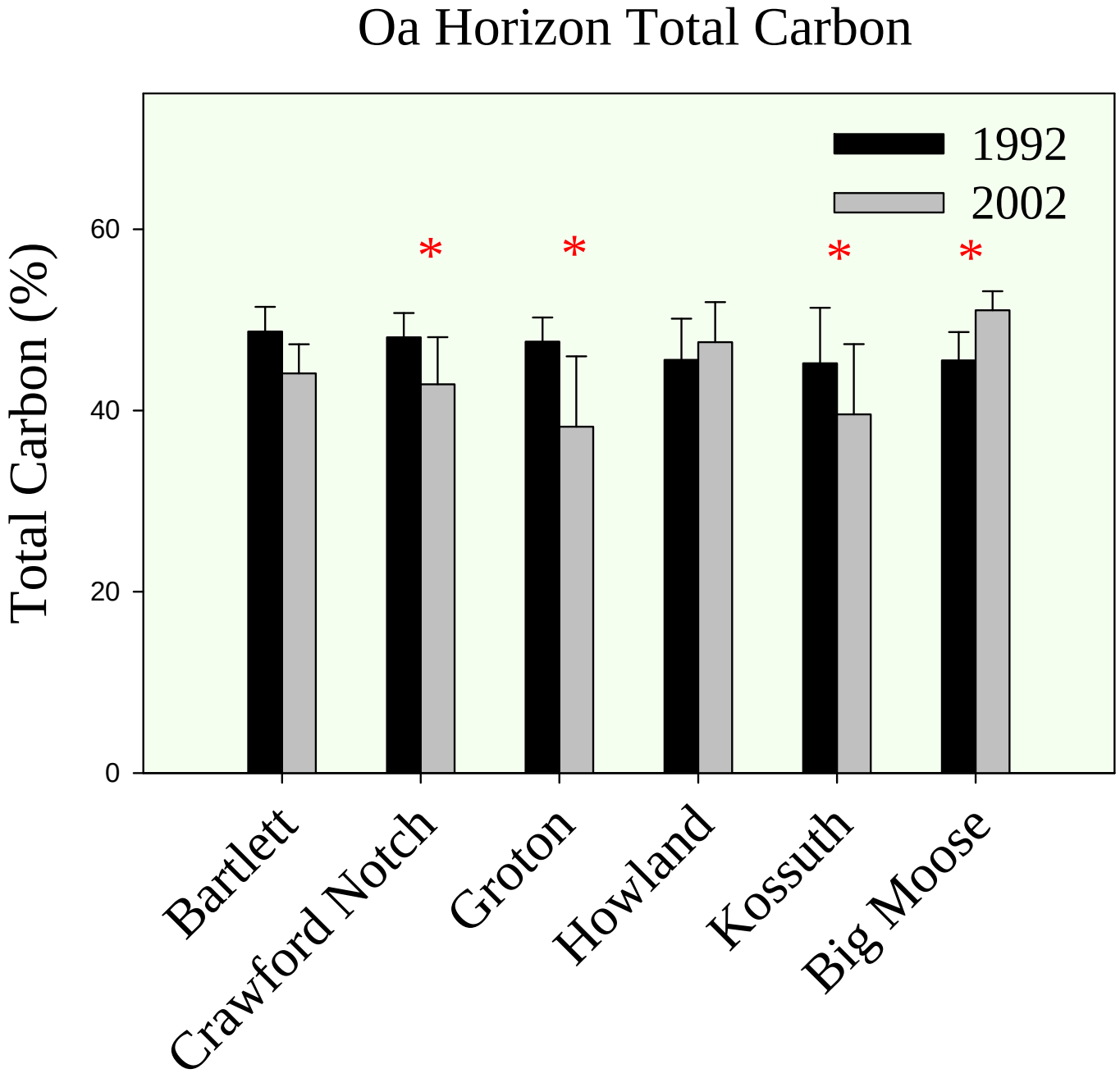

Upper B Horizon Base Saturation
Base Saturation (%)
25
20
15
10
5
0
1992
2002
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

