Understanding and Sustaining Ecosystem Health in Northern Forests

Northern Forest Ecosystem Response to Environmental Change: Regional Collaboration and Database Development Progress Report, January 2007

Principal Investigator: : Lindsey Rustad, USDA Forest Service, 35 Crystal Lane, Cumberland, Maine 04021, Phone/fax: 207 829 6817; Email: rustad@maine.edu

Cooperators, Participating Institutions, and Relevant Databases

Name*	Institution	Database
Elizabeth Boyer	SUNY Syracuse	Climate Database
John Campbell	USDA Forest Service	NERC Watershed N Budgets
Tom Clair	Environmental Canada	NERC Hg Database
David Evers	BioDiversity Research Institute	NERC Hg Database
Ivan Fernandez	Univ. of Maine	Maine Soils Database
Christy Goodale	Cornell Univ.	NERC N Saturation Database
Peter Groffman	IES	NERC N Gas Database
Rich Hallett	USDA Forest Service	NERC Foliar Database
Steve Kahl	Univ. of Maine	HELM Lakes Survey
Scott Ollinger	Univ. of New Hampshire	NERC N Saturation Database
Linda Pardo	USDA Forest Service	NERC ^{15}N Database
Lindsey Rustad	USDA Forest Service	NERC N Database
Shaun Watmough	Trent University	NERC Base Cation Database

Goals: The goals of this project are to: (1) promote better information exchange between thirteen of the existing NSRC-funded synthesis efforts, and (2) construct a 'master' regional database on northern forest and aquatic ecosystem response to environmental change. We will use this collaboration and 'master' database to (1) describe regional trends in surface water, vegetation, and soil chemistry, (2) investigate interactions between two or more vectors of change across the region (e.g. N and Hg), and (3) to identify major gaps in our research agendas and data acquisition processes.

Progress to Date:

1. An initial meeting of cooperating scientists was held in September 30, 2004. Major questions were reviewed and a structure and plan for the database was decided upon.

2. Phase 1 of the database project has been completed, and an initial Microsoft Access searchable meta database has been developed to provide information on what types of formation are available in the various databases.

3. A pass word protected website was developed to house the meta database and other project information: http://www.ecostudies.org/nerc/index_new.htm

4. A second meeting of cooperating scientists was convened on April 13, 2005 in Durham, NH. Elements of Phase 2, including investigator permission letters and the structure and content of the regional database were discussed.

5. Permissions have been obtained from all data contributors at varying levels.

6. Data from 12 of the 13 databases have been entered into a Microsoft Access searchable database.

7. The following graphical and statistical analyses have been performed for 'Surface Water', 'Vegetation', and 'Soils' subsets of the data for the period 1990-2003 (see Appendix A, B, and C):
   a. Summary statistics
   b. Cumulative probability diagrams (with the exception of Soils)
   c. Box Plots by State and Provence
   d. Regional Maps
   e. Linear regressions for each parameter against latitude, longitude, and elevation
   f. Scatter plots of parameters with r^2's > 0.10 with latitude, longitude, and elevation
   g. Classification and regression trees (CART) for all parameters
   h. Random Forest plots

8. Regional maps for N, S, and Hg deposition have been compiled (Appendix D).

9. A geospatial climate, soil characteristics and landscape characteristics database has been developed (Appendix E). This can be accessed at: http://nature.berkeley.edu/boyerlab/nercgis.html, and is expected to be in a final form by the end of May.

Preliminary Observations – By Ecosystem Strata:

Surface Water: Surface water chemistry is available from 997 sites (Appendix A-1). Surface water NO_3, SO_4, and total N decrease from west to east, and from south to north. Na and Cl increase from west to east. Surface water SO_4 and Al increase with increasing elevation whereas Na, Cl, and K decrease with increasing elevation (Appendices A-3 to A-5).

Foliage: Foliar data are available for 135 to 239 sites, depending on the species and nutrient (Appendix B-1). Foliar N (*F. Americana* and *Q. rubra*), Al (*A. saccharum*) and lignin (*F. grandifolia, A. rubra, and Q. rubra*) decrease significantly from west to east, whereas Ca (*A. balsamea*), Mg (*Q. rubra and A. balsamea*), Sr (*F. americana, Q. rubra* and *P. rubens*), and cellulose increase. Foliar N, (*Q. rubra*), Mg (*F. americana*), P (*A. saccharum* and *F. americana*), and lignin (*A. rubrum* and *Q. rubra*) decrease with increasing latitude, whereas Ca (*A. balsamea*), Al (*Q. rubra*) and Sr (*B. alleghaniensis, F. americana, Q. rubra P. rubens and A. balsamea*) increase with increasing latitude. Nitrogen (all species), P (*Q. rubra*), and lignin (*A. saccharum, A. rubrum., F. americana*, and *A. balsamea*) increase significantly with elevation, and Ca (*B. alleghaniensis, F. americana, P. rubens* and *A. balsamea*), Mg (*Q. rubra*), K (*P. rubens and A. balsamea*), and Al (*Q. rubra and A. balsamea*) decrease. Cellulose and Sr elevational trends vary with species (Appendices B-3 to B-5). The lack of stronger latitudinal and longitudinal patterns is in part due to the fact that much of this data is concentrated in NH and NY, and thus has a limited geographical spread.

Soils: O horizon, upper mineral (0-20 cm), and lower mineral horizon (>20 cm) soil chemistry data are available from 199, 170, and 67 sites, respectively (Appendix C-1). For the O horizon, pH (softwood), total N (mixed), Al (mixed) and nitrification/mineralization ratios decreased from west to east. In the mineral soil nitrification/mineralization ratios increased from west to east (softwood). For the O horizon, CN (hardwood) and Ca (mixed) increased with increasing latitude and nitrification/mineralization ratios (hardwood) decreased. For the mineral soil, pH (hardwood) decreased with increasing latitude whereas total C (mixed), total N (all stand types) and Al (hardwood and mixed) increased. For the O horizon, pH (softwood) and CN (softwood) decreased with increasing elevation, whereas total N (mixed) and Ca (mixed) increased. For the mineral soil, no elements decreased with increasing elevation, whereas total C and N (all stand types). K (hardwood), and Al (hardwood and mixed) increased (Appendices C-3 to C-5).

Preliminary Observations: By Element

Nitrogen: Surface water, foliar, and soil nitrogen tend to decrease from west to east, following broad nitrogen deposition patterns. Mineral soil N also increases with increasing latitude and increasing elevation, and foliar nitrogen increases with increasing elevation, both consistent with broad climatic patterns.

Carbon: Mineral horizon carbon increases with increasing latitude and increasing elevation, consistent with broad climatic patterns. Foliar lignin tends to decrease with increasing latitude and longitude, but increases with elevation. Foliar cellulose trends were less apparent and varied with species.

Base Cations: No trends were observed for surface water Ca or Mg concentrations; surface water Na increased towards the ocean, and surface water Na and K decreased with increasing elevation. Although few latitudinal or longitudinal trends were observed for foliar base cations, foliar Ca did tend to decrease with increasing elevation. Similarly few trends were observed for soil base cations, with the exception of the increase in soil Ca with increasing elevation.

Continuing Work:

An interim report will be prepared to include the information in appendices A, B, and C, and distributed to all participants for internal review. The working group will collaboratively decide if more data are needed to elucidate regional trends, what additional analyses should be done, and how and where the material should be published.

NERC Database Project Report

Phase 2 Appendices

Appendix A: Surface Water Chemistry Analysis

Table of Contents

Appendix A-1: Surface Water Chemistry Summary Statistics

Table 1. Summary statistics for surface water chemistry dataset. Most variables were transformed to log scale for analysis as noted in the last column. No hypolimnon lake samples were included in the analysis.

All Surface Water

	mean	median	min	max	sd	n	transformation
pH (air-eq)	6.23	6.37	3.98	9.44	0.89	836	none
Ca (mg/L)	2.20	1.32	0.15	54.50	4.51	614	ln(x)
Mg (mg/L)	0.53	0.37	0.02	6.00	0.53	502	ln(x)
K (mg/L)	0.35	0.29	0.04	2.30	0.25	500	ln(x)
Na (mg/L)	2.45	1.50	0.09	60.80	4.03	500	ln(x)
NH_4 (mg N/L)	0.02	0.01	0.00	0.26	0.03	319	ln(x+1)
ANC (mg/L)	5.89	1.66	-6.30	112.30	12.26	525	ln(x+10)
NO_3 (mg N/L)	0.08	0.01	0.00	0.81	0.13	682	ln(x+1)
SO_4 (mg S/L)	1.42	1.19	0.06	38.74	2.02	923	ln(x)
Cl (mg/L)	3.32	1.80	0.09	81.70	6.00	501	ln(x)
DOC/TOC (mg/L)	5.52	4.40	0.00	92.05	4.97	997	ln(x+1)
Total Al (ug/L)	81.03	51.83	0.00	493.09	91.36	319	ln(x+1)
Total N (mg N/L)	0.28	0.27	0.03	2.01	0.20	467	ln(x)
Total P (ug/L)	12.39	9.61	1.53	129.60	12.10	317	ln(x)
Total Hg (ng/L)	2.79	2.26	0.22	19.76	2.27	450	ln(x)
MeHg (ng/L)	0.31	0.21	0.01	3.02	0.34	240	ln(x)

Lakes Only

	mean	median	min	max	sd	n	transformation
pH (air-eq)	6.19	6.30	3.98	9.44	0.95	564	none
Ca (mg/L)	1.90	1.22	0.15	40.90	3.65	469	ln(x)
Mg (mg/L)	0.49	0.36	0.02	4.06	0.45	469	ln(x)
K (mg/L)	0.34	0.27	0.04	2.30	0.24	469	ln(x)
Na (mg/L)	2.02	1.38	0.09	16.90	2.20	469	ln(x)
NH_4 (mg N/L)	0.02	0.01	0.00	0.26	0.03	317	ln(x+1)
ANC (mg/L)	3.49	1.26	-6.30	112.30	10.18	438	ln(x+10)
NO_3 (mg N/L)	0.05	0.01	0.00	0.49	0.09	527	ln(x+1)
SO_4 (mg S/L)	1.06	1.06	0.06	3.34	0.50	691	ln(x)
Cl (mg/L)	2.74	1.59	0.09	33.18	4.05	470	ln(x)
DOC/TOC (mg/L)	5.91	4.80	0.00	34.50	4.18	707	ln(x+1)
Total Al (ug/L)	81.03	51.83	0.00	493.09	91.36	319	ln(x+1)
Total N (mg N/L)	0.30	0.28	0.05	2.01	0.20	436	ln(x)
Total P (ug/L)	12.39	9.61	1.53	129.60	12.10	317	ln(x)
Total Hg (ng/L)	2.45	2.14	0.24	10.79	1.73	254	ln(x)
MeHg (ng/L)	0.28	0.22	0.02	1.81	0.25	142	ln(x)

Streams Only

	mean	median	min	max	sd	n	transformation
pH (air-eq)	6.30	6.49	4.43	8.52	0.77	272	none

Ca (mg/L)	3.16	1.76	0.52	54.50	6.50	145	ln(x)
Mg (mg/L)	1.10	0.80	0.22	6.00	1.02	33	ln(x)
K (mg/L)	0.50	0.40	0.10	1.90	0.38	31	ln(x)
Na (mg/L)	8.84	4.00	2.50	60.80	12.21	31	ln(x)
ANC (mg/L)	17.99	15.00	0.32	54.00	14.55	87	ln(x+10)
NO_3 (mg N/L)	0.21	0.20	0.00	0.81	0.16	155	ln(x+1)
SO_4 (mg S/L)	2.48	1.75	0.19	38.74	3.75	232	ln(x)
Cl (mg/L)	12.09	5.80	2.50	81.70	16.10	31	ln(x)
DOC/TOC (mg/L)	4.57	3.00	0.40	92.05	6.41	290	ln(x+1)
NH_4 (mg N/L)	0.02	0.02	0.00	0.04	0.02	2	ln(x+1)
Total Al (ug/L)	NA	NA	NA	NA	NA	0	ln(x+1)
Total N (mg N/L)	0.09	0.03	0.03	0.38	0.08	31	ln(x)
Total P (ug/L)	NA	NA	NA	NA	NA	0	ln(x)
Total Hg (ng/L)	3.24	2.51	0.22	19.76	2.75	196	ln(x)
MeHg (ng/L)	0.34	0.19	0.01	3.02	0.44	98	ln (x)

Appendix A-2: Surface Water Chemistry Cumulative Probability Diagrams

Figure 1. Cumulative probability diagrams for surface water cations. Most parameters were converted to a natural log scale for analysis.

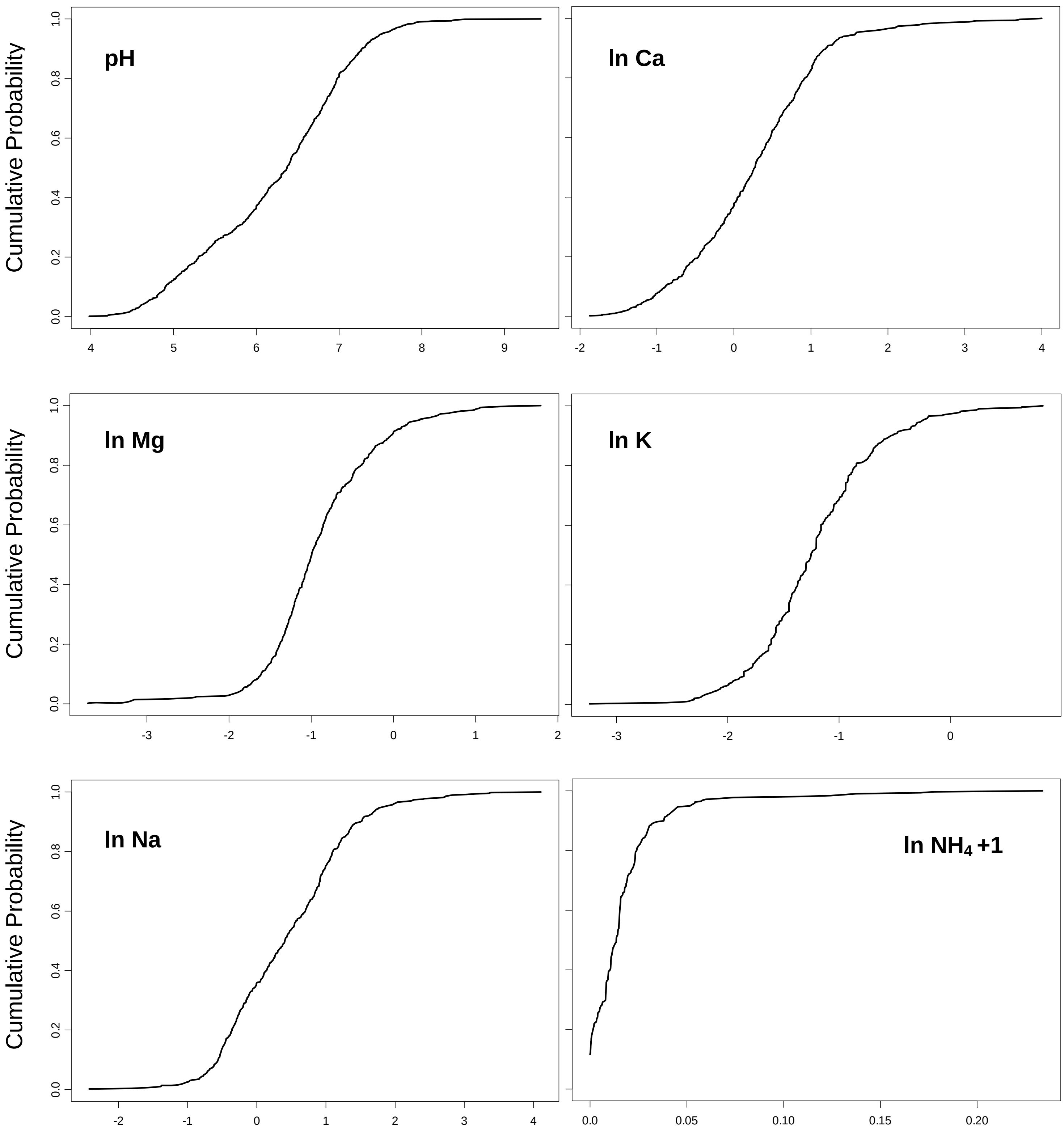


Figure 2. Cumulative probability diagrams for surface water anions. Most parameters were converted to a natural log scale for analysis.

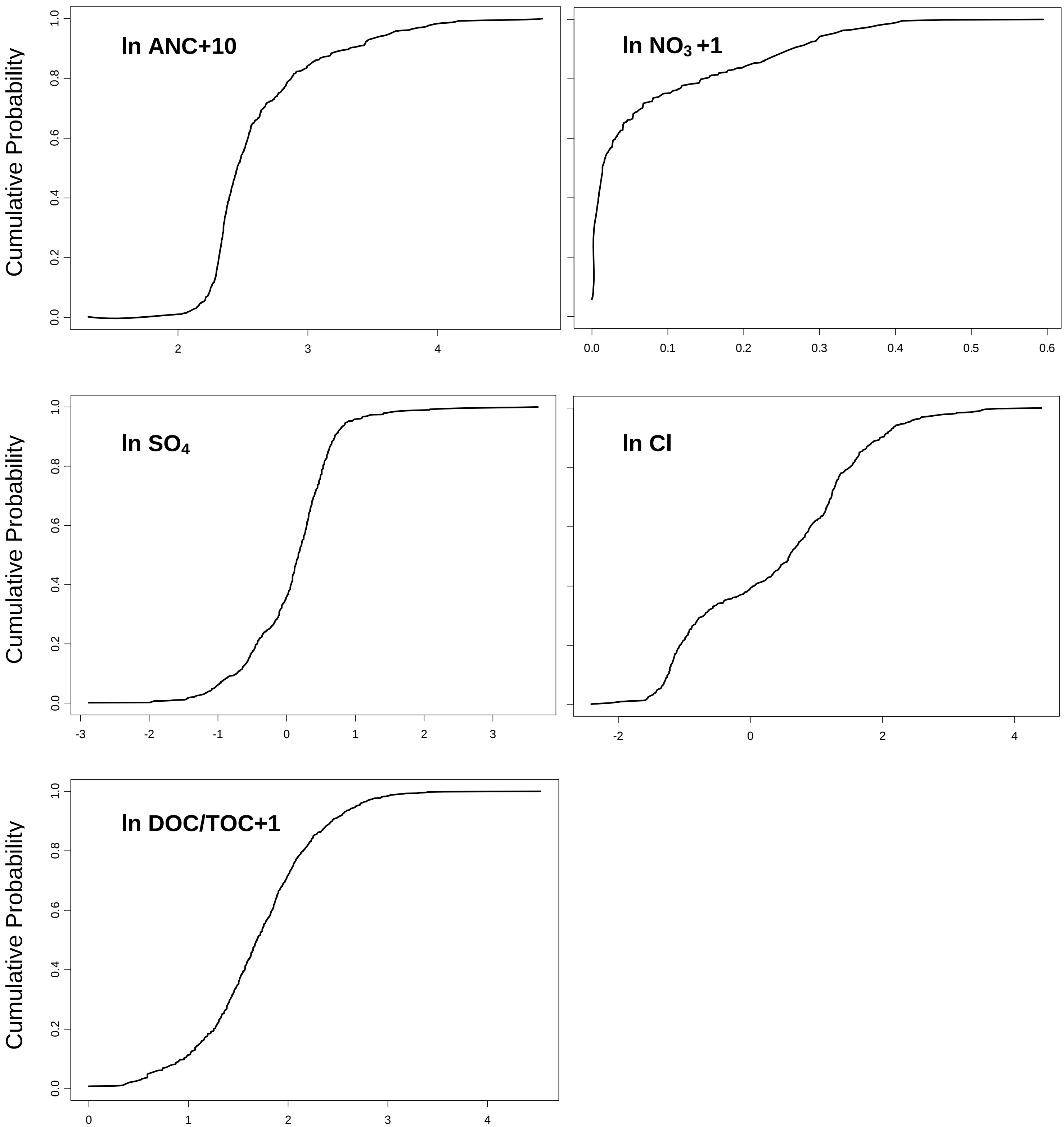
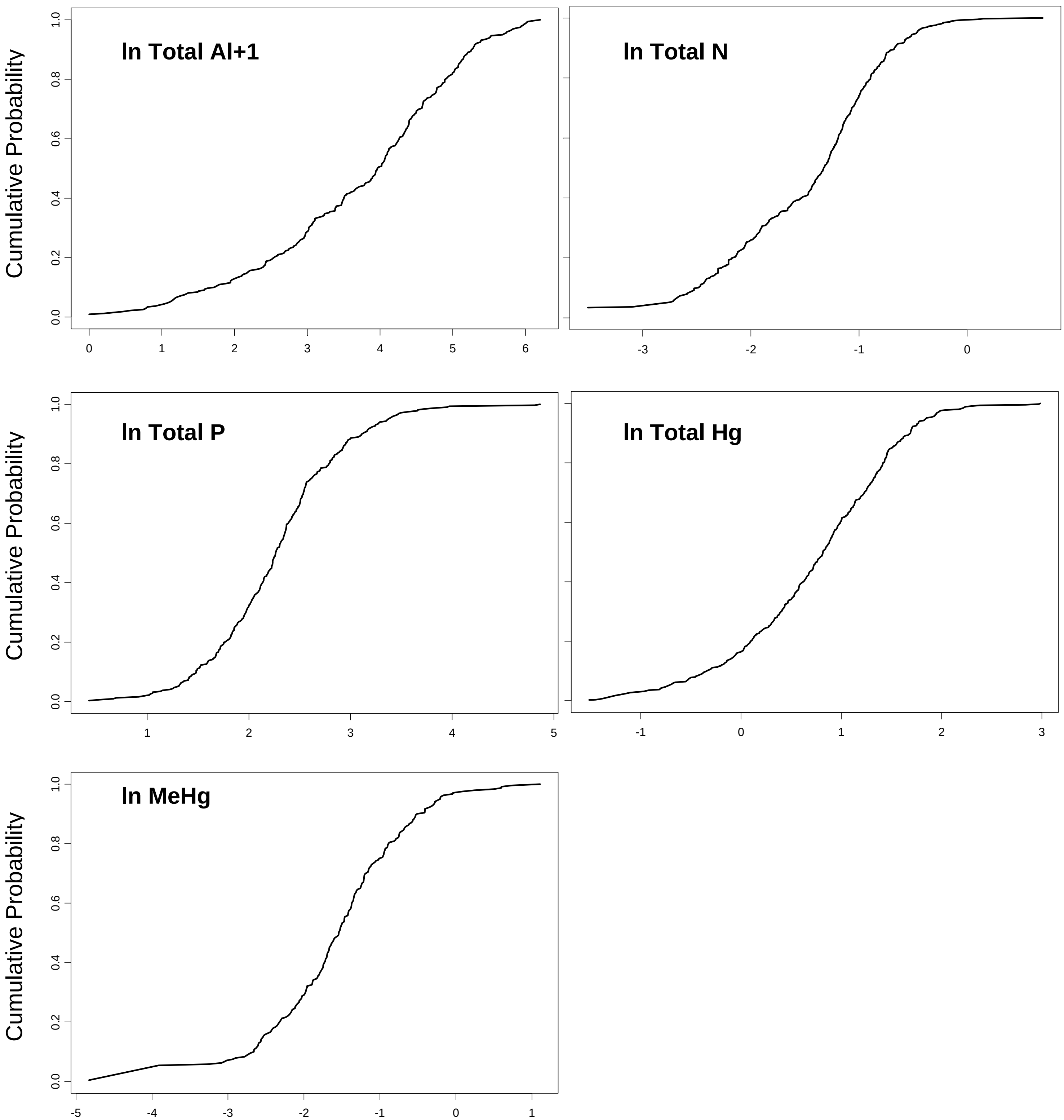


Figure 3. Cumulative probability diagrams for surface water Total Al, N, P and Hg. Most parameters were converted to a natural log scale for analysis.



Appendix A-3: Surface Water Chemistry Boxplots

Figure 4. Boxplots for surface water cations. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

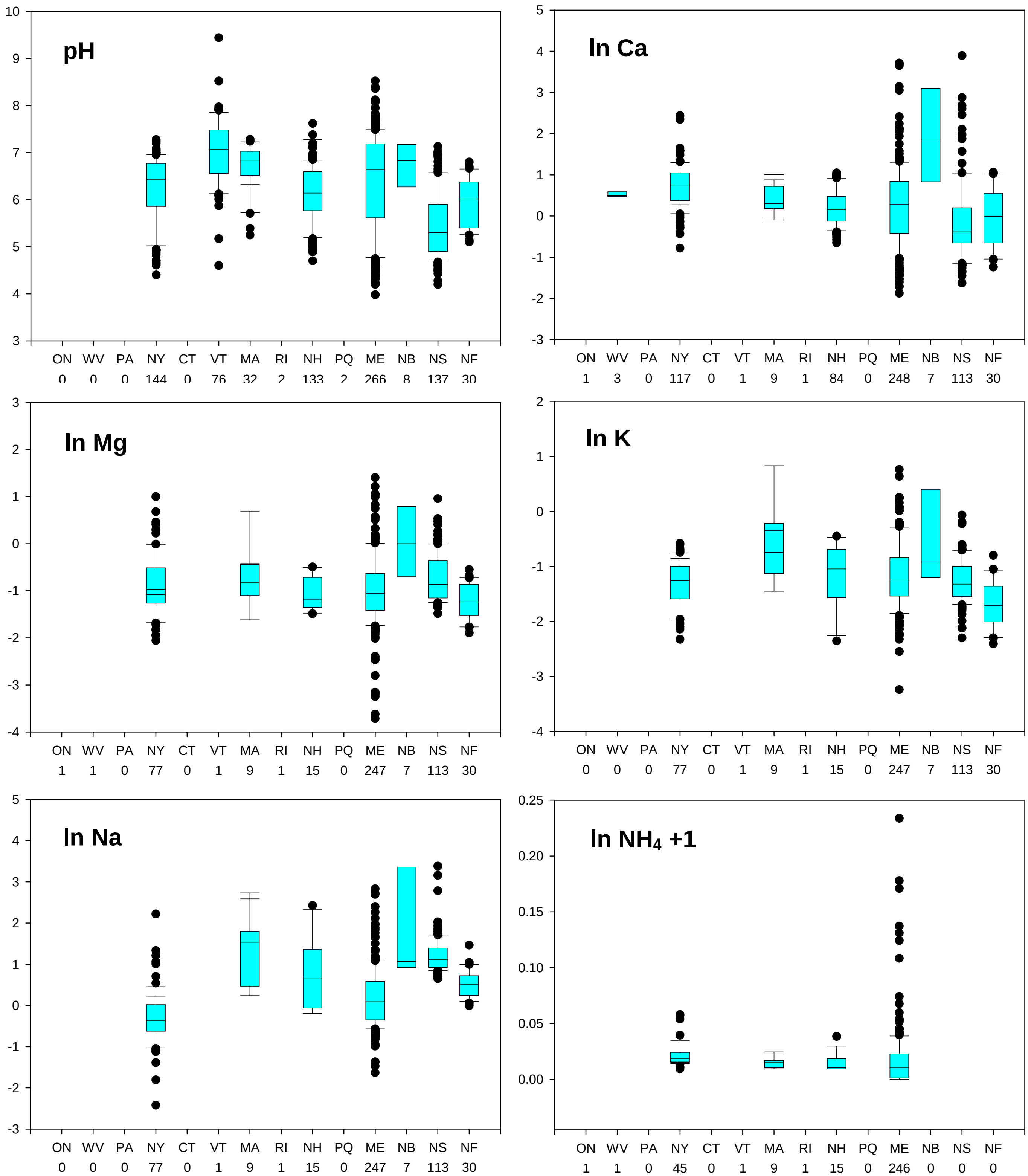


Figure 5. Boxplots for surface water anions. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

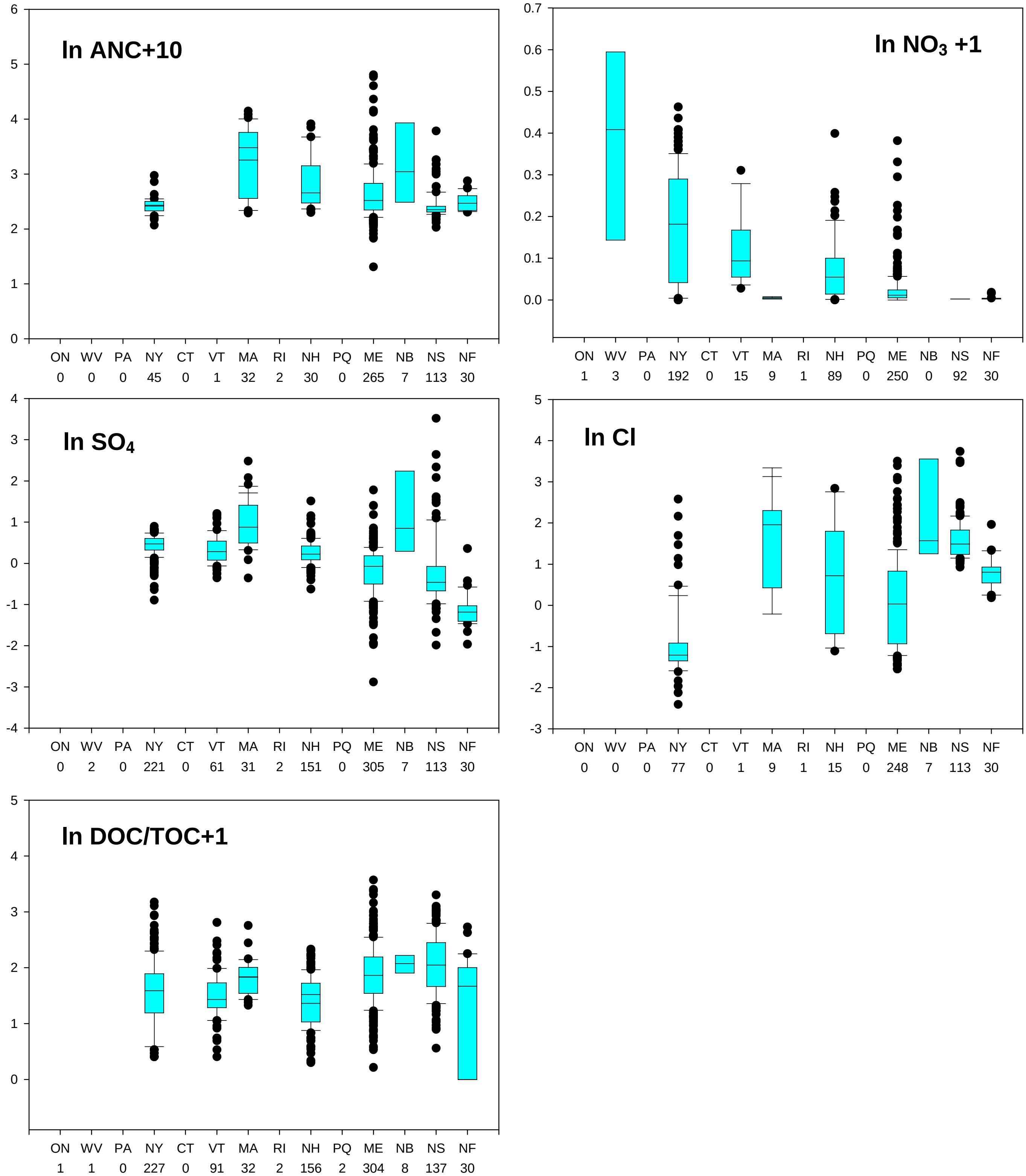
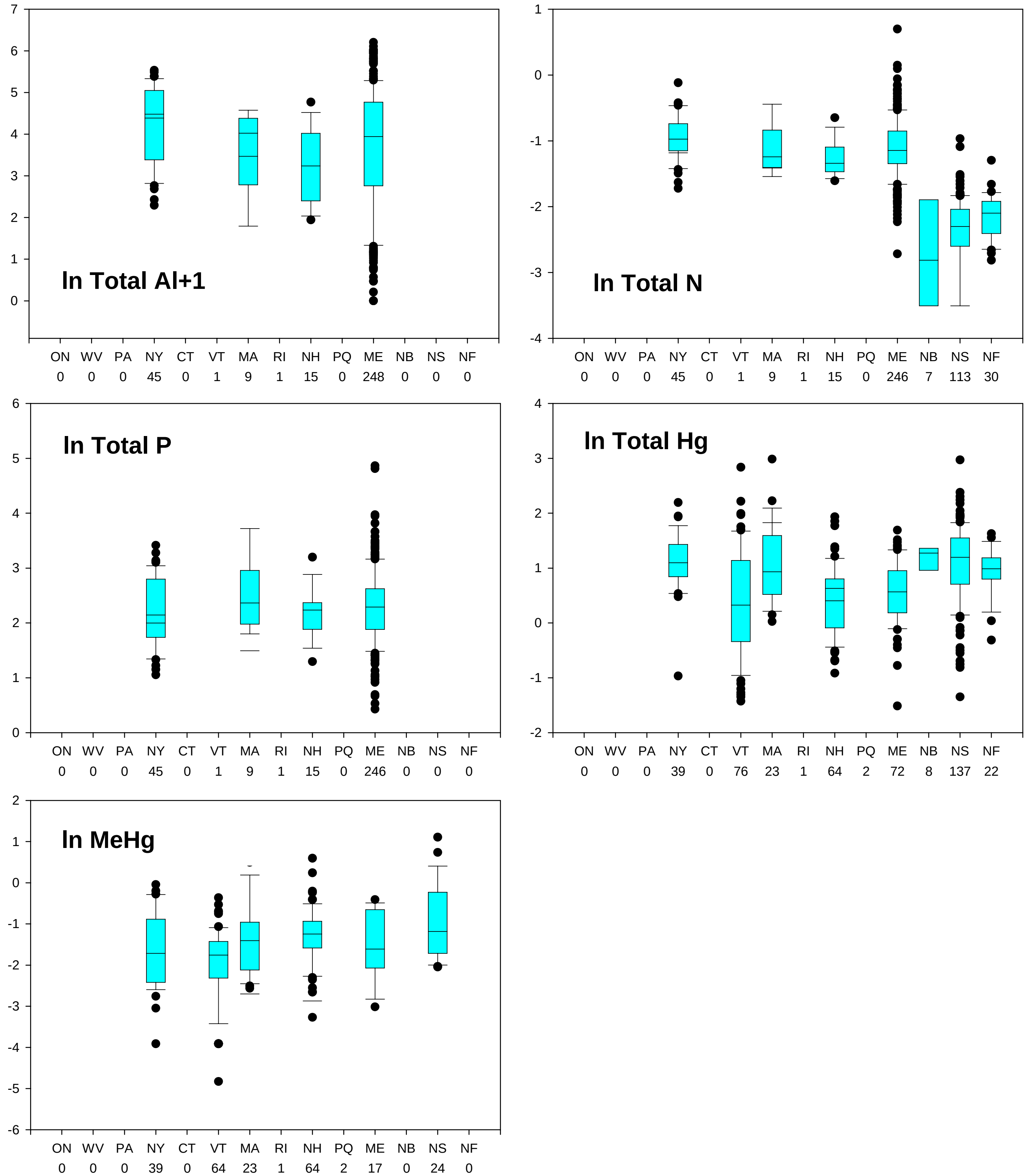
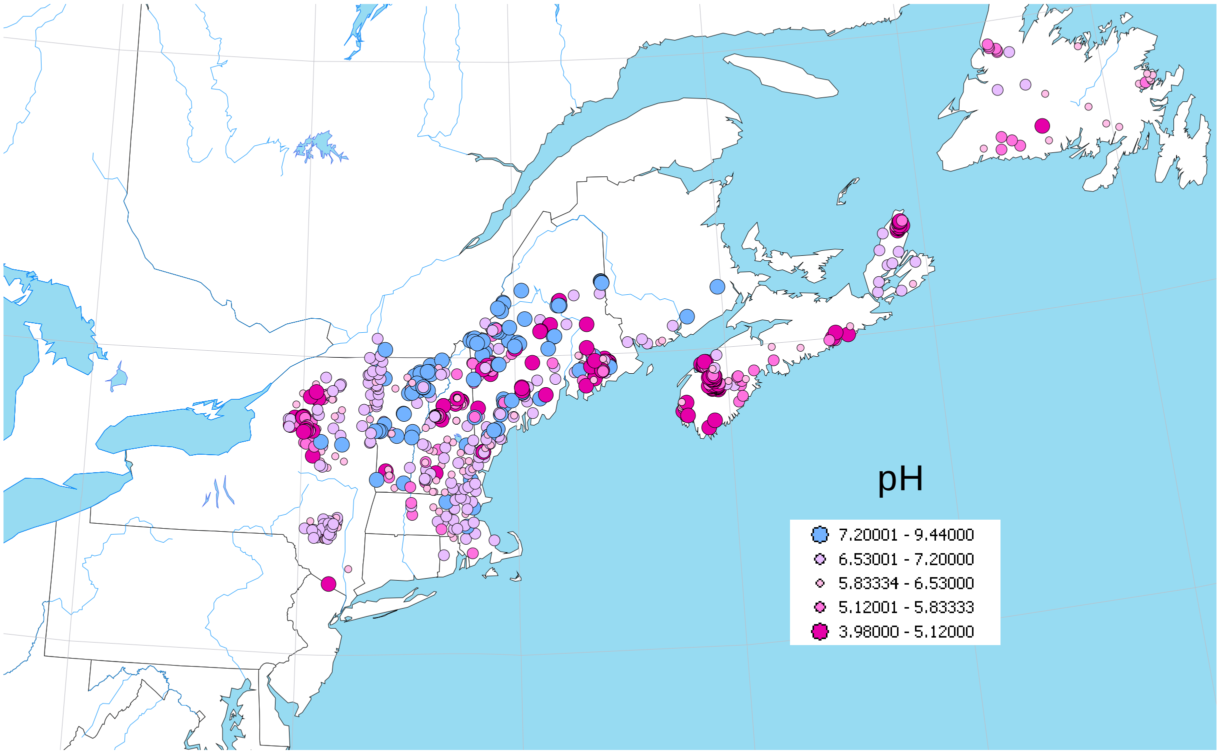


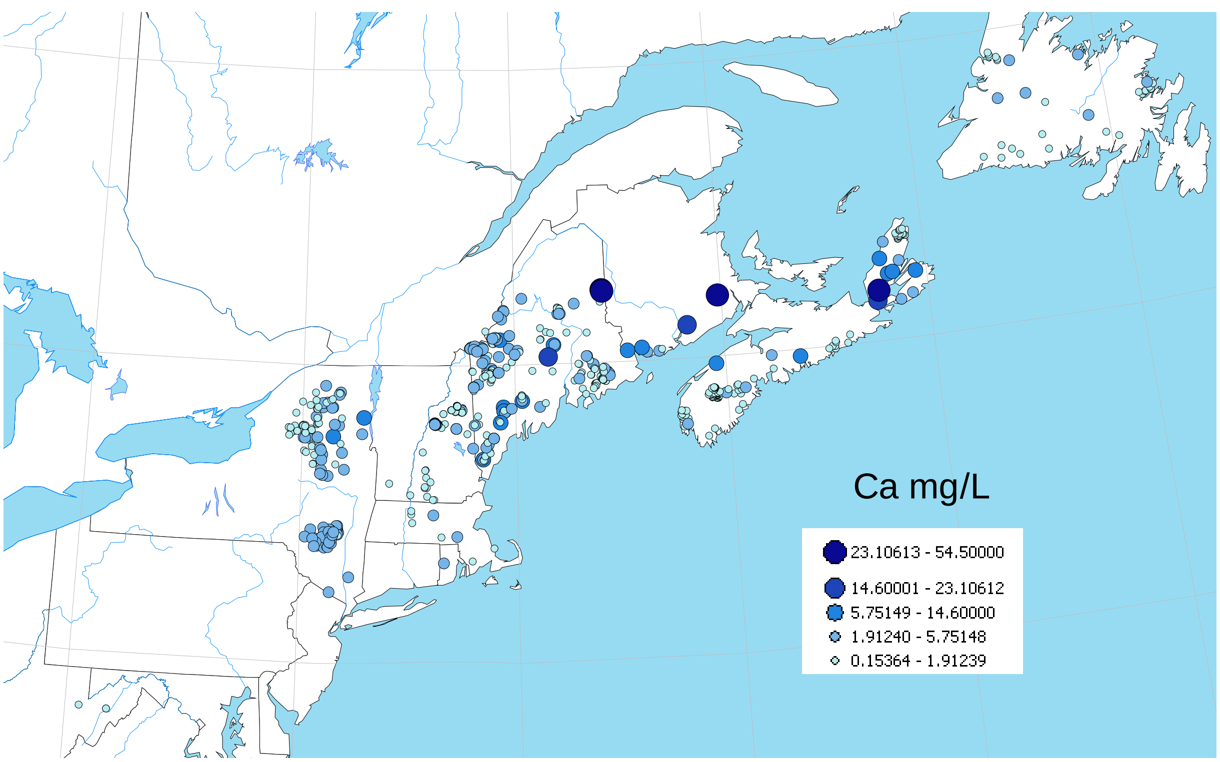
Figure 6. Boxplots for surface water Total Al, N, P and Hg. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

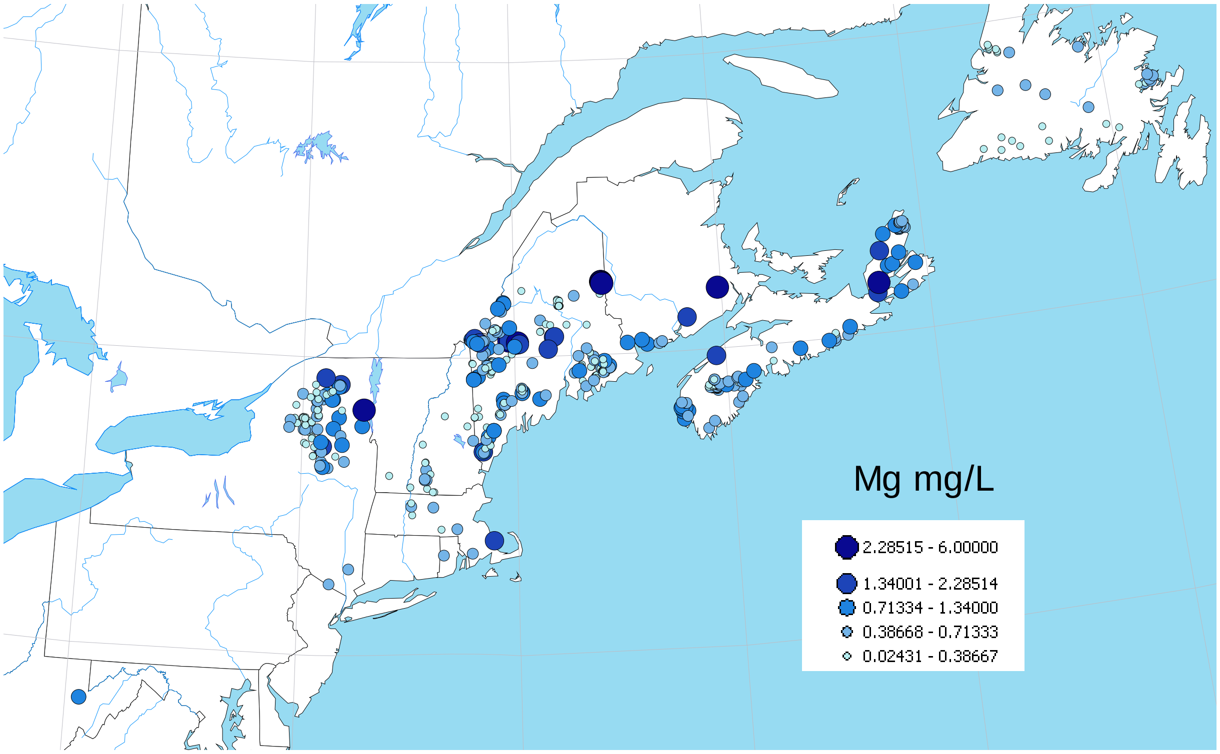


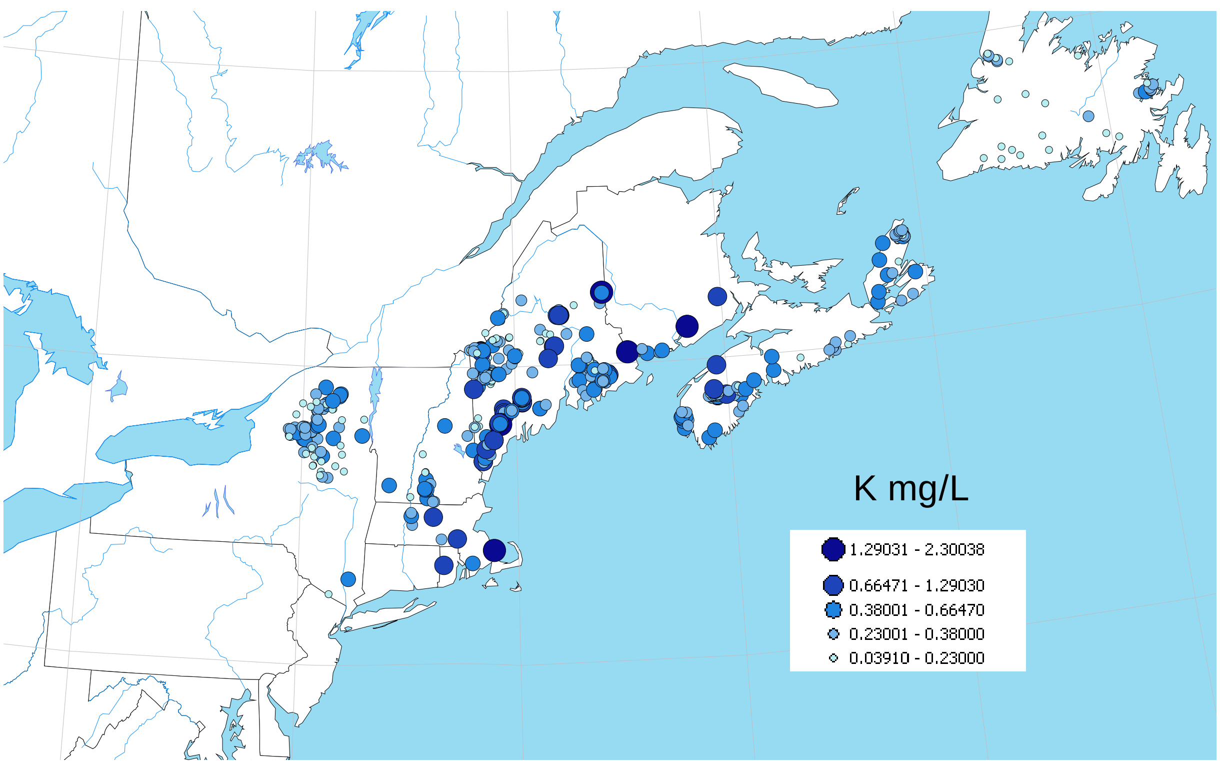
Appendix A-4: Surface Water Chemistry Maps

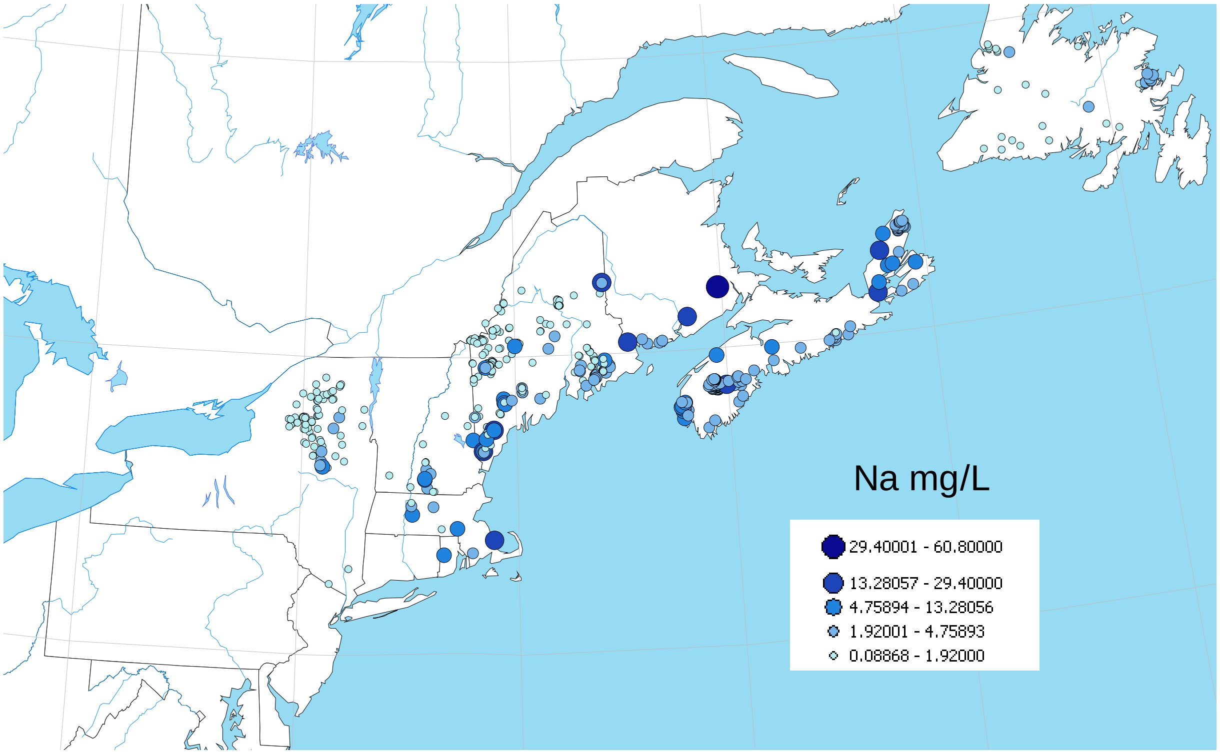
Figure 7. Maps for surface water cations. Note that values used in these maps were not converted to log scale. (figure spans multiple pages)