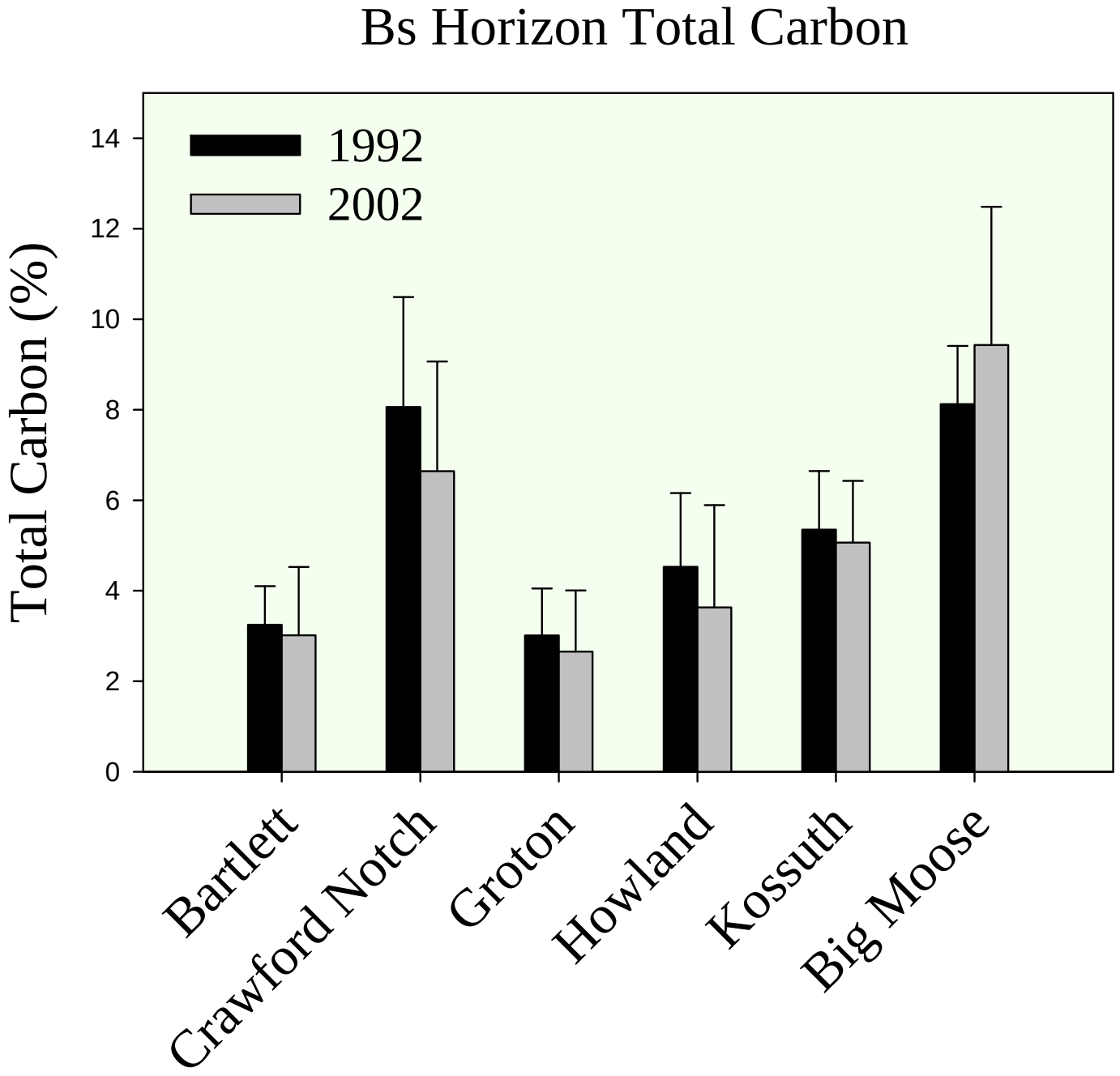
Major Changes

1. Increase in pH in Oa horizon.
2. Decrease in exchangeable Al in the Oa horizon.
3. Base saturation increases in the Oa and decreases in the upper B.

Major Questions

1. Are these changes real?
2. If they are real, how do they relate to the theory of Al mobilization in the upper B horizon?