Mg mg/L
2.28515 - 6.00000
1.34001 - 2.28514
0.71334 - 1.34000
0.38668 - 0.71333
0.02431 - 0.38667


K mg/L
1.29031 - 2.30038
0.66471 - 1.29030
0.38001 - 0.66470
0.23001 - 0.38000
0.03910 - 0.23000


Na mg/L
29.40001 - 60.80000
13.28057 - 29.40000
4.75894 - 13.28056
1.92001 - 4.75893
0.08868 - 1.92000

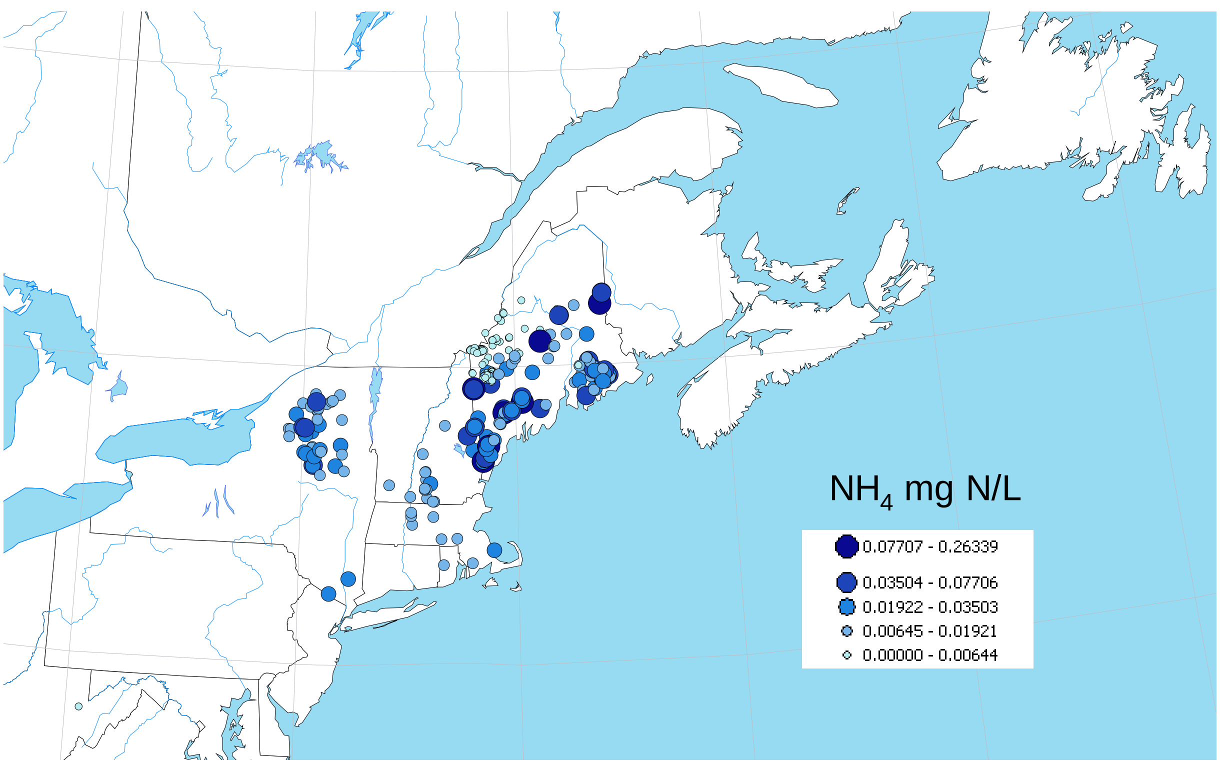
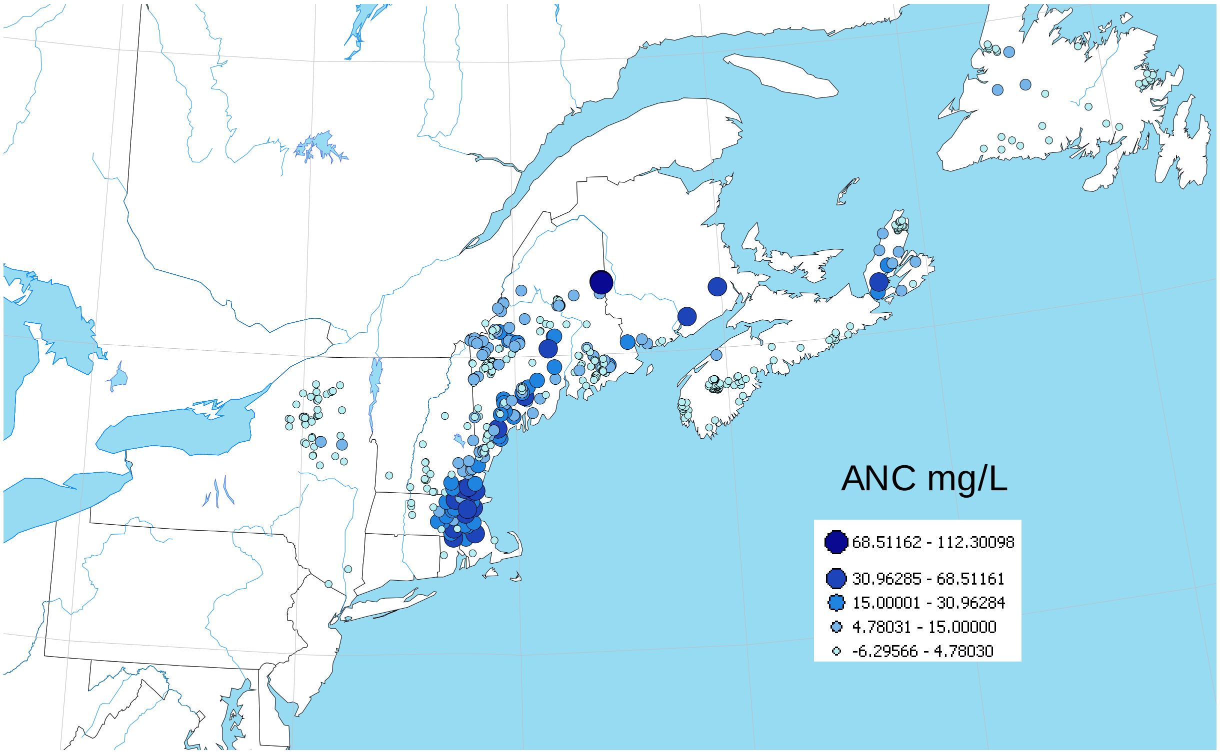
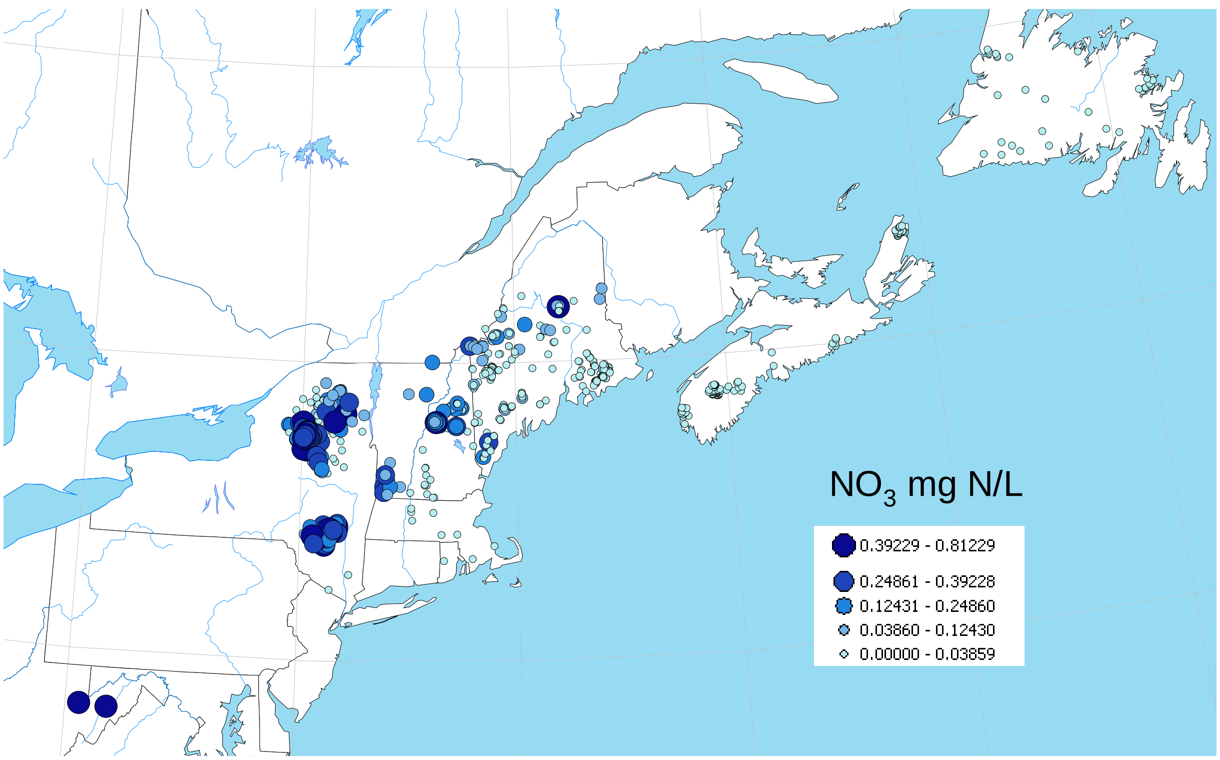
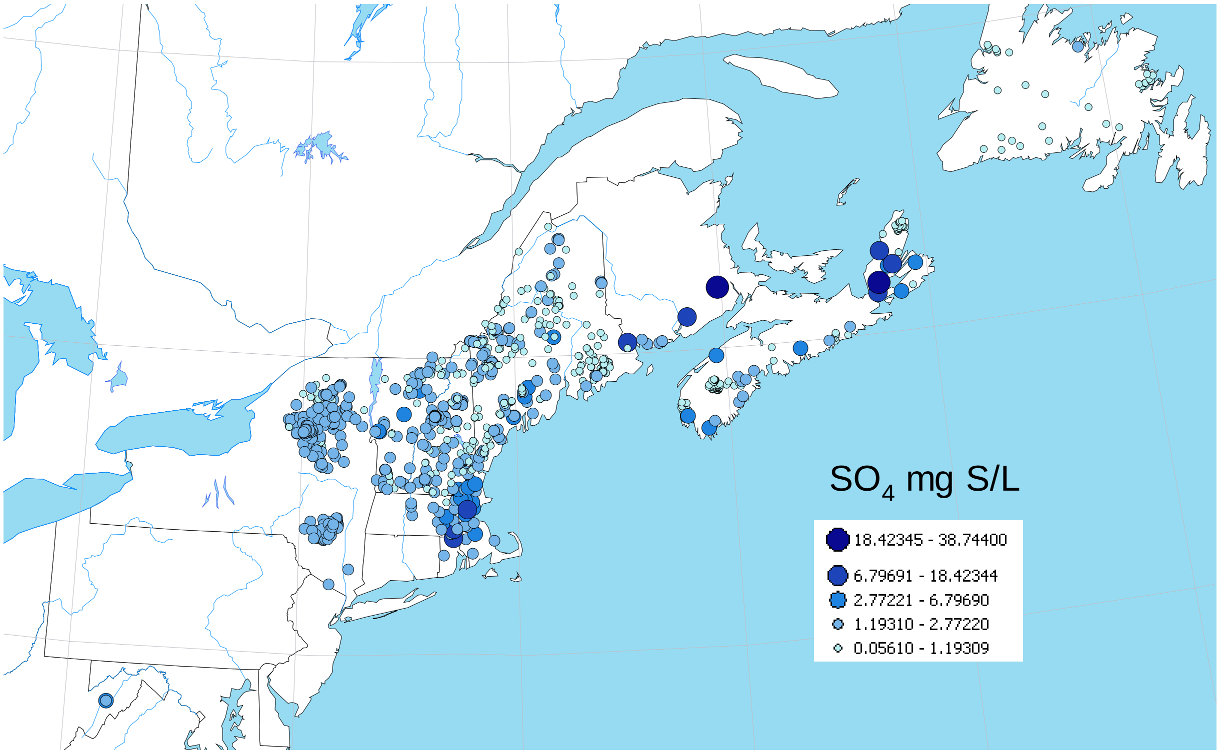
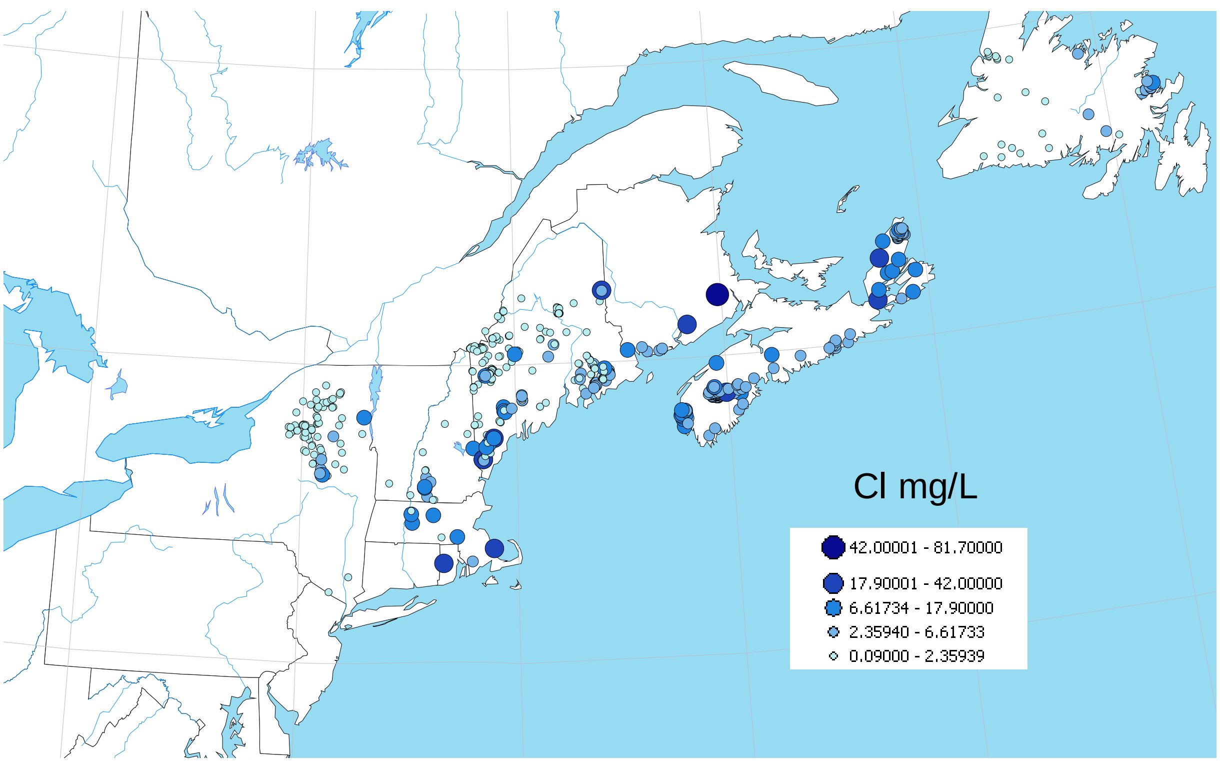

NH4 mg N/L
0.07707 - 0.26339
0.03504 - 0.07706
0.01922 - 0.03503
0.00645 - 0.01921
0.00000 - 0.00644

Figure 8. Maps for surface water anions. Note that values used in these maps were not converted to log scale. (figure spans multiple pages)






SO4 mg S/L
18.42345 - 38.74400
6.79691 - 18.42344
2.77221 - 6.79690
1.19310 - 2.77220
0.05610 - 1.19309


Cl mg/L
42.00001 - 81.70000
17.90001 - 42.00000
6.61734 - 17.90000
2.35940 - 6.61733
0.09000 - 2.35939

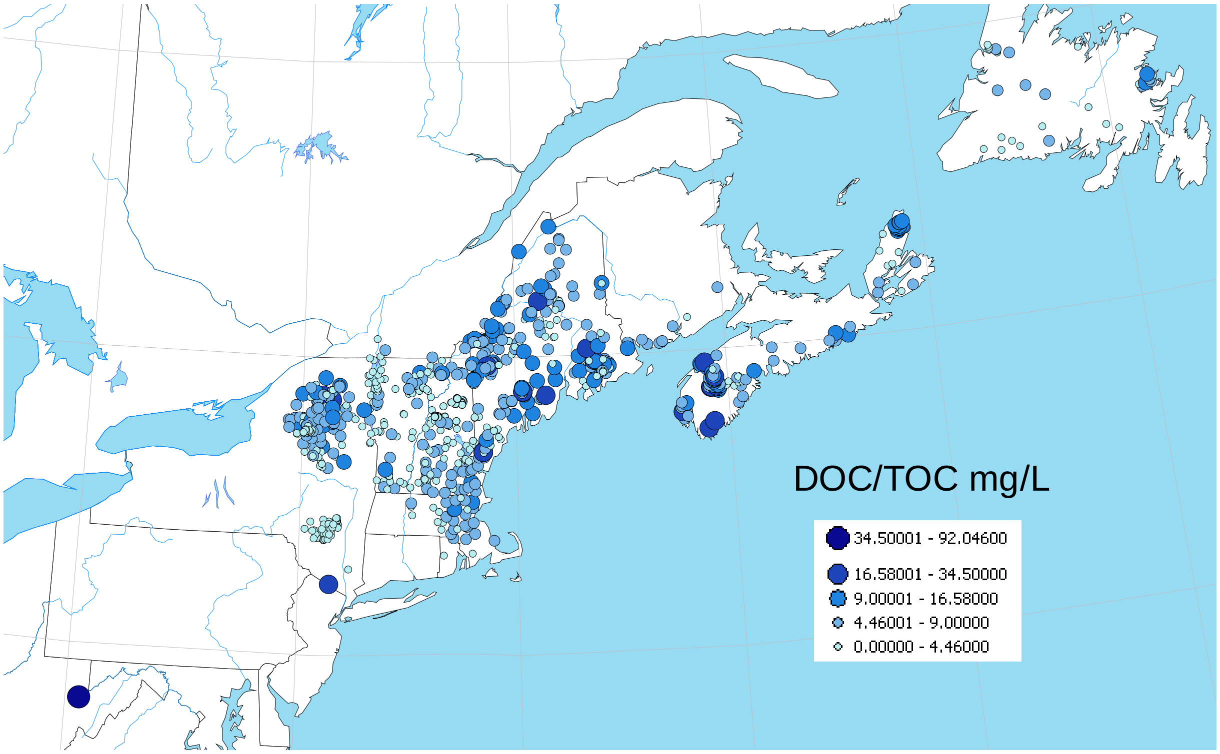
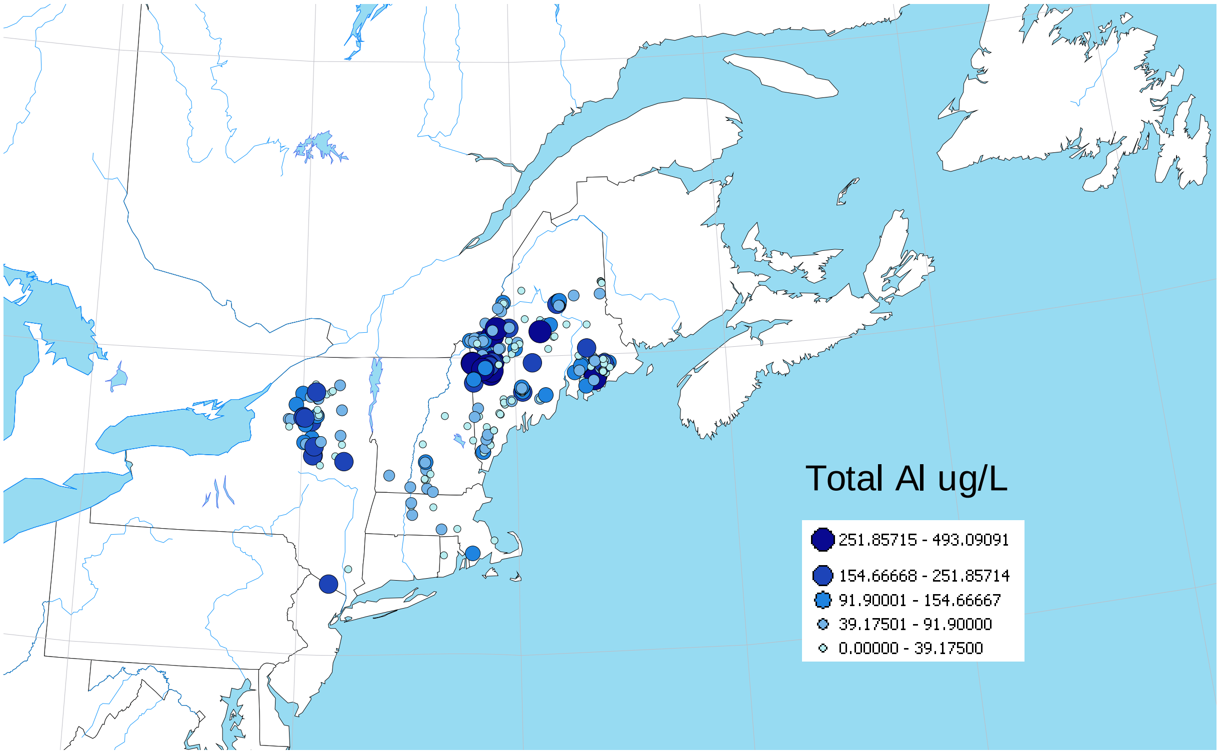
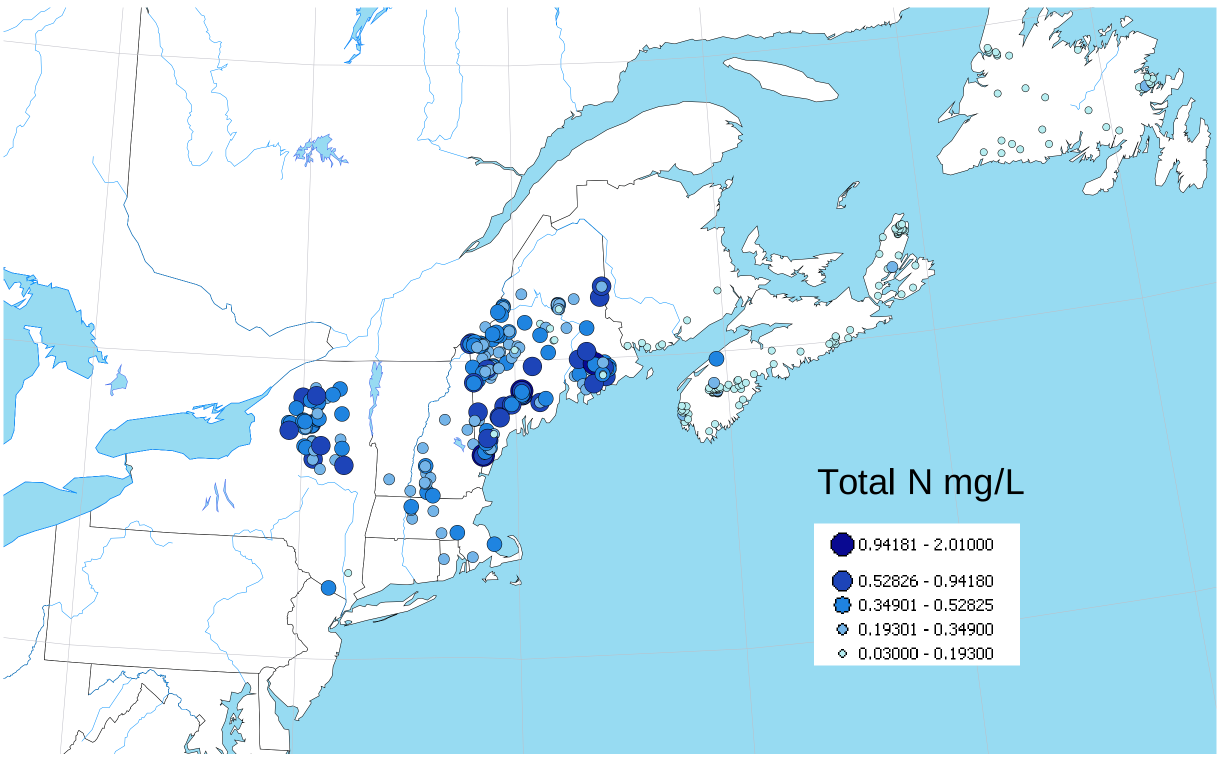
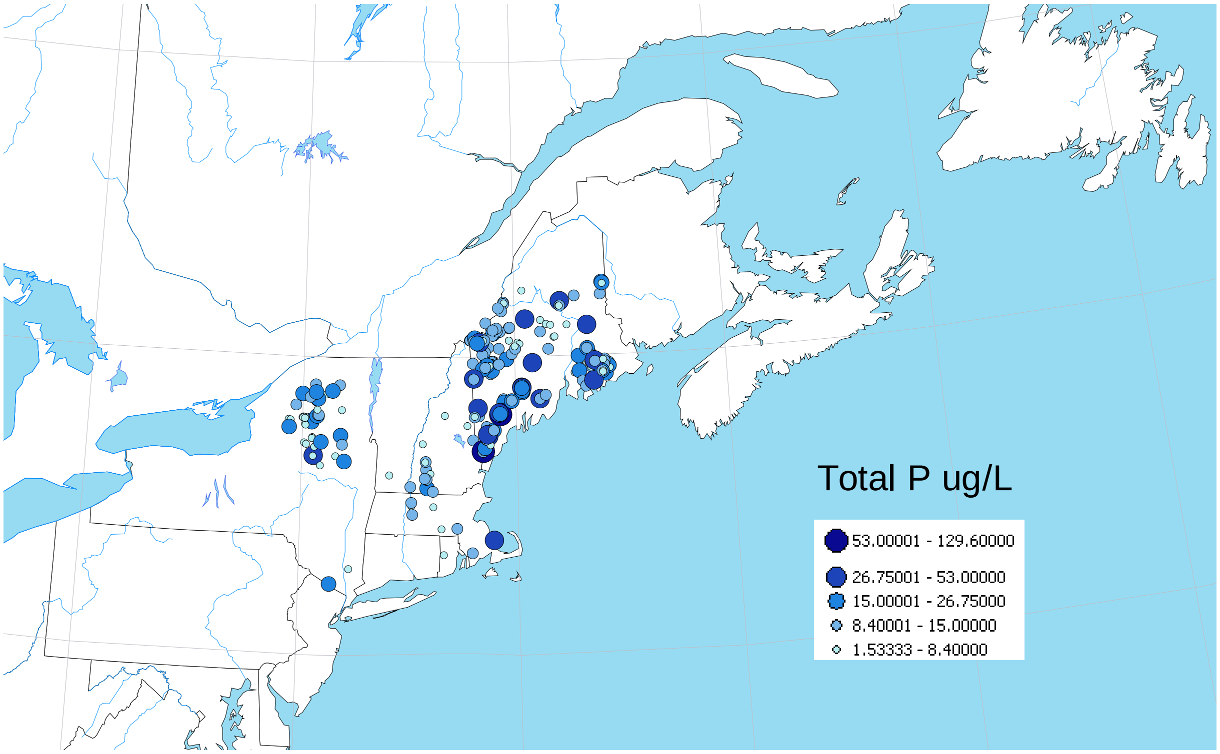
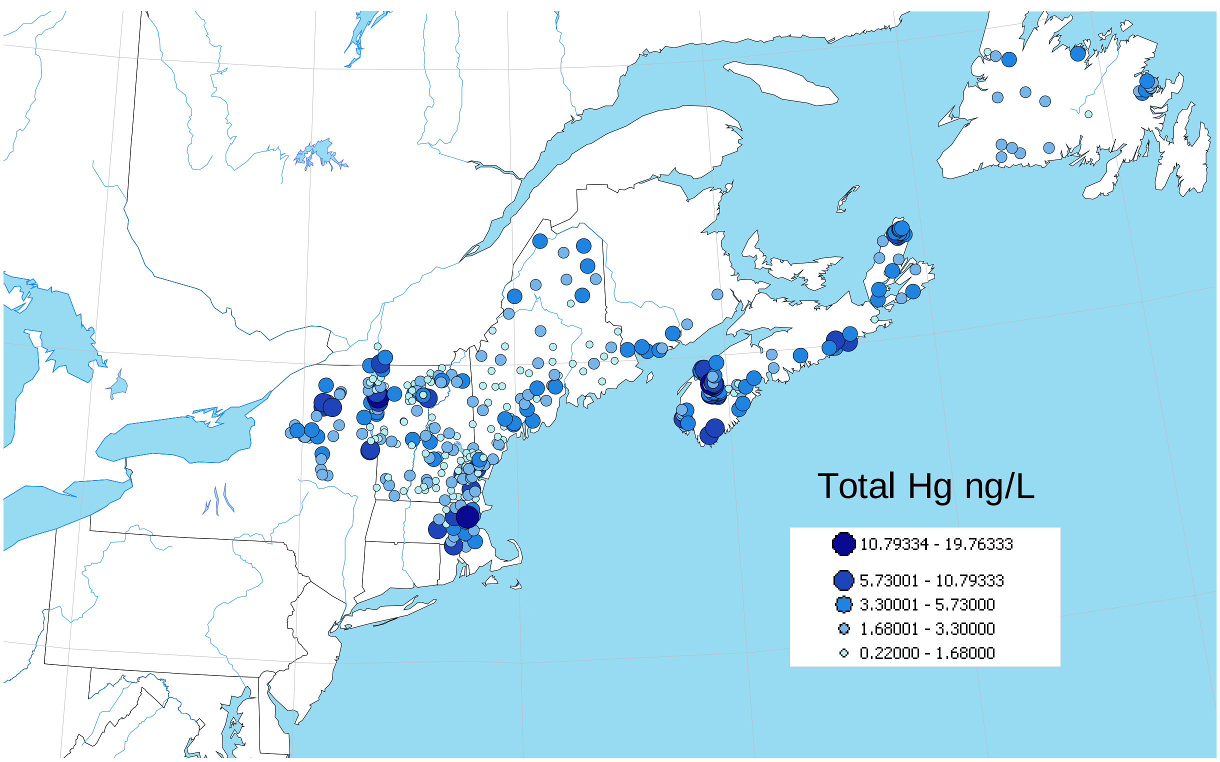

DOC/TOC mg/L
34.50001 - 92.04600
16.58001 - 34.50000
9.00001 - 16.58000
4.46001 - 9.00000
0.00000 - 4.46000

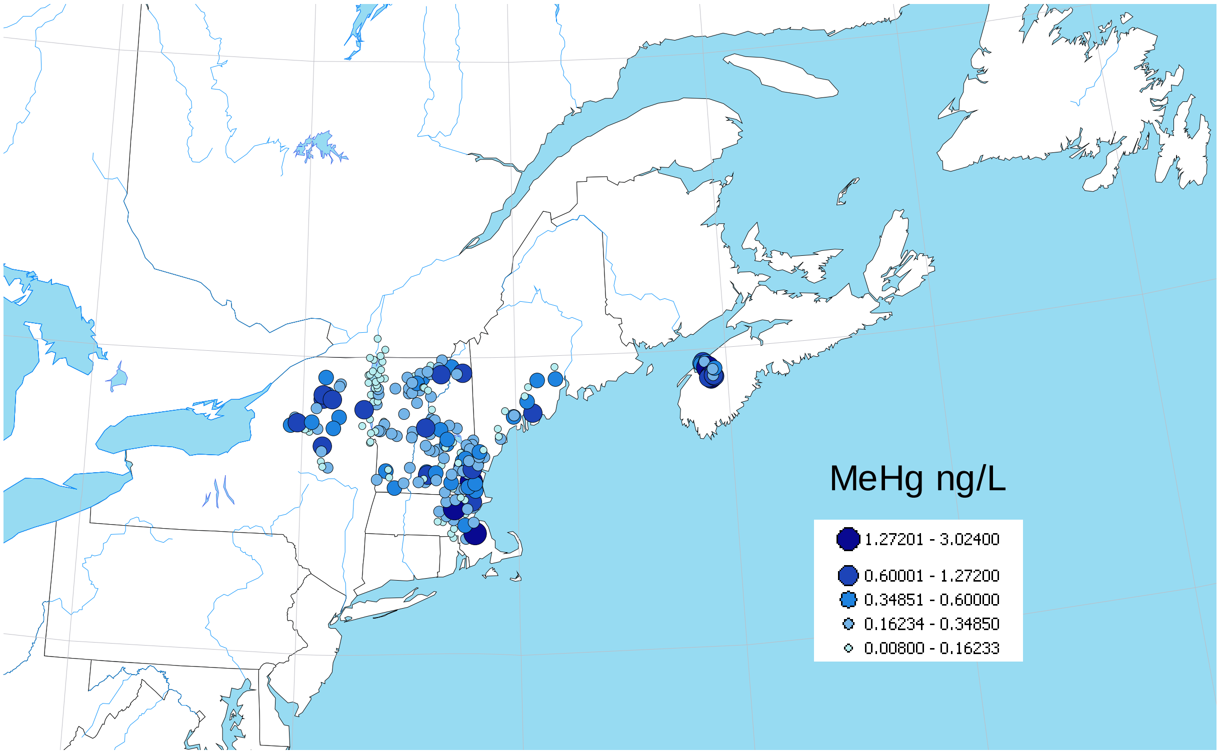
Figure 9. Maps for surface water Total Al, N, P and Hg. Note that values used in these maps were not converted to log scale. (figure spans multiple pages)






Total P ug/L
53.00001 - 129.60000
26.75001 - 53.00000
15.00001 - 26.75000
8.40001 - 15.00000
1.53333 - 8.40000


Total Hg ng/L
10.79334 - 19.76333
5.73001 - 10.79333
3.30001 - 5.73000
1.68001 - 3.30000
0.22000 - 1.68000


MeHg ng/L
1.27201 - 3.02400
0.60001 - 1.27200
0.34851 - 0.60000
0.16234 - 0.34850
0.00800 - 0.16233

Appendix A-5: Surface Water Chemistry Linear Regressions with Latitude, Longitude and Elevation

Table 2. Results of linear regression of each parameter against latitude, longitude and elevation. Trend indicates positive or negative correlation and R^2 coefficients for the relationship are given in right hand columns. Log transformed data was used for this analysis.

	Trend			R^2		
	Latitude	**Longitude**	**Elevation**	**Latitude**	**Longitude**	**Elevation**
pH	0	0	0	0.0076	0.0694	0.0040
Ca	0	0	0	0.0088	0.0438	0.0404
Mg	0	0	0	0.0043	0.0004	0.0090
K	0	0	**---**	0.0506	0.0180	0.2061
Na	0	**+++**	**---**	0.0001	0.1971	0.2766
NH_4	0	0	0	0.0153	0.0007	0.0903
ANC	0	0	0	0.0252	0.0206	0.0000
NO_3	**---**	**---**	0	0.2077	0.2525	0.0841
SO_4	**---**	**---**	**+++**	0.2222	0.2293	0.1752
Cl	0	**+++**	**---**	0.0004	0.2808	0.5154
DOC/TOC	0	0	0	0.0282	0.0241	0.0017
Total Al	0	0	**+++**	0.0100	0.0436	0.2715
Total N	0	**---**	0	0.0783	0.4050	0.0012
Total P	0	0	0	0.0077	0.0026	0.0177
Total Hg	0	0	NA	0.0202	0.0673	NA
MeHg	0	0	NA	0.0260	0.0838	NA

'**---**' indicates a significant negative relationship with an r2 >0.10.
'**+++**' indicates a significant positive relationship with r2 >0.10.
'0' indicates either no significant relationship or significant with an r2 < 0.10.

Figure 10. Graphs of parameters with strongest trends with latitude. Each pair includes a plot of untransformed data in original units on left, and a plot of log-transformed data on right (with which the linear regression was calculated).

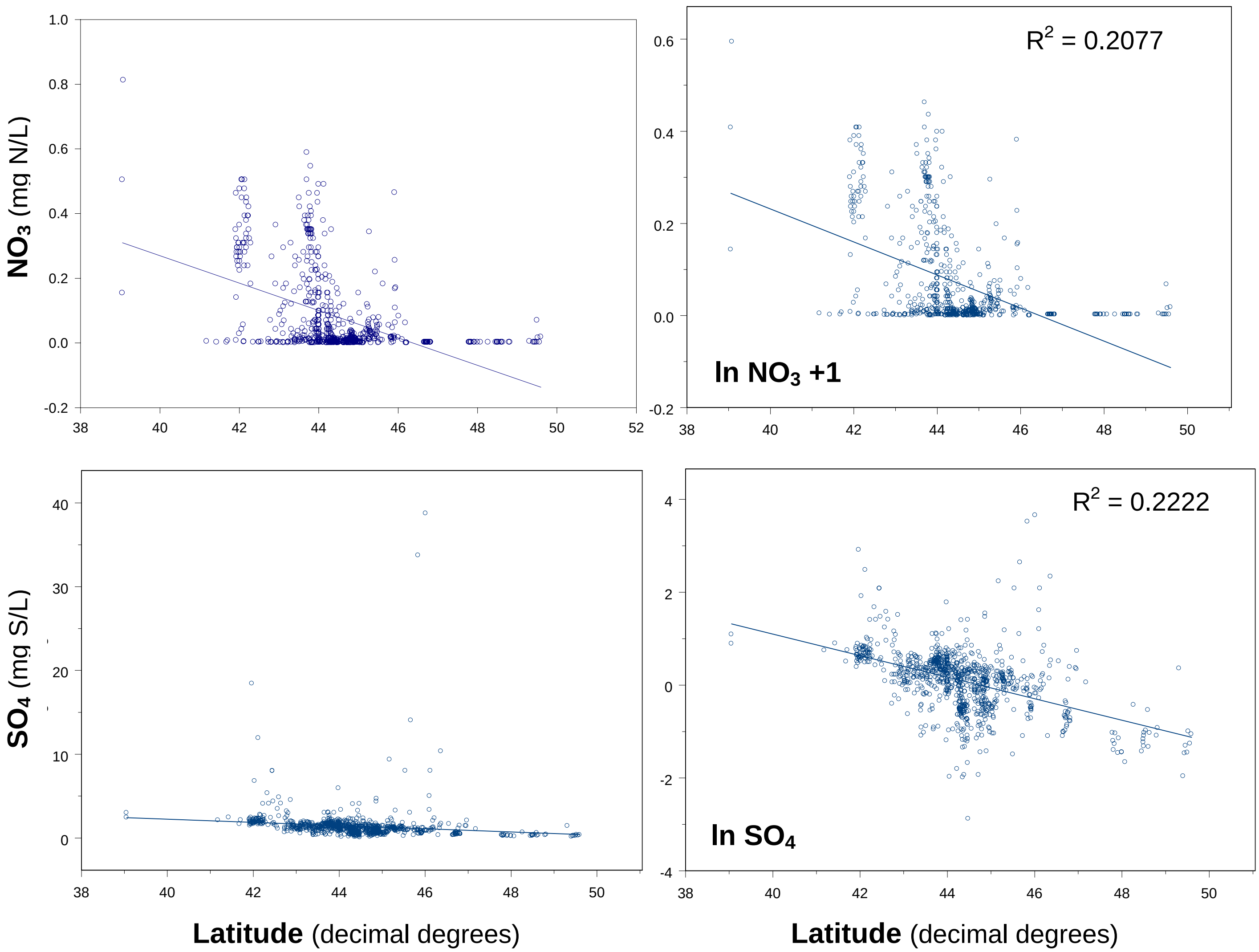
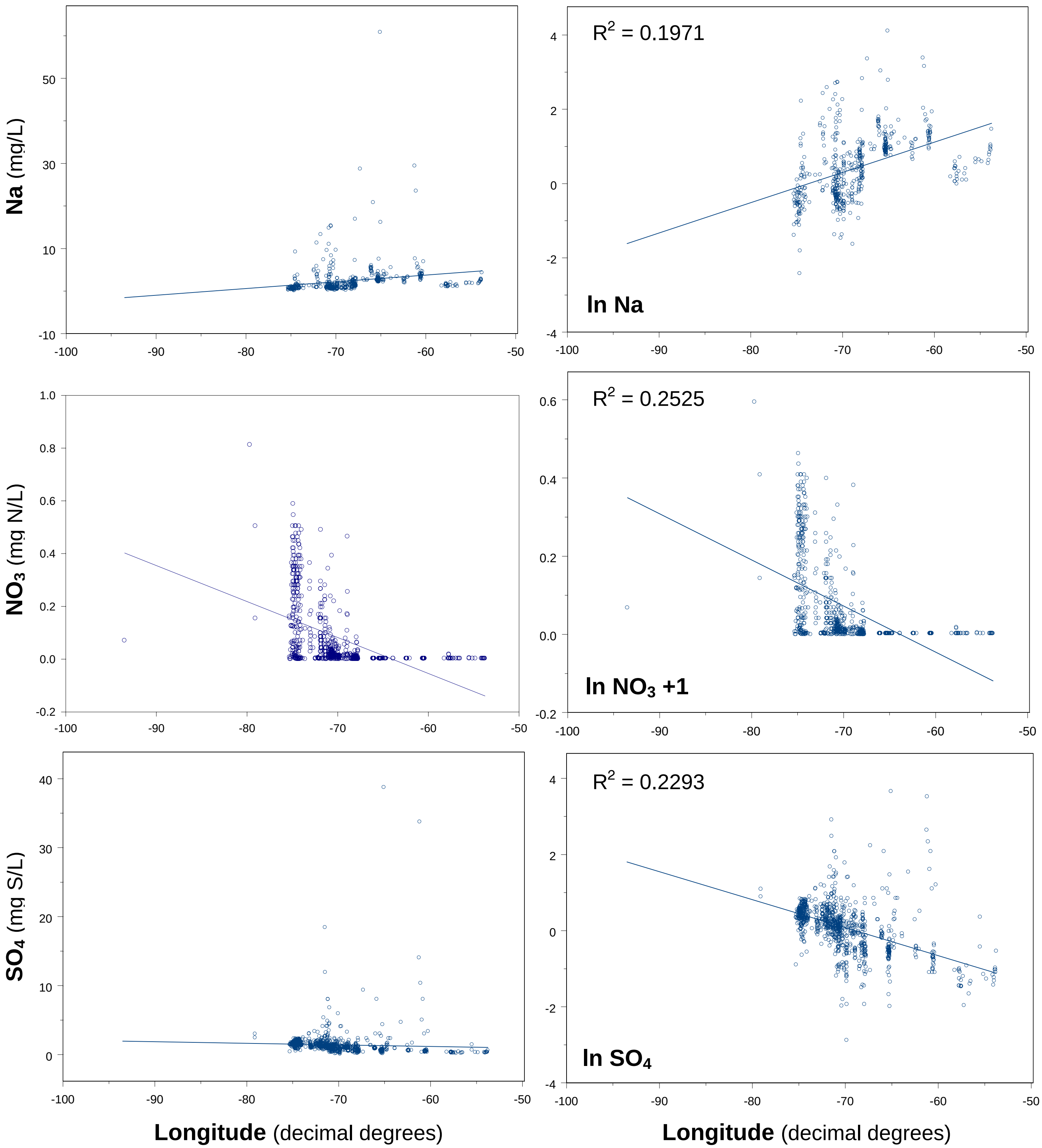


Figure 11. Graphs of parameters with strongest trends with longitude. Each pair includes a plot of untransformed data in original units on left, and a plot of log-transformed data on right (with which the linear regression was calculated). (figure spans multiple pages)



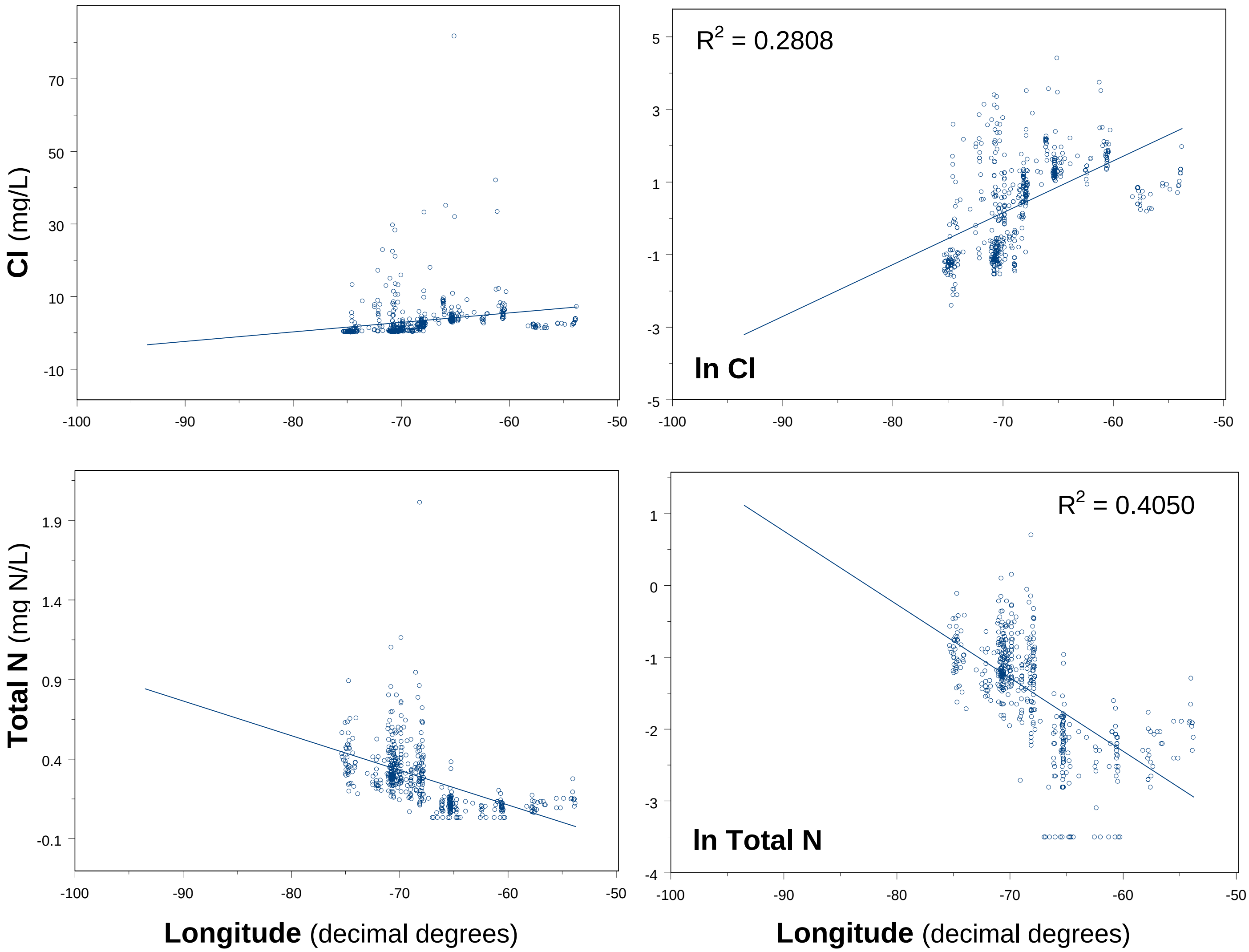
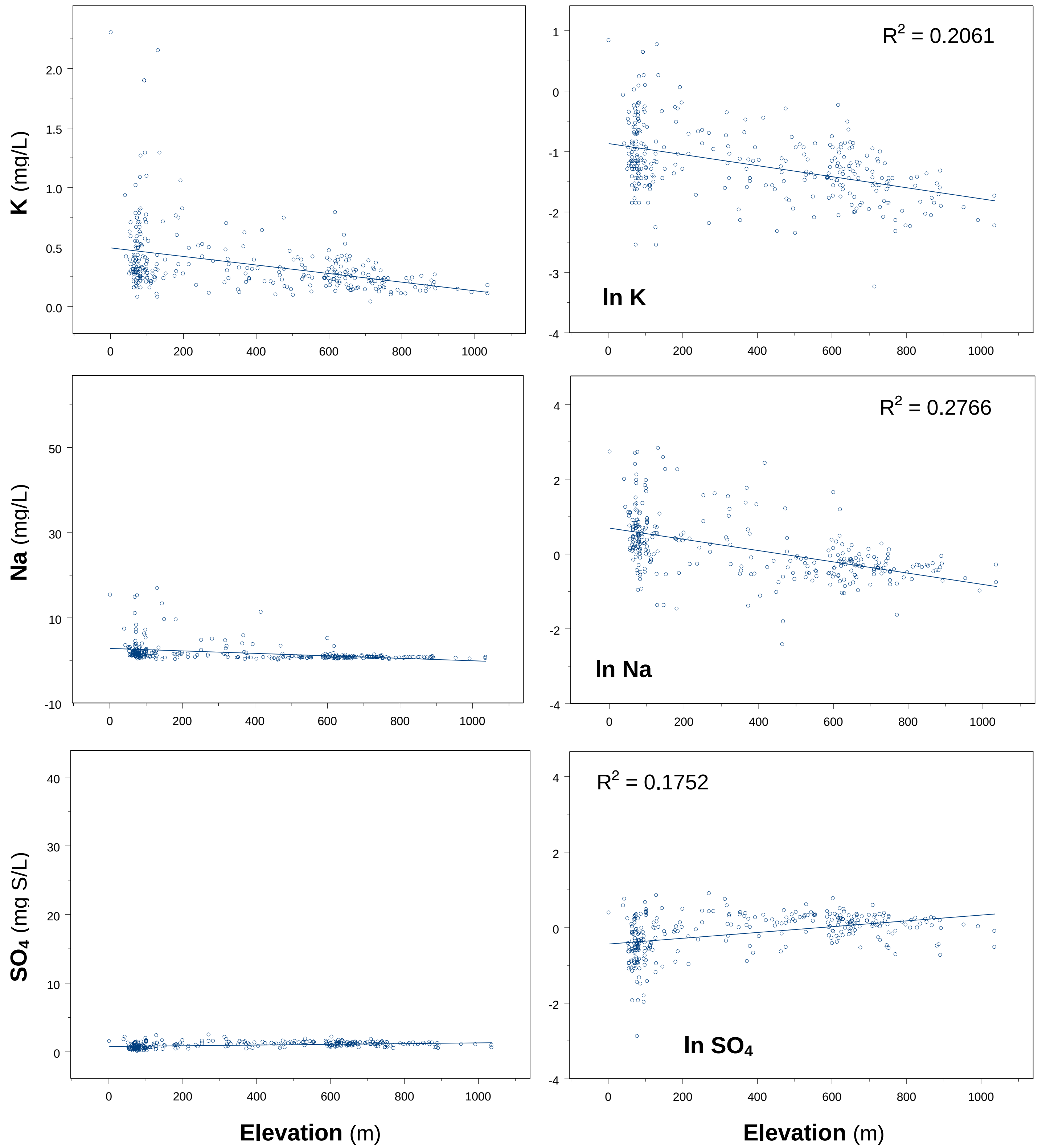
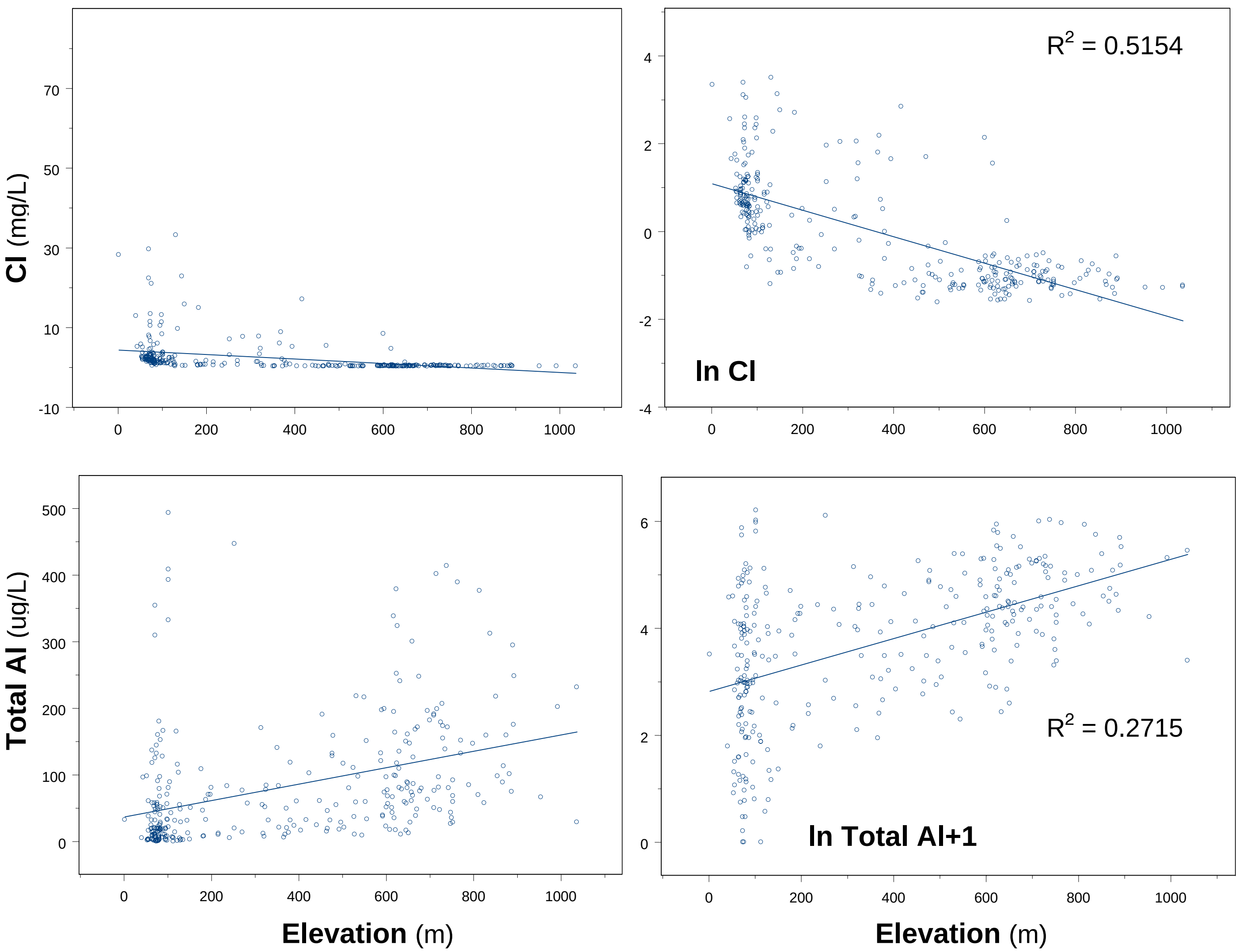