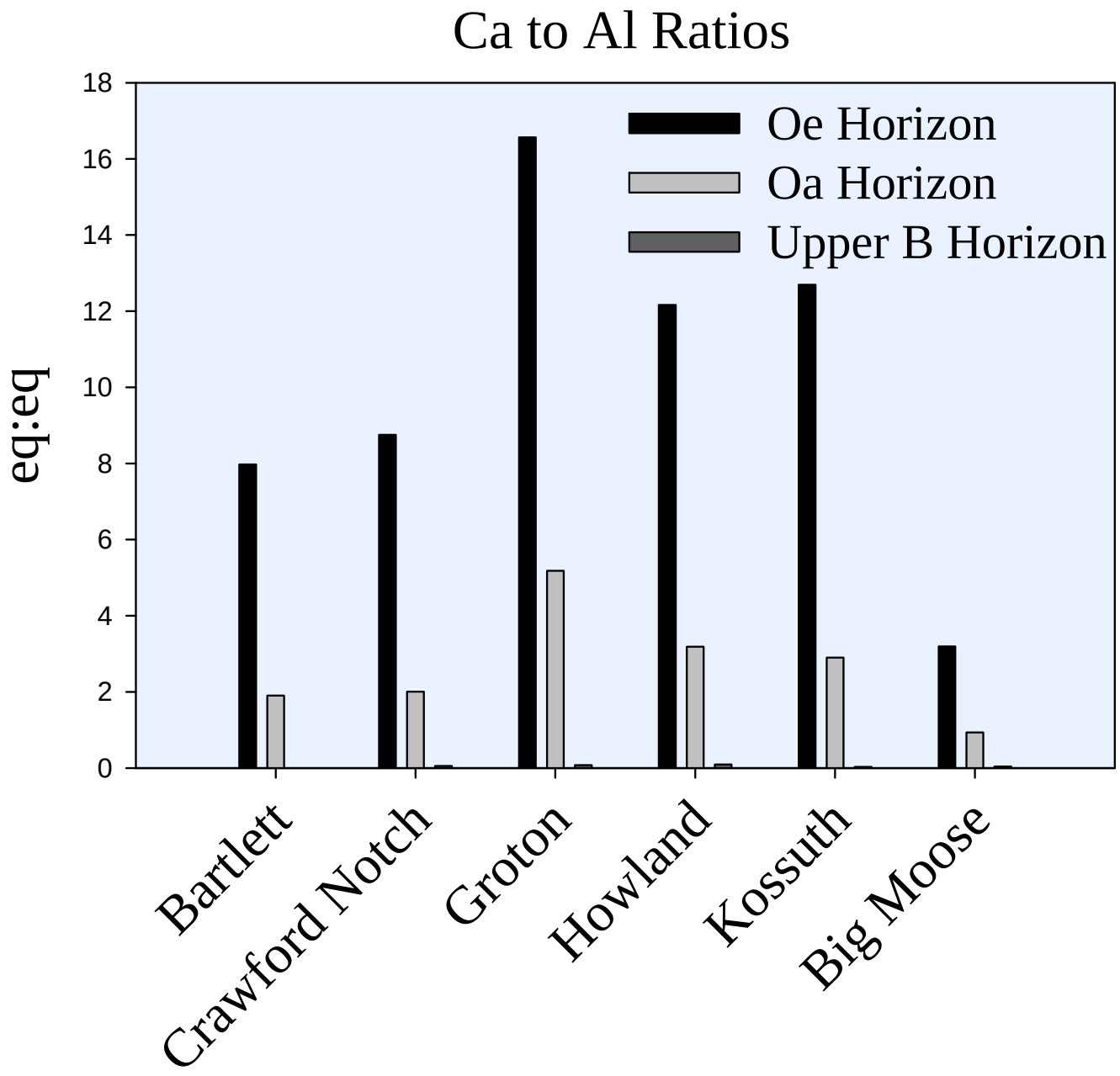

Oa Horizon Total Carbon
1992
2002
Total Carbon (%)
60
40
20
0
*
*
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