Cl (mg/L)
R2 = 0.2808
ln Cl
Total N (mg N/L)
R2 = 0.4050
ln Total N
Longitude (decimal degrees)
Longitude (decimal degrees)

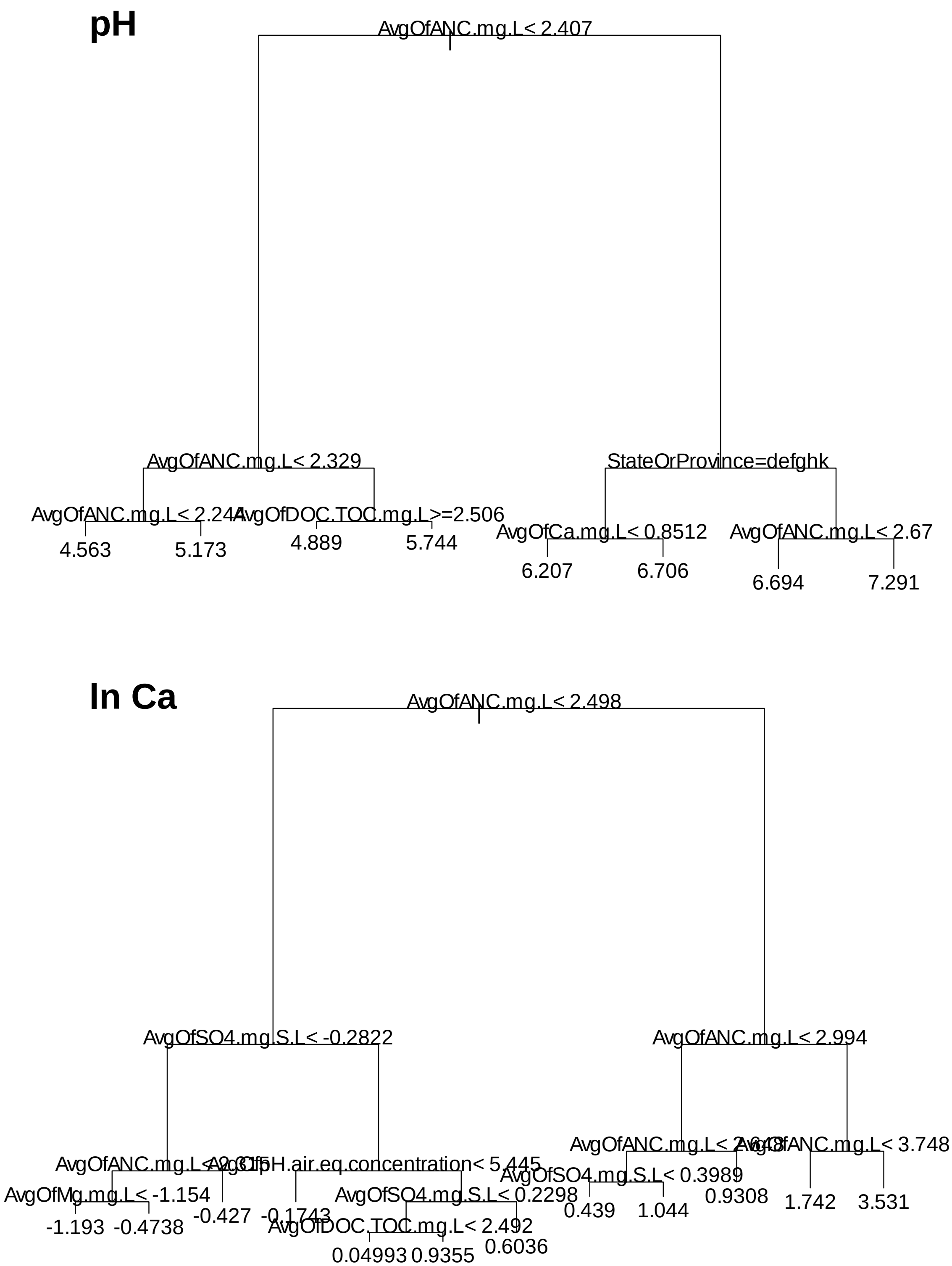
Figure 12. Graphs of parameters with strongest trends with elevation. Each pair includes a plot of untransformed data in original units on left, and a plot of log-transformed data on right (with which the linear regression was calculated). (figure spans multiple pages)



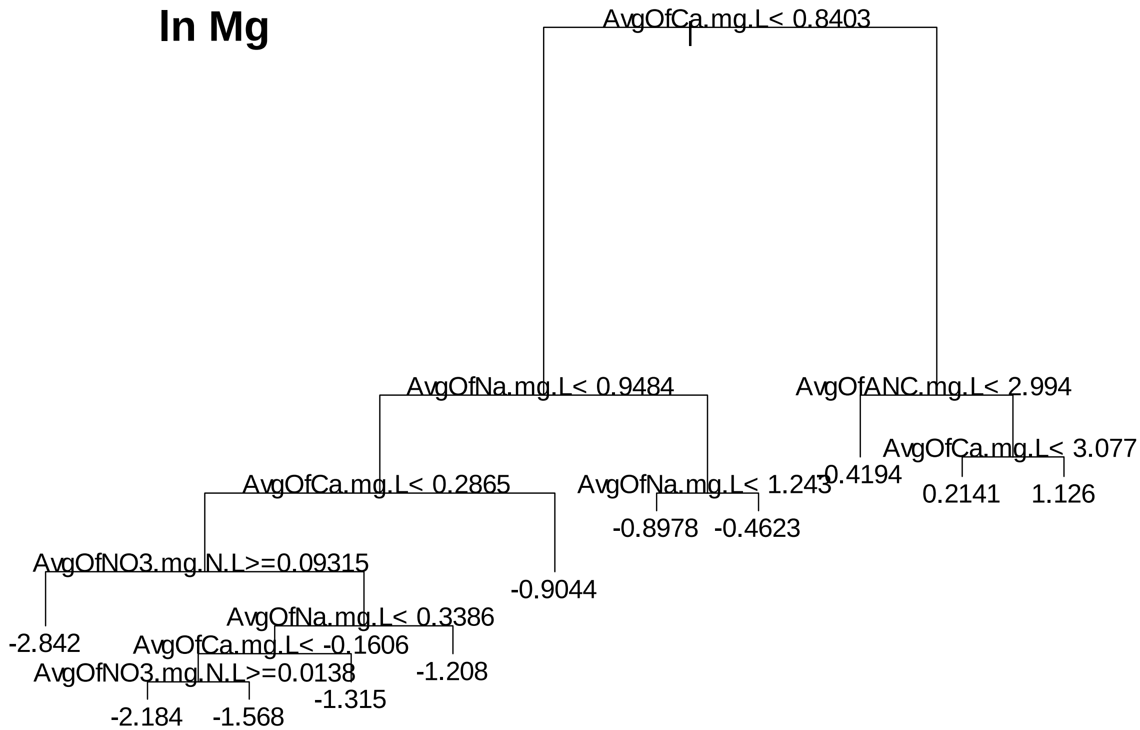

Cl (mg/L)
Total Al (ug/L)
R^2 = 0.5154
ln Cl
R^2 = 0.2715
ln Total Al+1
Elevation (m)
Elevation (m)

Appendix A-6: Surface Water Chemistry Classification and Regression Trees (CART)

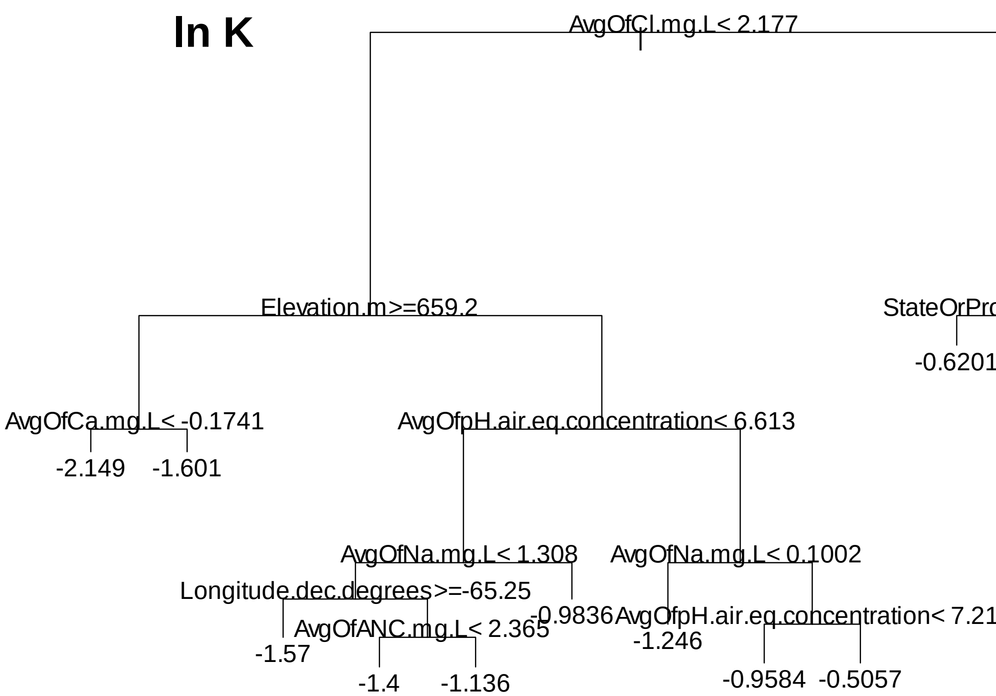
Figure 13. Classification and regression trees (CART) for surface water cations. (figure spans multiple pages)



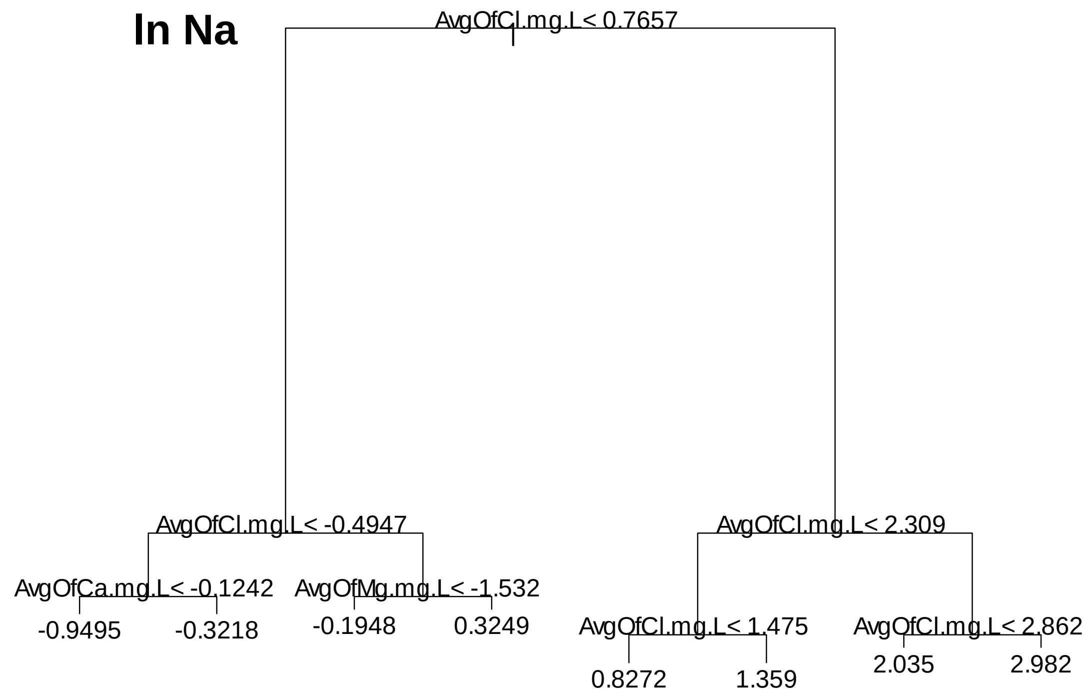
ln Mg


AvgOfCa.mg.L< 0.8403
AvgOfNa.mg.L< 0.9484
AvgOfANC.mg.L< 2.994
AvgOfCa.mg.L< 3.077
AvgOfCa.mg.L< 0.2865
AvgOfNa.mg.L< 1.243
-0.4194
0.2141
1.126
-0.8978
-0.4623
AvgOfNO3.mg.N.L>=0.09315
-0.9044
AvgOfNa.mg.L< 0.3386
-2.842
AvgOfCa.mg.L< -0.1606
AvgOfNO3.mg.N.L>=0.0138
-1.208
-1.315
-2.184
-1.568

ln K


AvgOfCl.mg.L< 2.177
Elevation.m>=659.2
StateOrProvince=efgk
-0.6201
-0.004769
AvgOfCa.mg.L< -0.1741
AvgOfpH.air.eq.concentration< 6.613
-2.149
-1.601
AvgOfNa.mg.L< 1.308
AvgOfNa.mg.L< 0.1002
Longitude.dec.degrees>=-65.25
-0.9836
AvgOfpH.air.eq.concentration< 7.21
AvgOfANC.mg.L< 2.365
-1.246
-1.57
-1.4
-1.136
-0.9584
-0.5057

ln Na


AvgOfCl.mg.L< 0.7657
AvgOfCl.mg.L< -0.4947
AvgOfCl.mg.L< 2.309
AvgOfCa.mg.L< -0.1242
AvgOfMg.mg.L< -1.532
AvgOfCl.mg.L< 1.475
AvgOfCl.mg.L< 2.862
-0.9495
-0.3218
-0.1948
0.3249
0.8272
1.359
2.035
2.982

ln NH_4 +1

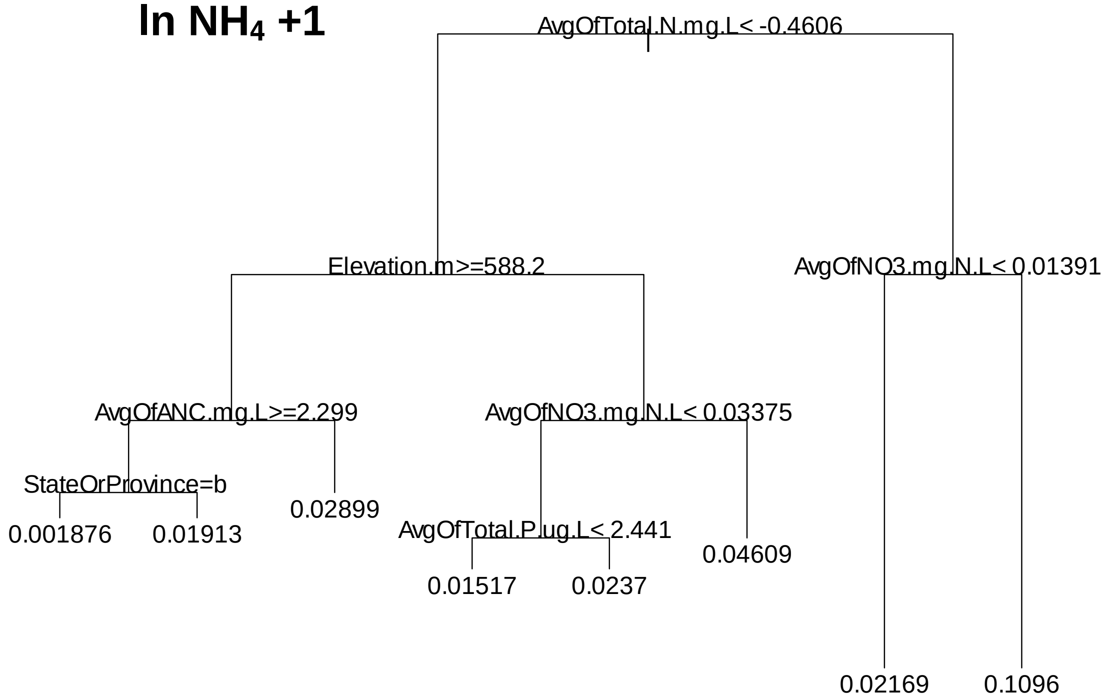
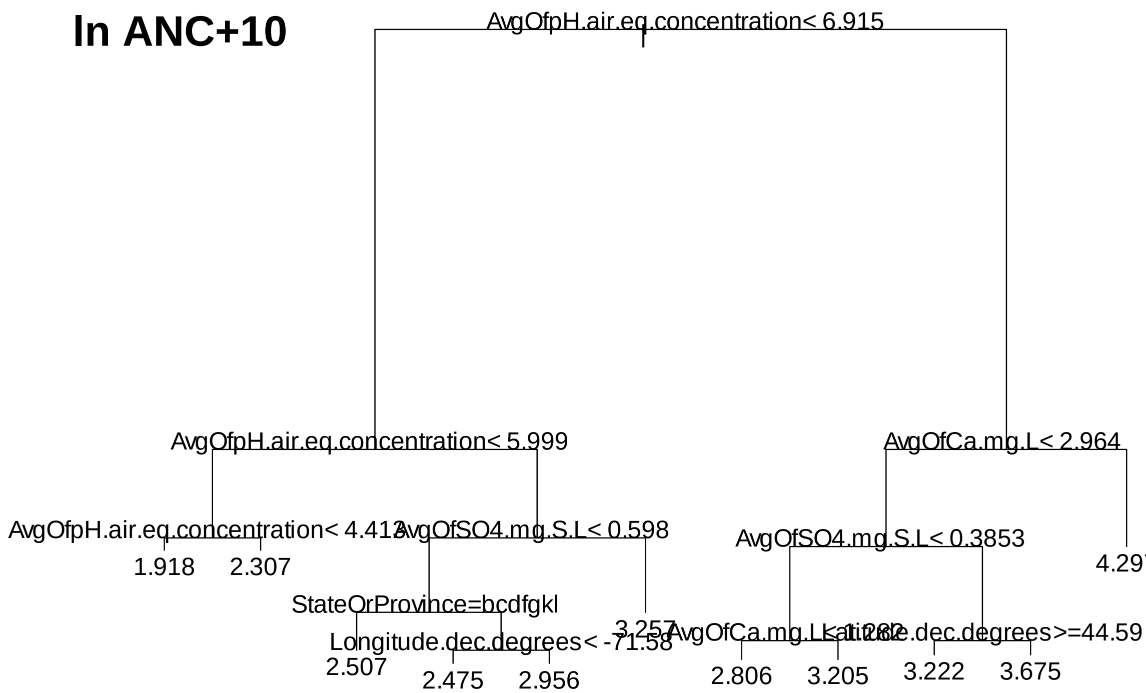
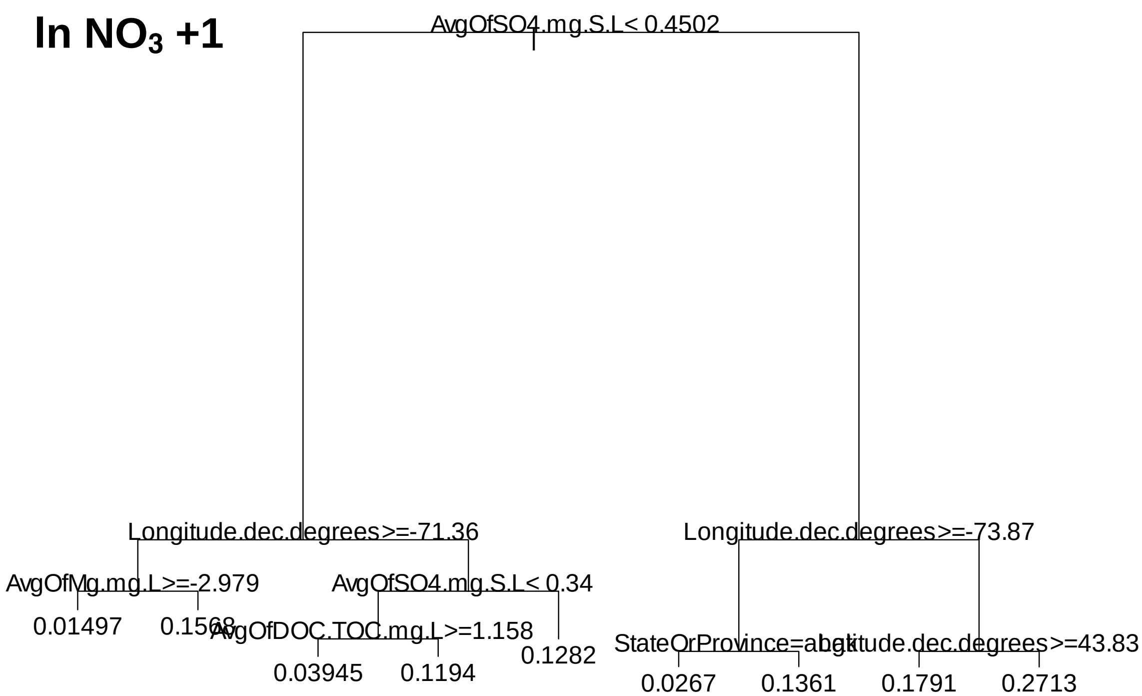