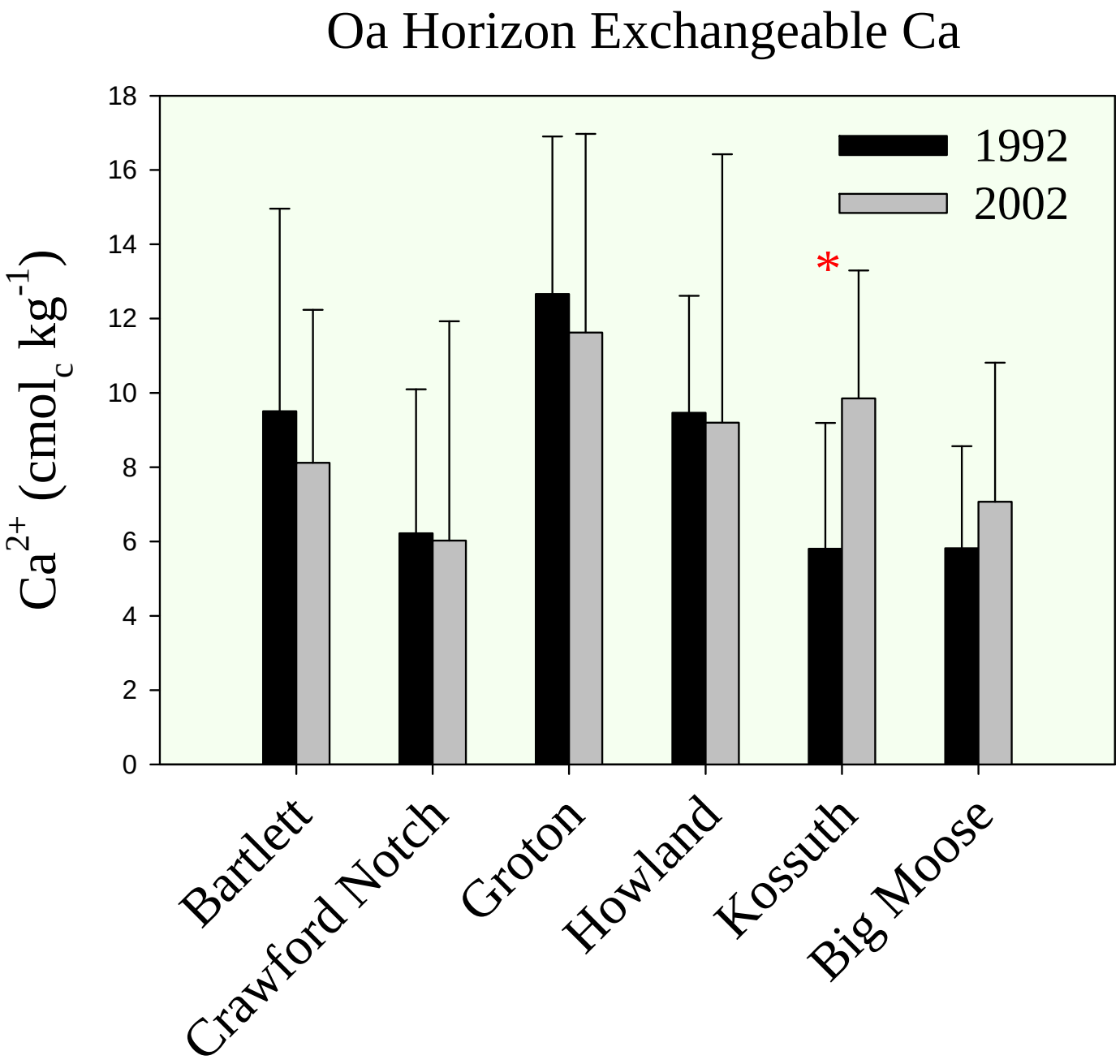

Bs Horizon Total Carbon
1992
2002
Total Carbon (%)
0
2
4
6
8
10
12
14
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

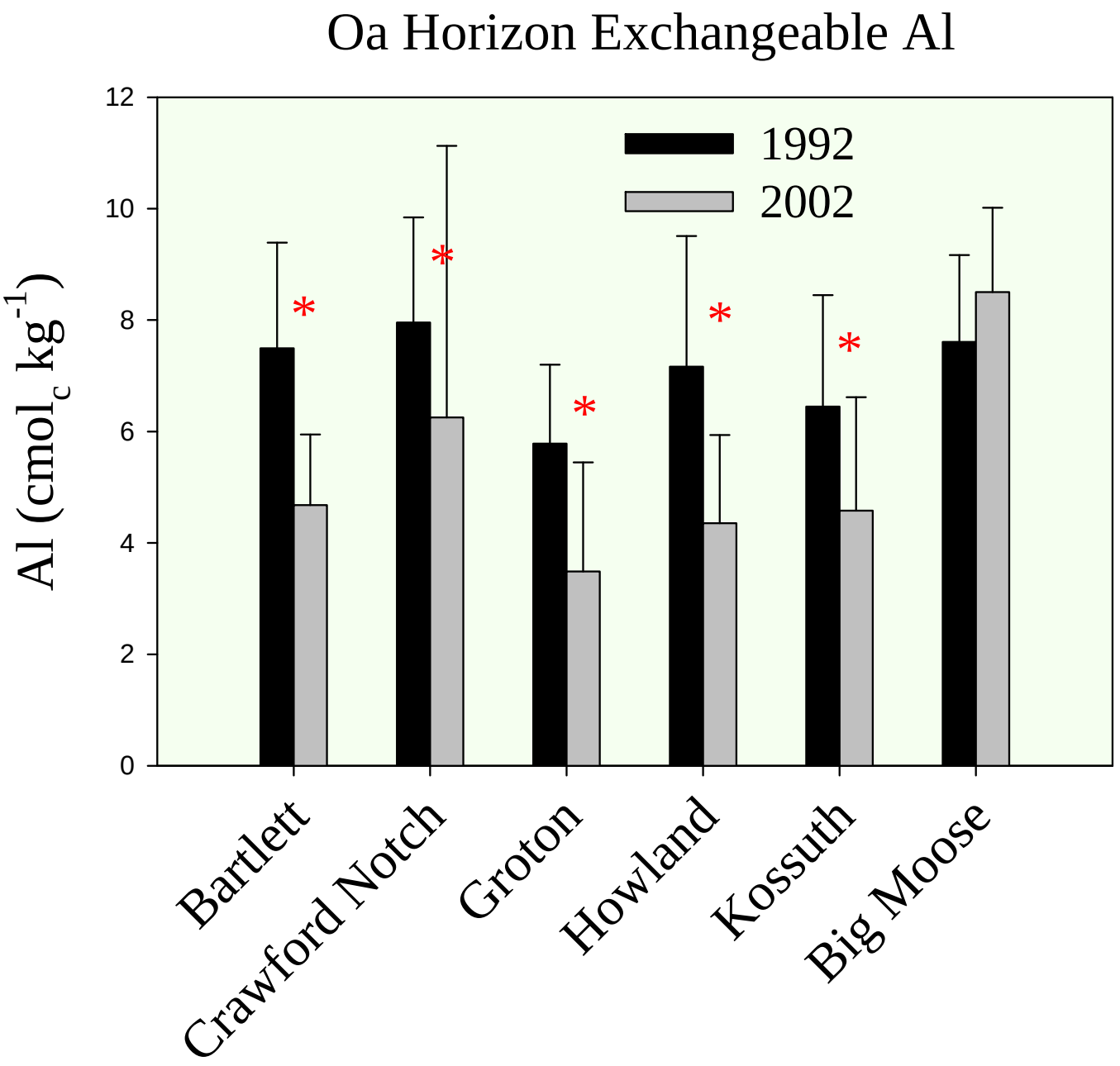
What if we *resampled* the Oa horizon too deep/too shallow