AvgOfTotal.N.mg.L< -0.4606
Elevation.m>=588.2
AvgOfNO3.mg.N.L< 0.01391
AvgOfANC.mg.L>=2.299
AvgOfNO3.mg.N.L< 0.03375
StateOrProvince=b
0.02899
AvgOfTotal.P.ug.L< 2.441
0.04609
0.001876
0.01913
0.01517
0.0237
0.02169
0.1096

Figure 14. Classification and regression trees (CART) for surface water anions. (figure spans multiple pages)

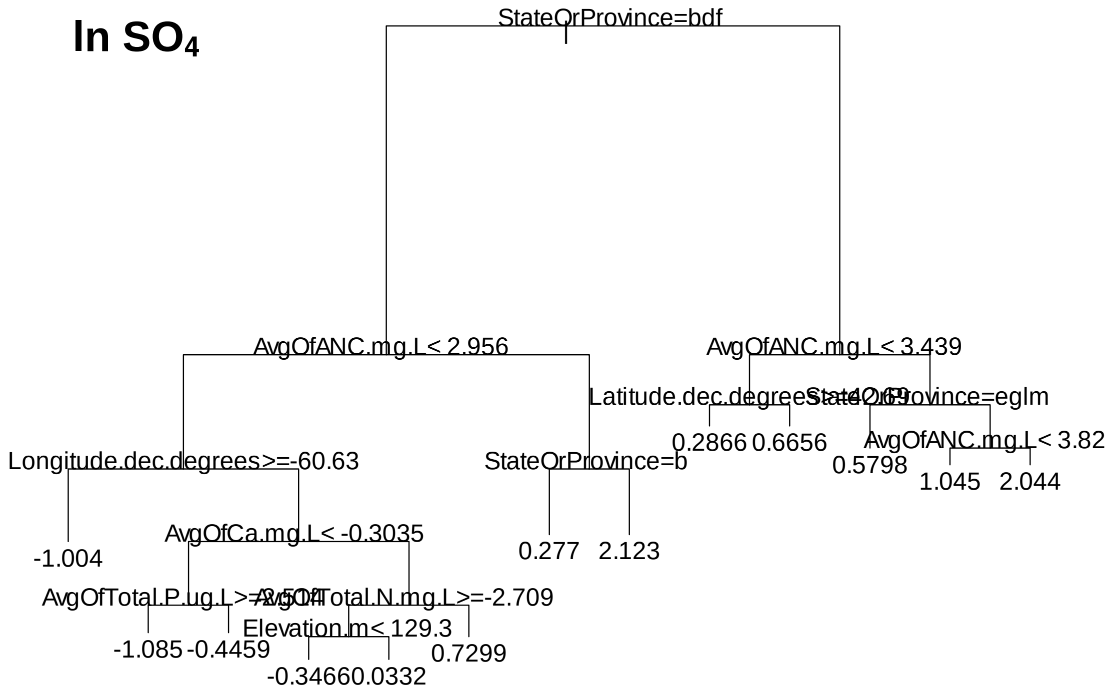
ln ANC+10



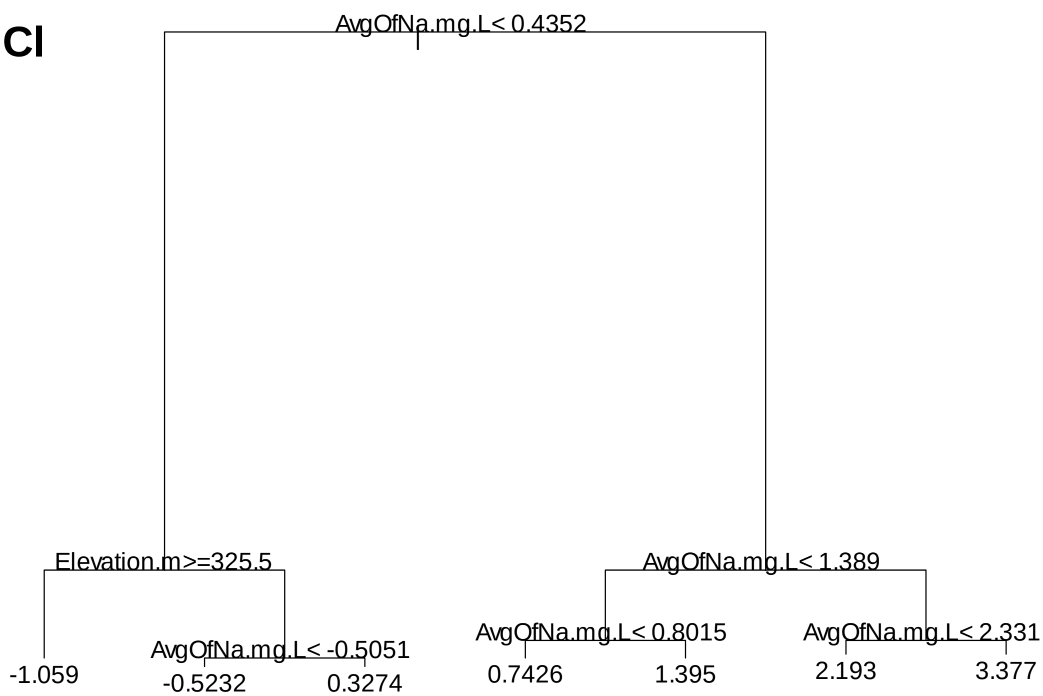
ln NO_3 +1



ln SO_4


StateOrProvince=bdf
AvgOfANC.mg.L< 2.956
AvgOfANC.mg.L< 3.439
Latitude.dec.degrees>=42.69
StateOrProvince=eglm
0.2866
0.6656
AvgOfANC.mg.L< 3.82
0.5798
1.045
2.044
Longitude.dec.degrees>=-60.63
StateOrProvince=b
AvgOfCa.mg.L< -0.3035
-1.004
0.277
2.123
AvgOfTotal.P.ug.L>=2.507
AvgOfTotal.N.mg.L>=-2.709
Elevation.m< 129.3
-1.085
-0.4459
0.7299
-0.3466
0.0332

ln Cl


AvgOfNa.mg.L< 0.4352
Elevation.m>=325.5
AvgOfNa.mg.L< 1.389
AvgOfNa.mg.L< 0.8015
AvgOfNa.mg.L< 2.331
AvgOfNa.mg.L< -0.5051
-1.059
-0.5232
0.3274
0.7426
1.395
2.193
3.377

ln DOC/TOC+1

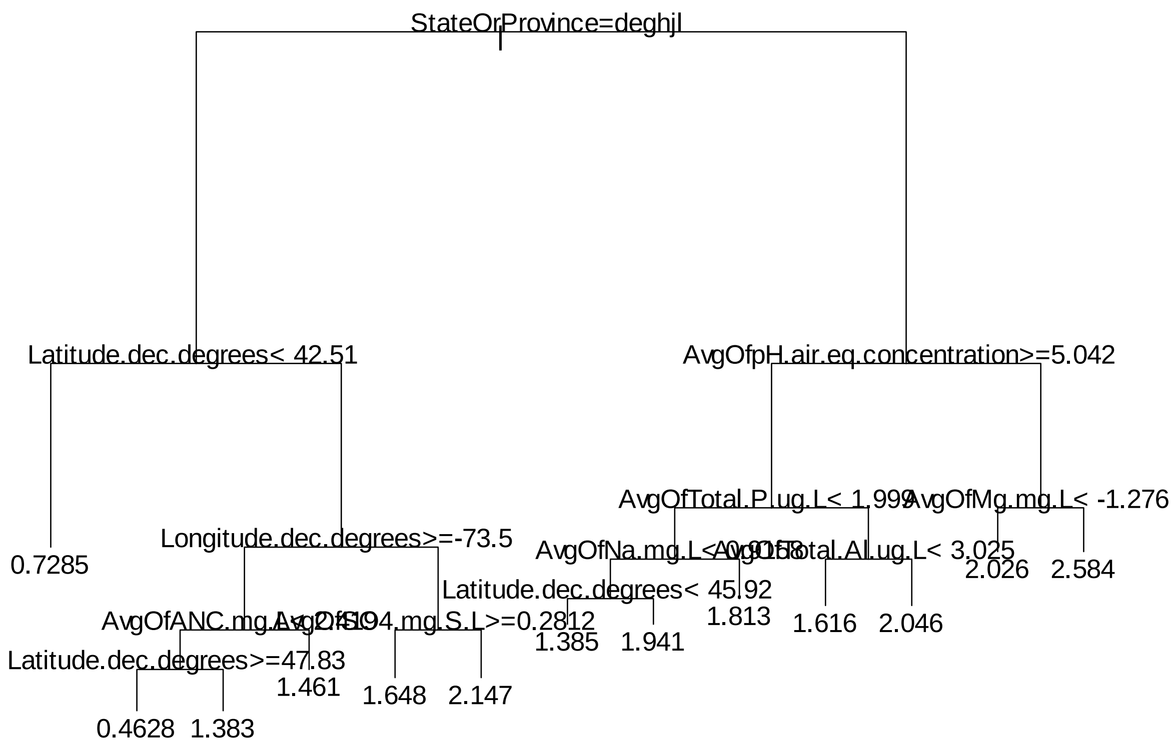
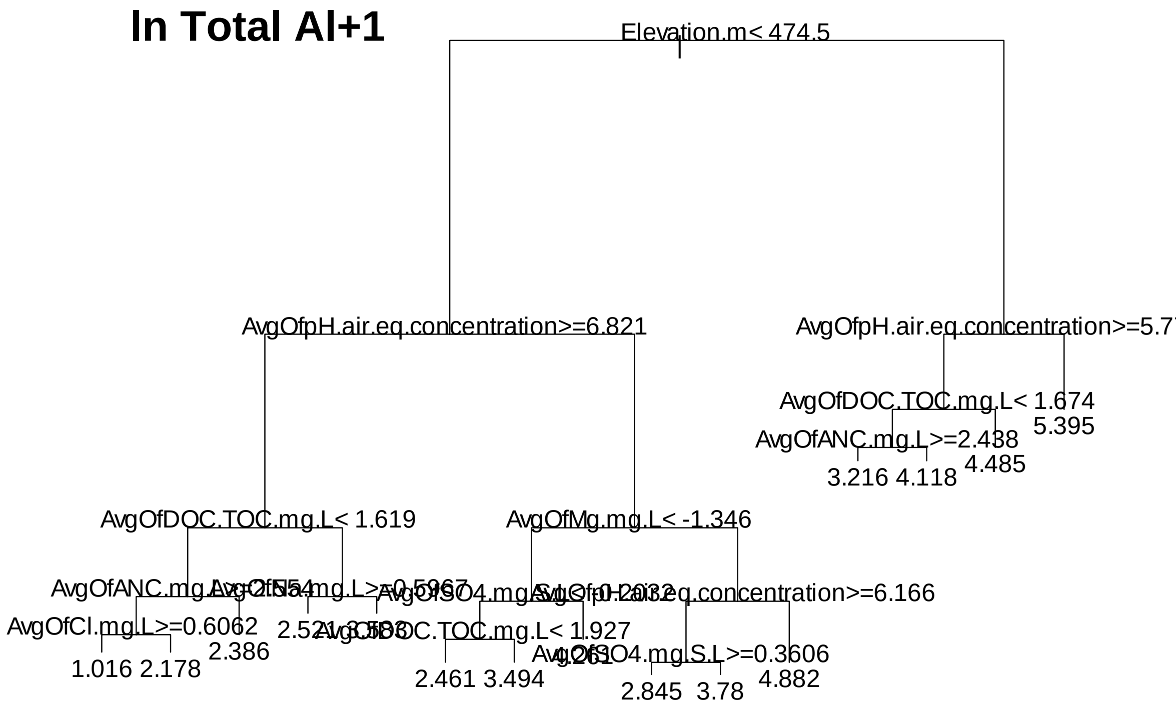
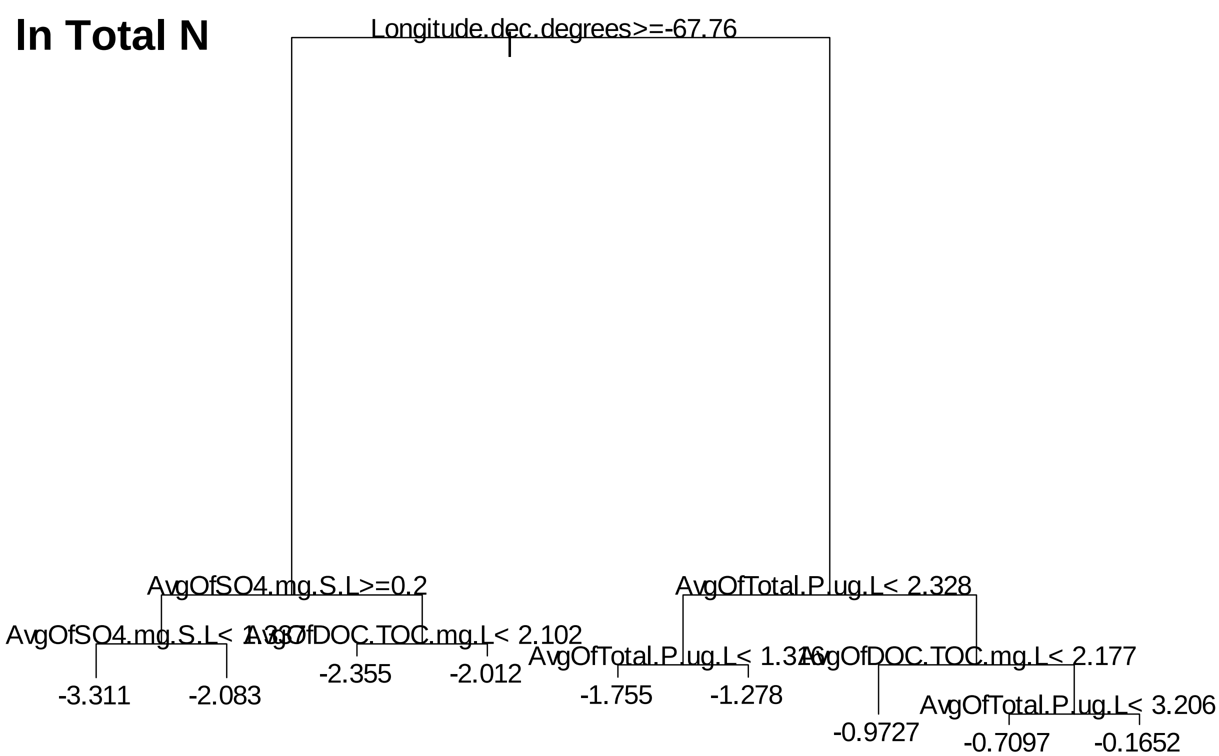
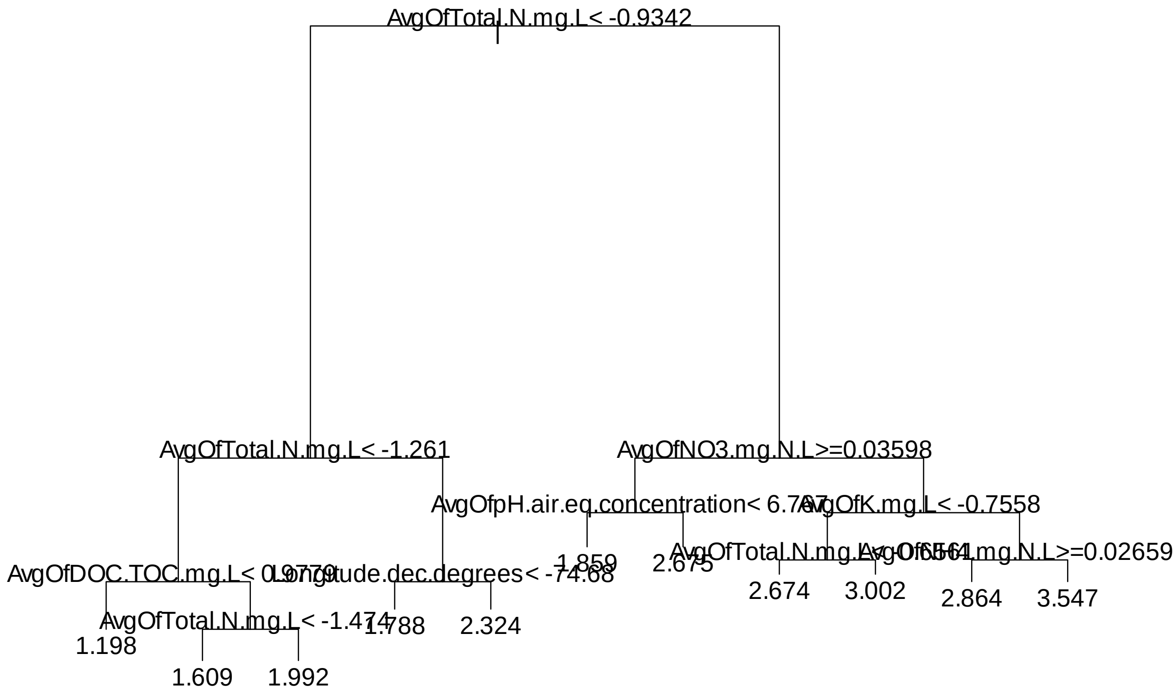

StateOrProvince=deghjl
Latitude.dec.degrees< 42.51
AvgOfpH.air.eq.concentration>=5.042
AvgOfTotal.P.ug.L< 1.999
AvgOfMg.mg.L< -1.276
Longitude.dec.degrees>=-73.5
AvgOfNa.mg.L< 0.9158
AvgOfTotal.Al.ug.L< 3.025
0.7285
2.026
2.584
Latitude.dec.degrees< 45.92
1.813
AvgOfANC.mg.L< 2.419
AvgOfSO4.mg.S.L>=0.2812
1.616
2.046
1.385
1.941
Latitude.dec.degrees>=47.83
1.461
1.648
2.147
0.4628
1.383

Figure 15. Classification and regression trees (CART) for surface water Total Al, N, P and Hg. (figure spans multiple pages)

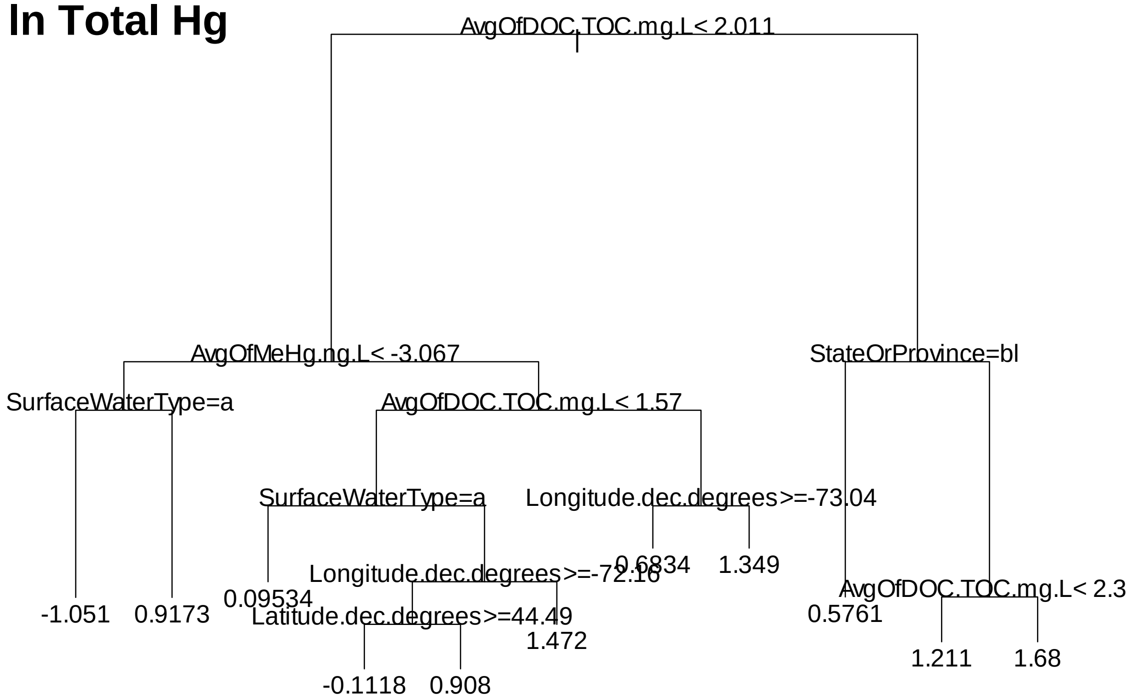




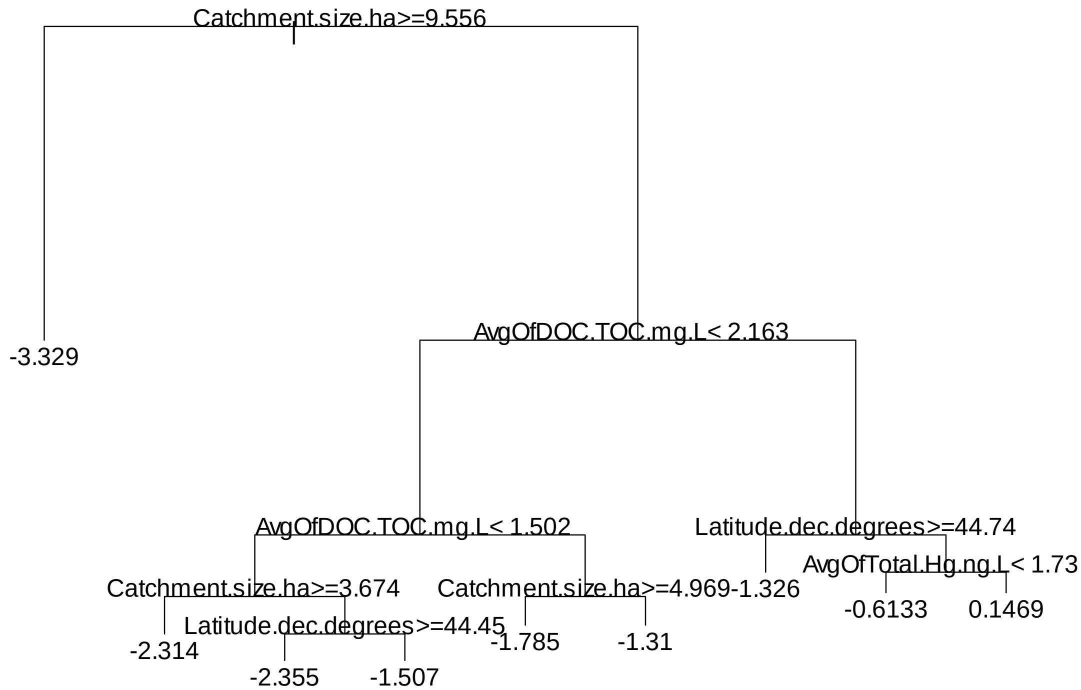
ln Total P



ln Total Hg



ln MeHg


Catchment.size.ha>=9.556
-3.329
AvgOfDOC.TOC.mg.L< 2.163
AvgOfDOC.TOC.mg.L< 1.502
Latitude.dec.degrees>=44.74
AvgOfTotal.Hg.ng.L< 1.73
Catchment.size.ha>=3.674
Catchment.size.ha>=4.969
-1.326
-0.6133
0.1469
Latitude.dec.degrees>=44.45
-2.314
-1.785
-1.31
-2.355
-1.507

Appendix A-7: Surface Water Chemistry Random Forest Diagrams

Figure 16. Random Forest diagrams for surface water cations. X axis is "IncnodePurity", which is an importance value.