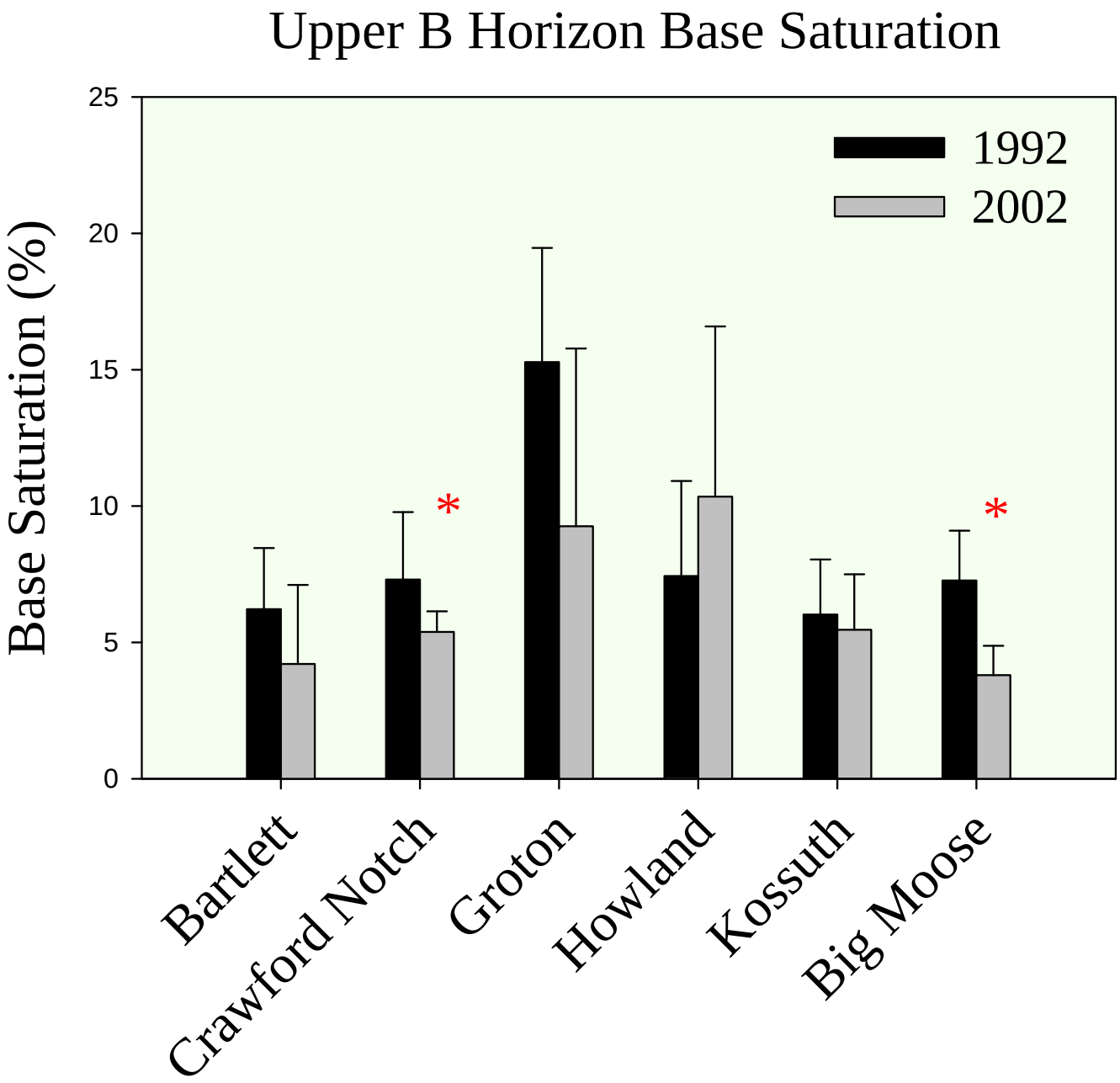
1. Too deep would decrease the Ca to Al ratio.

2. Too shallow would increase the Ca to Al ratio.


Ca to Al Ratios
eq:eq
18
16
14
12
10
8
6
4
2
0
Oe Horizon
Oa Horizon
Upper B Horizon
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Oa Horizon Exchangeable Ca
1992
2002
*
Ca^{2+} ($cmol_c$ kg^{-1})
0
2
4
6
8
10
12
14
16
18
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Oa Horizon Exchangeable Al
1992
2002
Al (cmol$_c$ kg^{-1})
0
2
4
6
8
10
12
*
*
*
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose


Upper B Horizon Base Saturation
Base Saturation (%)
25
20
15
10
5
0
1992
2002
*
*
Bartlett
Crawford Notch
Groton
Howland
Kossuth
Big Moose

How do we interpret these changes?

1. Increased Oa pH was due to decreased deposition, decreased organic matter or something else?
2. Decreased Oa Al was due to decreased mobilization in the B horizon (which we didn’t see in the 90’s), or something else?