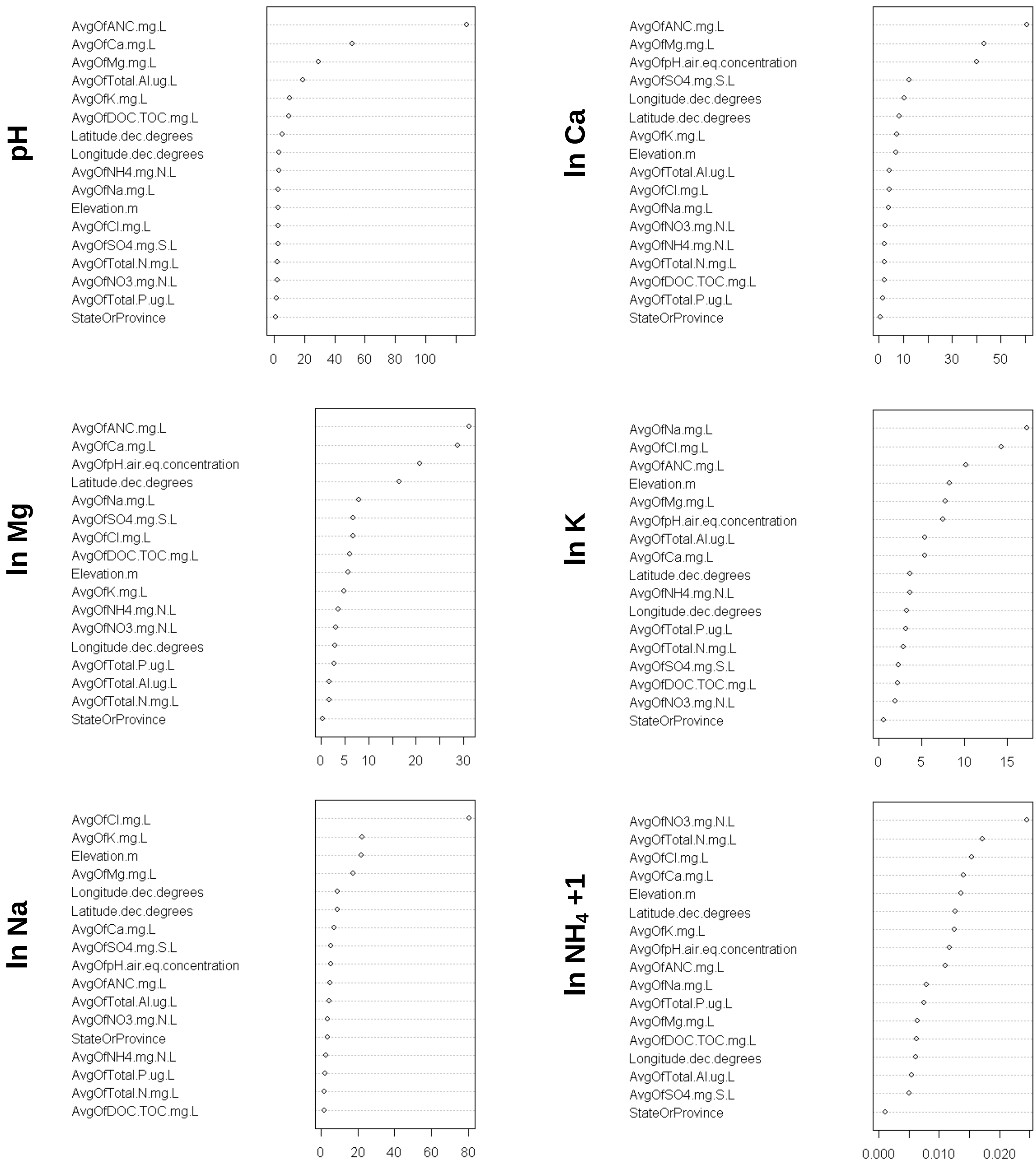


Figure 17. Random Forest diagrams for surface water anions. X axis is "IncnodePurity", which is an importance value.

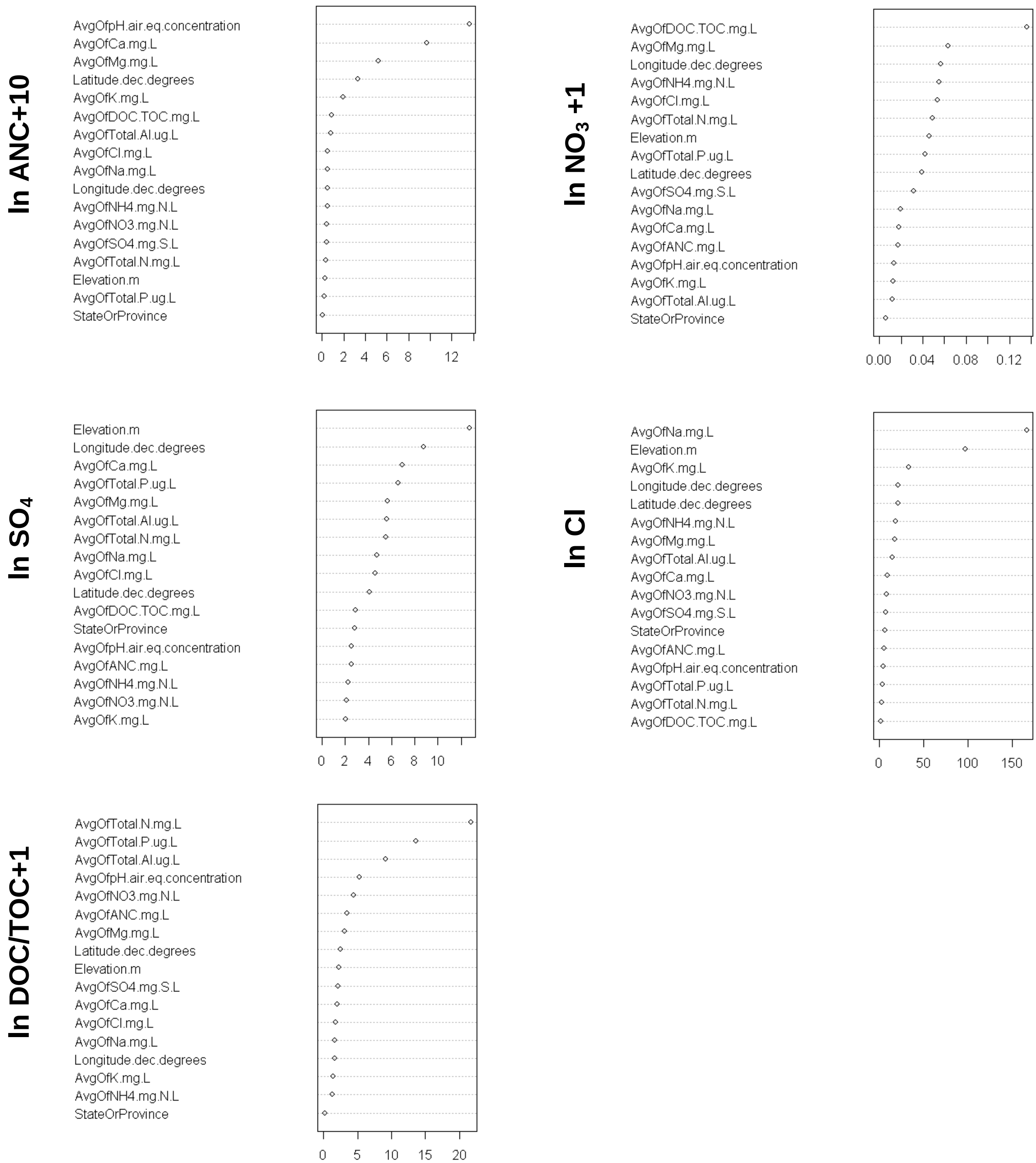
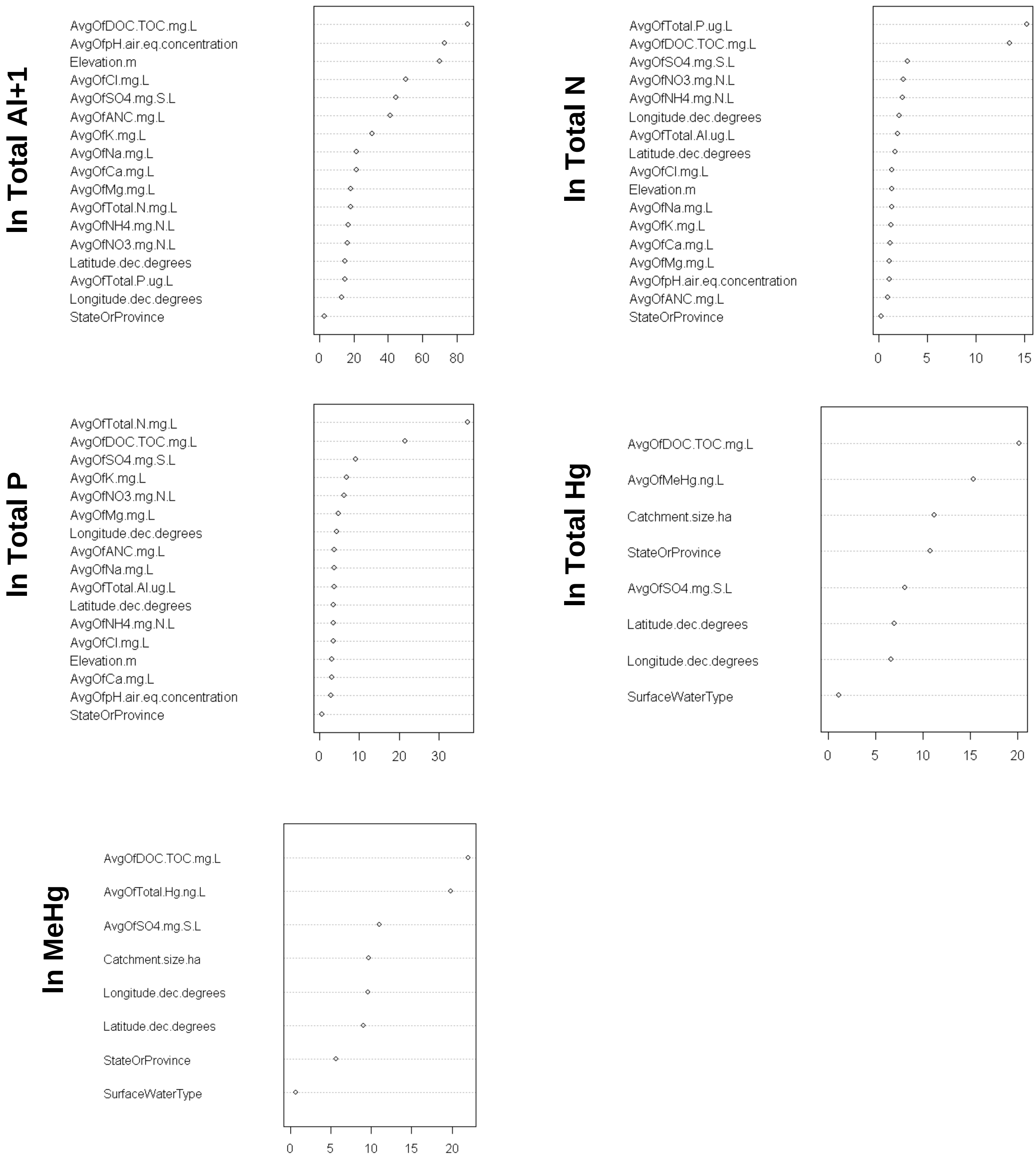


Figure 18. Random Forest diagrams for surface water Total Al, N, P and Hg. X axis is "IncnodePurity", which is an importance value.



Appendix B: Foliar Chemistry Analysis

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Appendix B-1: Foliar Chemistry Summary Statistics

Table 1. Summary statistics for foliar chemistry dataset. (table spans multiple pages)

Acer saccharum

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	1.890	1.923	0.734	2.600	0.266	165
Ca (mg/kg)	7153.297	6491.343	1876.804	21763.528	3126.575	239
Mg (mg/kg)	1232.553	1149.437	438.505	3412.377	465.224	239
K (mg/kg)	7737.274	7890.526	3490.000	11844.900	1035.301	239
P (mg/kg)	1250.475	1191.083	388.170	3447.202	365.871	228
Al (mg/kg)	29.358	24.430	0.000	96.629	16.202	232
Mn (mg/kg)	1193.327	1030.975	122.603	4890.790	716.464	232
Sr (mg/kg)	23.579	20.831	2.333	106.440	14.360	193
Cellulose (%)	32.690	32.965	26.503	38.190	2.452	140
Lignin (%)	17.982	17.937	12.833	23.570	1.927	140

Fagus grandifolia

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	2.268	2.254	1.710	2.855	0.232	152
Ca (mg/kg)	5715.528	5652.218	2757.024	9062.970	1256.563	170
Mg (mg/kg)	1461.088	1444.380	596.610	2639.217	377.740	170
K (mg/kg)	7839.121	7858.467	4198.590	17030.500	1439.234	170
P (mg/kg)	1256.490	1171.150	443.310	3647.525	383.603	165
Al (mg/kg)	26.747	24.095	0.000	157.420	15.894	166
Mn (mg/kg)	1105.489	984.200	100.650	4082.159	611.226	169
Sr (mg/kg)	13.914	12.833	3.000	61.783	8.277	130
Cellulose (%)	43.125	43.329	35.760	50.718	2.739	135
Lignin (%)	25.482	25.143	14.768	36.280	2.372	135

Acer rubrum

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	1.906	1.900	1.465	2.644	0.223	99
Ca (mg/kg)	5718.900	5561.880	2560.270	11659.300	1656.641	107
Mg (mg/kg)	1293.569	1250.360	785.643	2788.337	342.170	107
K (mg/kg)	6871.123	6763.469	4561.208	11744.850	1237.029	106
P (mg/kg)	1224.868	1149.684	406.680	3457.150	381.487	98
Al (mg/kg)	18.250	14.135	0.901	121.855	14.975	103
Mn (mg/kg)	875.407	688.321	125.430	2950.856	555.228	104
Sr (mg/kg)	11.705	10.000	3.000	50.745	7.671	67
Cellulose (%)	30.532	30.370	25.645	36.800	2.092	87
Lignin (%)	19.239	19.284	16.478	22.680	1.404	87

Betula alleghaniensis

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	2.412	2.434	1.610	3.665	0.288	174
Ca (mg/kg)	8554.394	8525.583	2729.110	13501.840	2122.623	196
Mg (mg/kg)	2323.401	2302.715	867.010	3914.120	595.695	196
K (mg/kg)	9171.465	9036.642	4893.035	13661.695	1704.038	196
P (mg/kg)	1462.055	1392.865	669.650	4236.005	411.382	188
Al (mg/kg)	24.819	22.700	0.000	83.626	11.416	191
Mn (mg/kg)	1780.287	1563.755	385.305	6683.757	965.901	195
Sr (mg/kg)	29.077	24.722	5.500	136.846	18.664	155
Cellulose (%)	39.208	39.073	34.407	43.590	1.893	151
Lignin (%)	22.174	22.133	18.670	26.770	1.621	151

Fraxinus americana

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	2.283	2.291	1.353	2.840	0.267	54
Ca (mg/kg)	10833.808	10146.921	4296.162	29064.060	4165.204	93
Mg (mg/kg)	2408.832	2299.755	1051.665	4898.790	691.967	93
K (mg/kg)	12139.904	12437.228	5583.230	18748.380	2195.303	93
P (mg/kg)	1688.884	1608.342	774.840	4706.920	509.074	86
Al (mg/kg)	42.574	21.413	2.880	739.478	89.295	91
Mn (mg/kg)	110.570	70.213	18.630	885.503	144.547	93
Sr (mg/kg)	30.926	28.185	5.000	109.683	16.989	83
Cellulose (%)	50.741	51.020	41.930	56.390	3.055	52
Lignin (%)	15.191	15.118	10.360	19.270	2.068	52

Quercus rubra

	mean	**median**	**min**	**max**	**sd**	**n**
N (%)	2.174	2.257	1.536	2.771	0.353	41
Ca (mg/kg)	6540.626	6374.322	3400.000	10696.950	1662.157	38
Mg (mg/kg)	1528.748	1491.795	983.895	2550.750	337.283	38
K (mg/kg)	8655.845	8565.481	5733.660	11733.235	1371.762	38
P (mg/kg)	1508.853	1450.200	754.485	4260.180	546.026	35
Al (mg/kg)	44.361	36.280	14.050	130.700	25.712	38
Mn (mg/kg)	1748.044	1563.870	320.290	4023.993	1010.362	36
Sr (mg/kg)	7.434	6.000	2.000	19.470	4.315	21
Cellulose (%)	40.147	40.063	36.690	45.053	2.026	25
Lignin (%)	24.503	24.183	19.430	29.313	2.353	25

Picea rubens

	mean	median	min	max	sd	n
N (%)	1.117	1.123	0.743	1.513	0.141	93
Ca (mg/kg)	3944.230	3716.730	1594.326	8916.465	1242.497	91
Mg (mg/kg)	658.979	634.350	334.200	1097.610	161.877	91
K (mg/kg)	5338.560	5237.210	3232.870	9940.710	1102.480	91
P (mg/kg)	896.322	821.257	330.390	1768.920	278.073	86
Al (mg/kg)	46.683	42.900	2.430	120.995	19.589	89
Mn (mg/kg)	1614.317	1422.138	362.200	3810.690	776.276	90
Sr (mg/kg)	8.177	6.329	1.000	30.582	6.756	58
Cellulose (%)	37.971	38.050	33.345	44.360	1.971	71
Lignin (%)	25.002	24.960	18.650	28.313	1.597	71

Abies balsamea

	mean	median	min	max	sd	n
N (%)	1.582	1.580	1.205	2.080	0.175	39
Ca (mg/kg)	6648.823	6286.485	2562.750	13855.200	2781.050	31
Mg (mg/kg)	945.393	903.317	598.387	1573.450	206.138	31
K (mg/kg)	5550.446	5277.550	3912.100	9586.960	1189.389	31
P (mg/kg)	1233.195	1161.314	714.360	2451.500	338.817	30
Al (mg/kg)	177.424	152.645	65.500	601.620	102.291	30
Mn (mg/kg)	842.770	757.148	198.050	2075.667	478.154	31
Sr (mg/kg)	8.963	5.000	1.000	27.959	7.916	19
Cellulose (%)	33.334	32.502	28.380	40.480	3.062	24
Lignin (%)	25.021	25.340	19.655	27.930	2.089	24

Appendix B-2: Foliar Chemistry Cumulative Probability Diagrams

Figure 1. Cumulative probability diagrams for foliar nitrogen in hardwood species. X axis is percent nitrogen concentration.

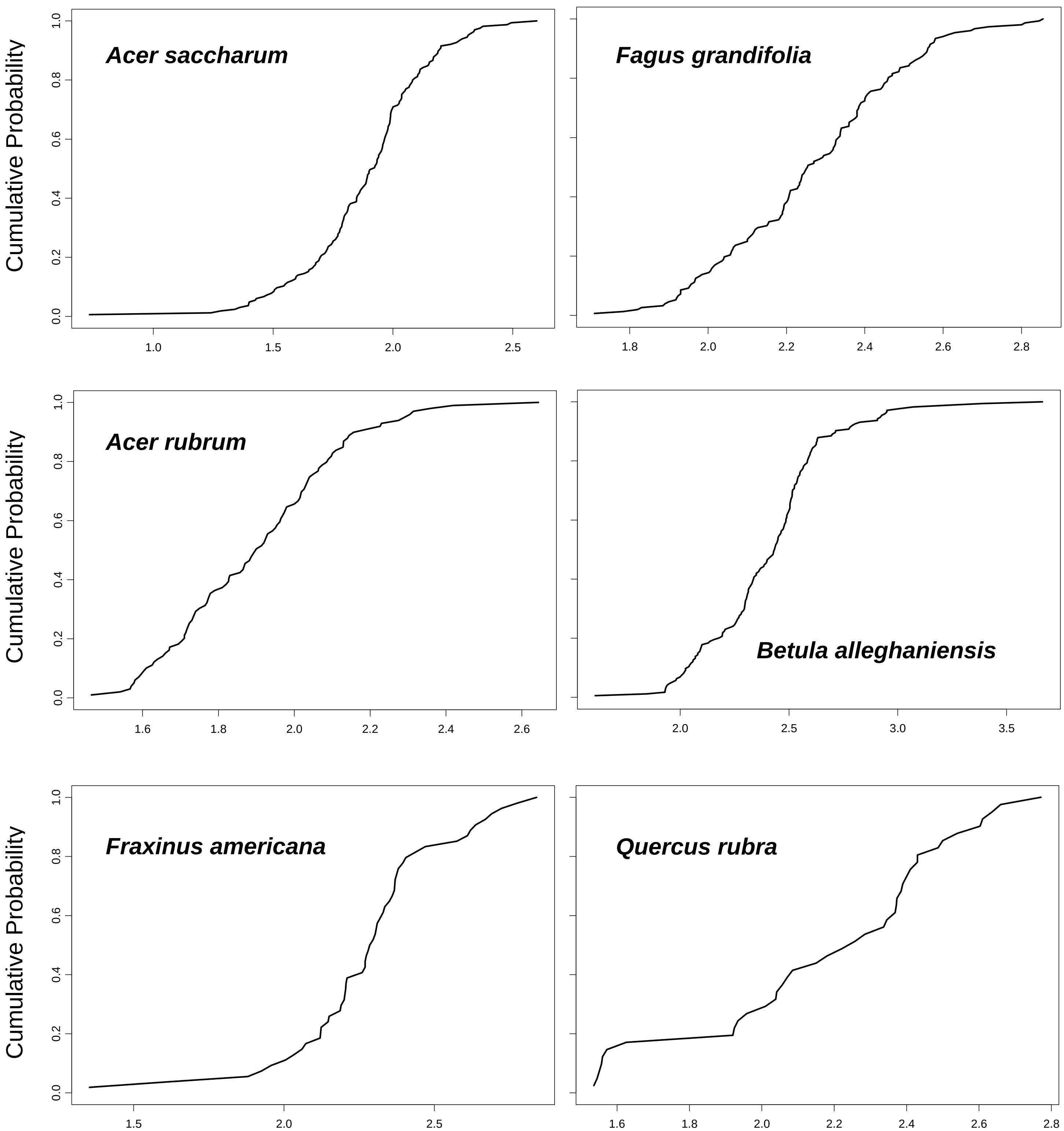


Figure 2. Cumulative probability diagrams for foliar nitrogen in softwood species. X axis is percent nitrogen concentration.

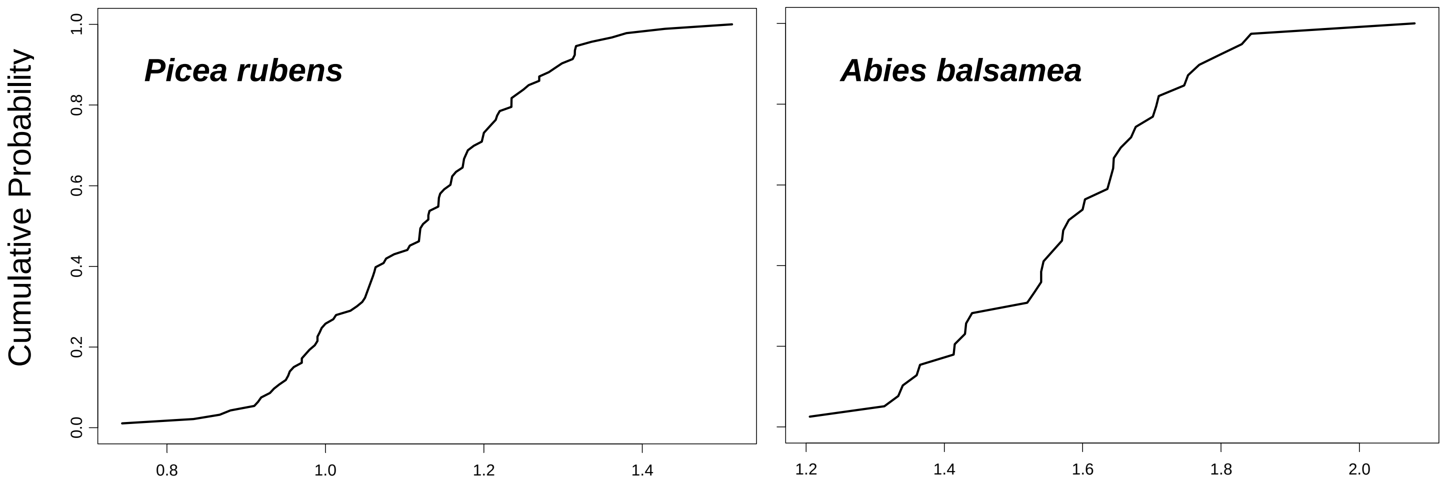


Figure 3. Cumulative probability diagrams for foliar calcium in hardwood species. X axis is calcium concentration in mg/kg.

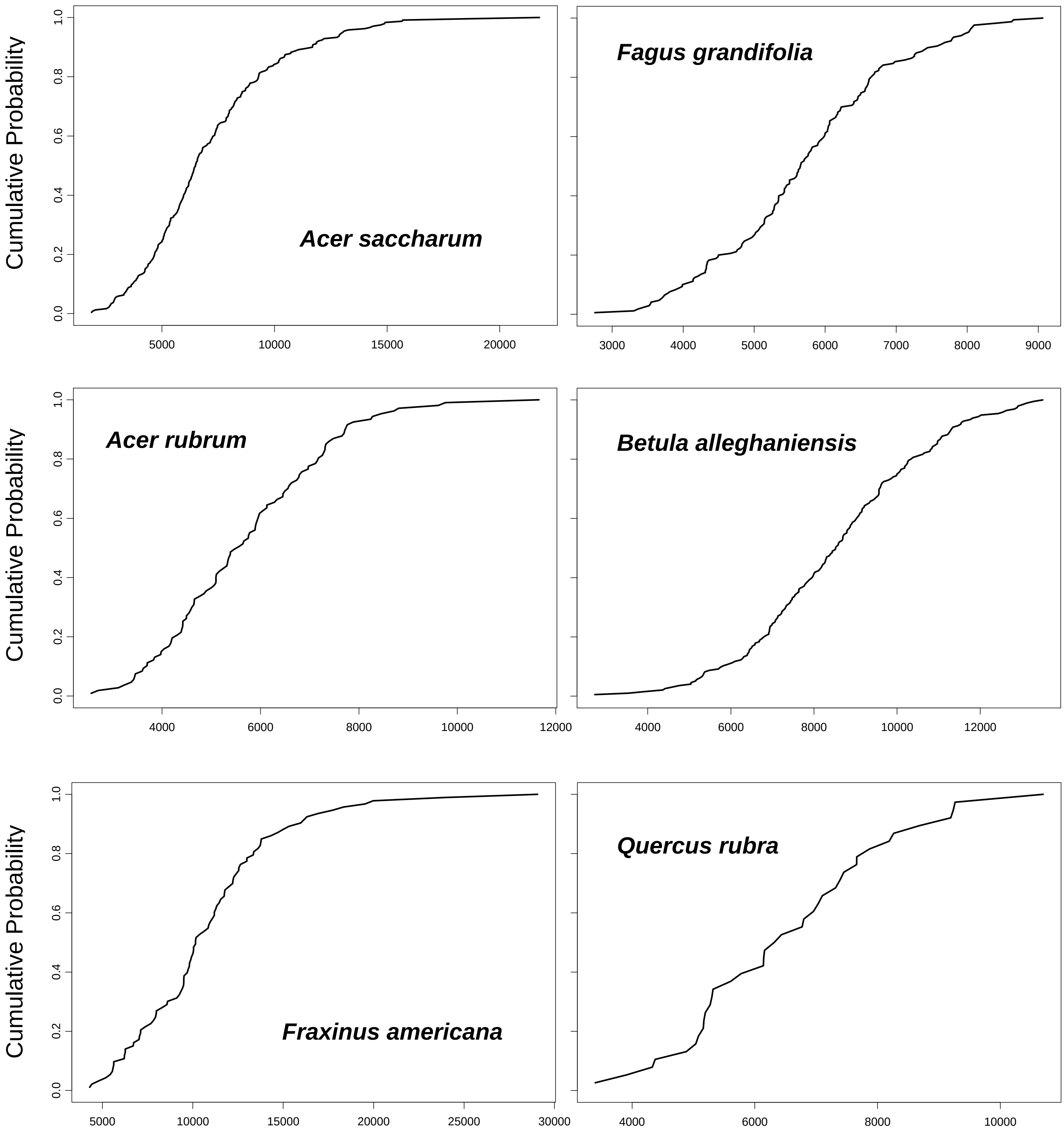


Figure 4. Cumulative probability diagrams for foliar calcium in softwood species. X axis is calcium concentration in mg/kg.

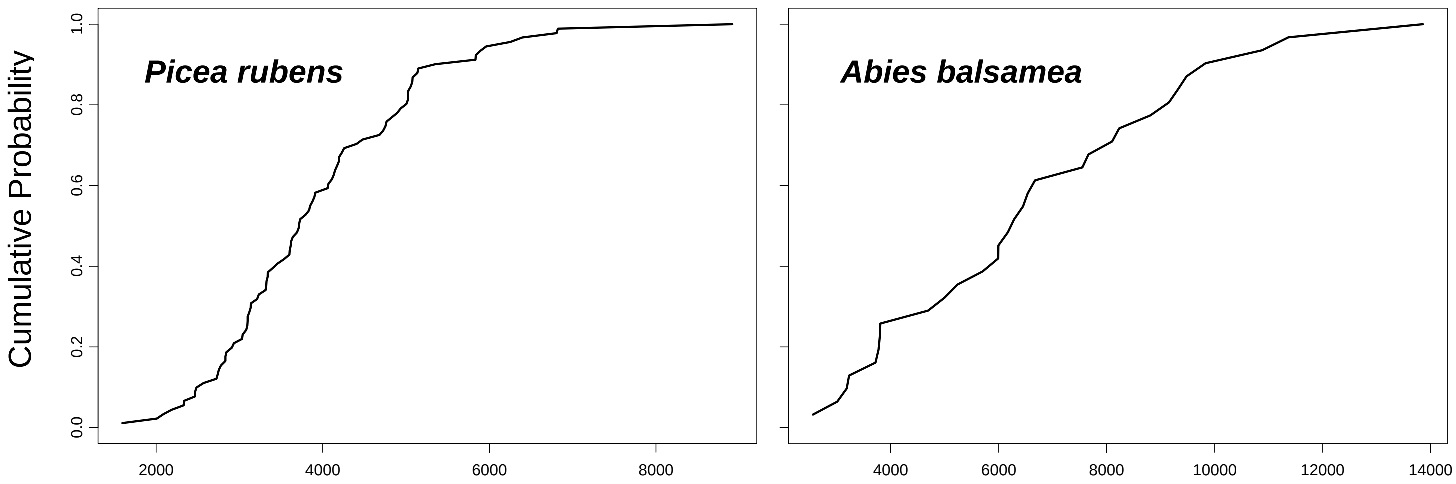


Figure 5. Cumulative probability diagrams for foliar magnesium in hardwood species. X axis is magnesium concentration in mg/kg.

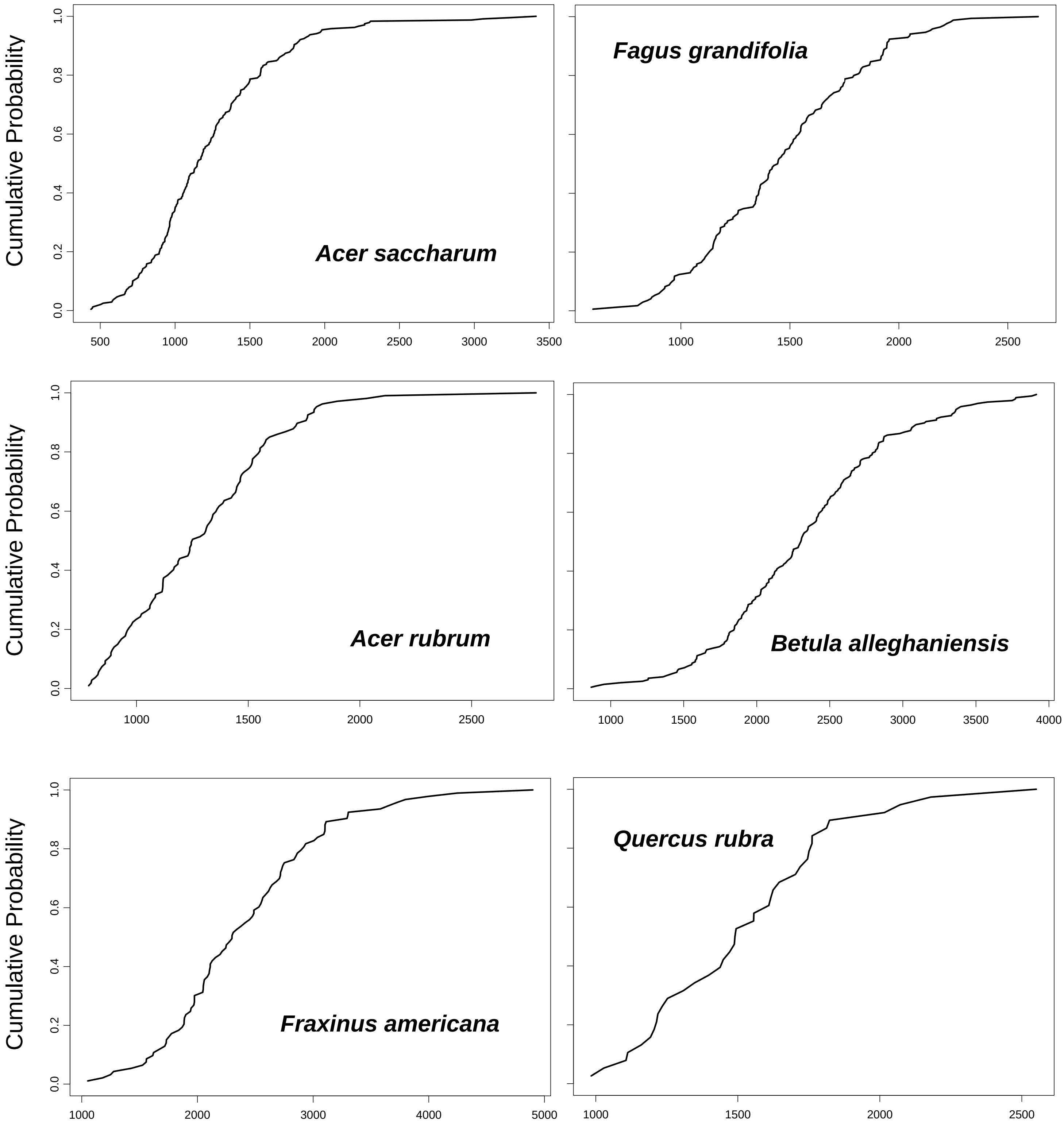


Figure 6. Cumulative probability diagrams for foliar magnesium in softwood species. X axis is magnesium concentration in mg/kg.

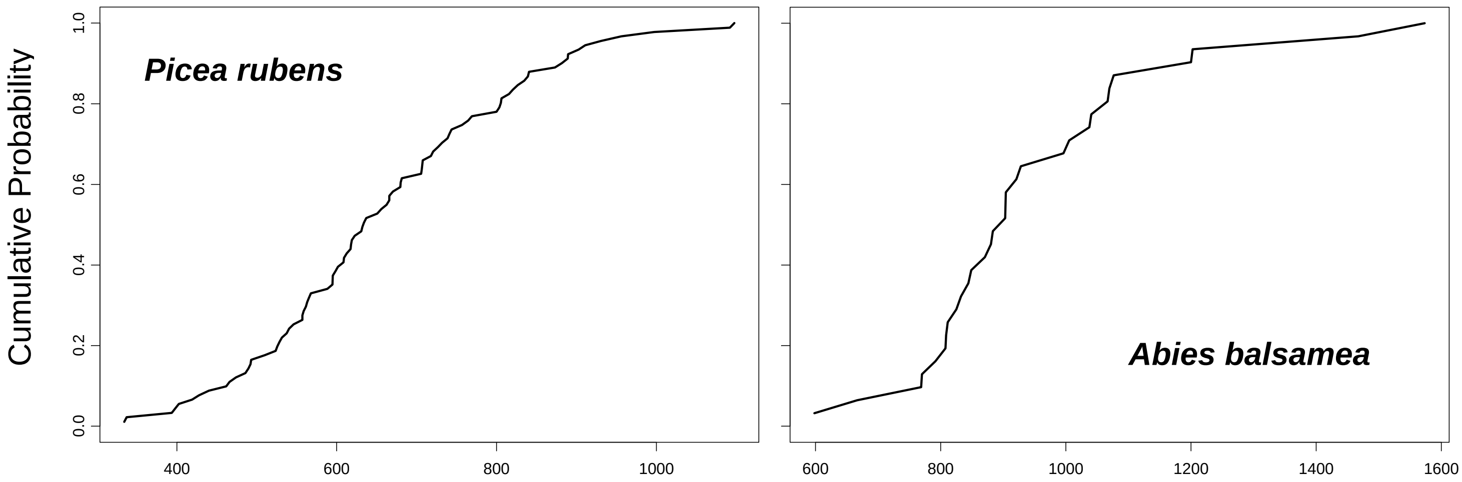


Figure 7. Cumulative probability diagrams for foliar potassium in hardwood species. X axis is potassium concentration in mg/kg.

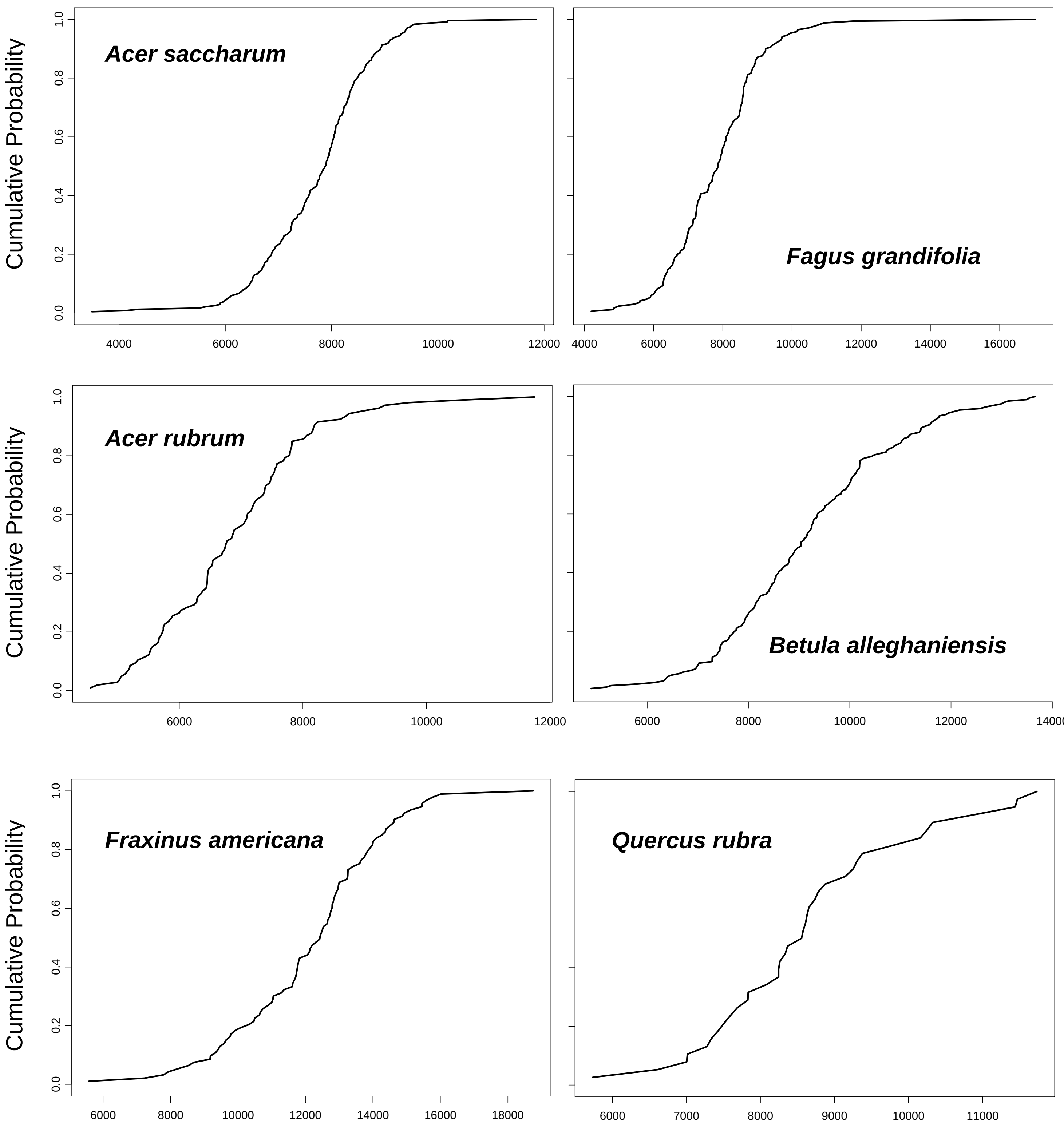


Figure 8. Cumulative probability diagrams for foliar potassium in softwood species. X axis is potassium concentration in mg/kg.

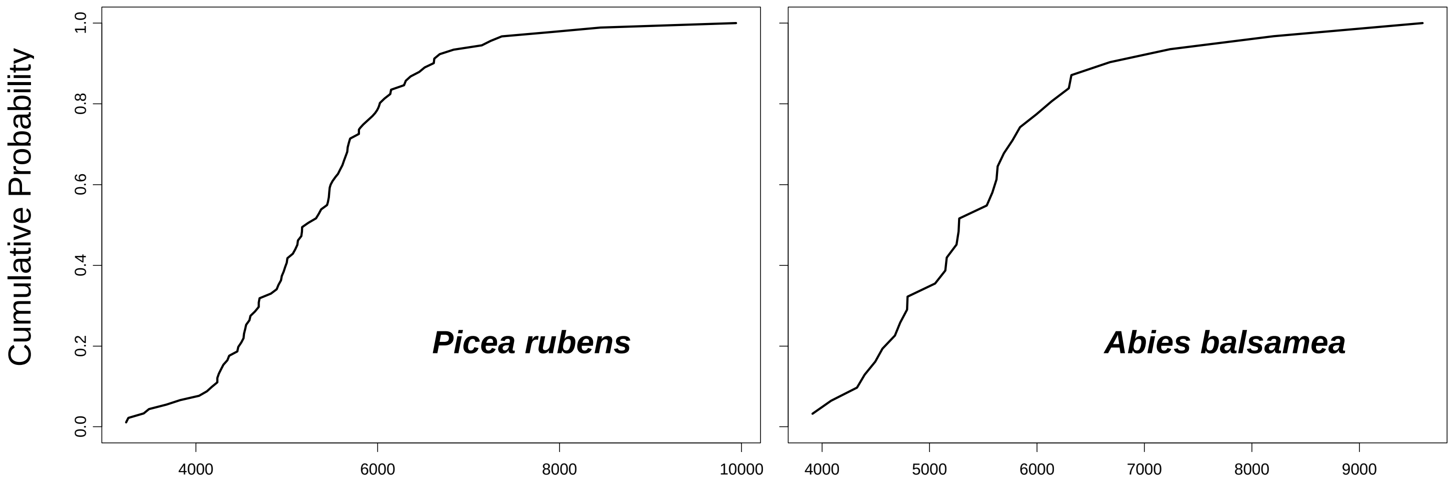


Figure 9. Cumulative probability diagrams for foliar phosphorus in hardwood species. X axis is potassium concentration in mg/kg.

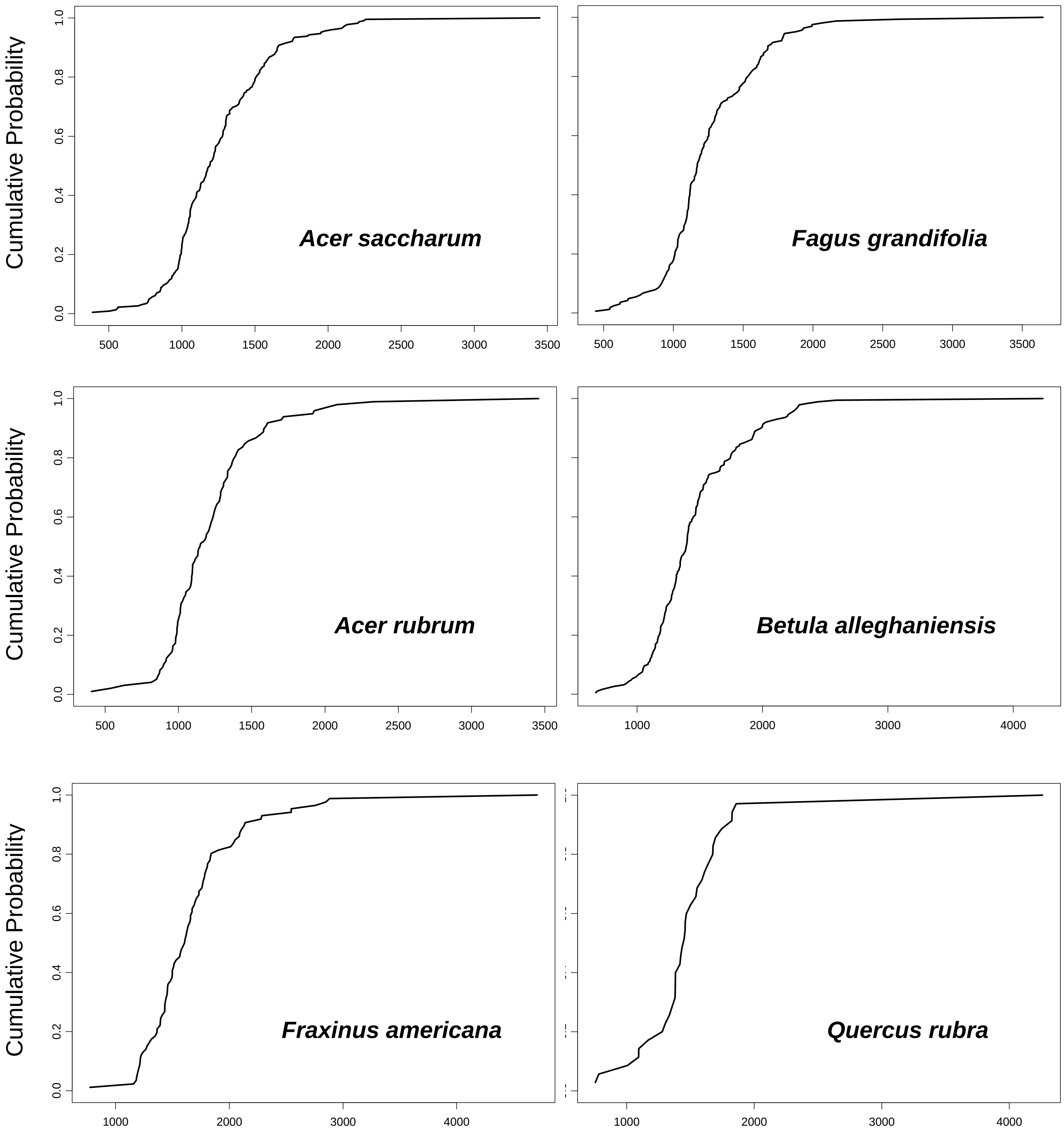


Figure 10. Cumulative probability diagrams for foliar phosphorus in softwood species. X axis is potassium concentration in mg/kg.

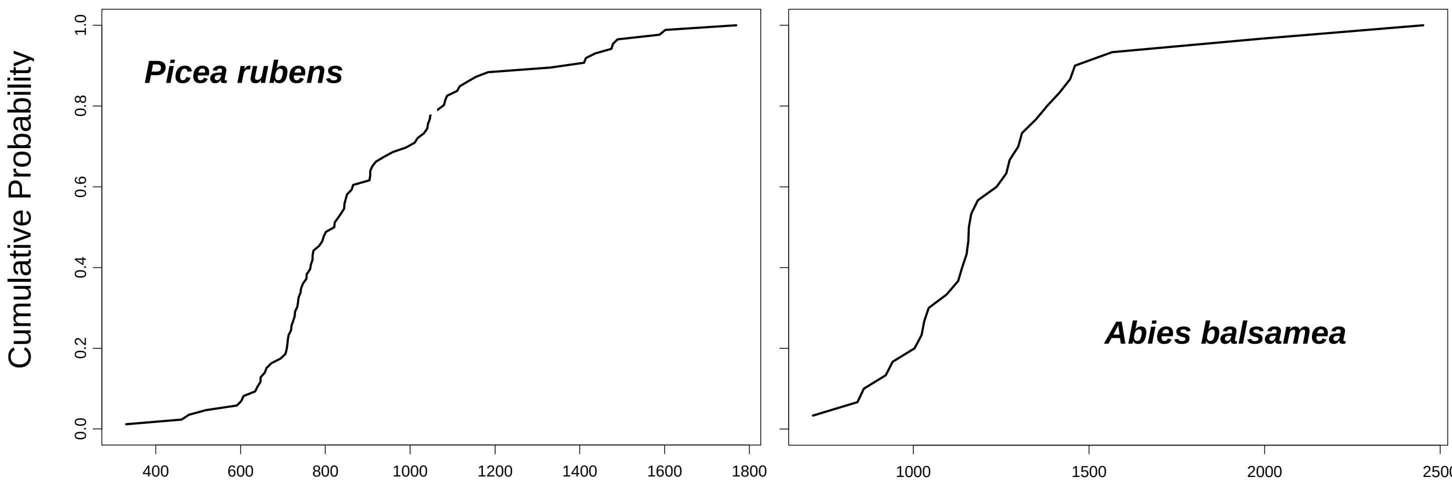


Figure 11. Cumulative probability diagrams for foliar aluminum in hardwood species. X axis is aluminum concentration in mg/kg.

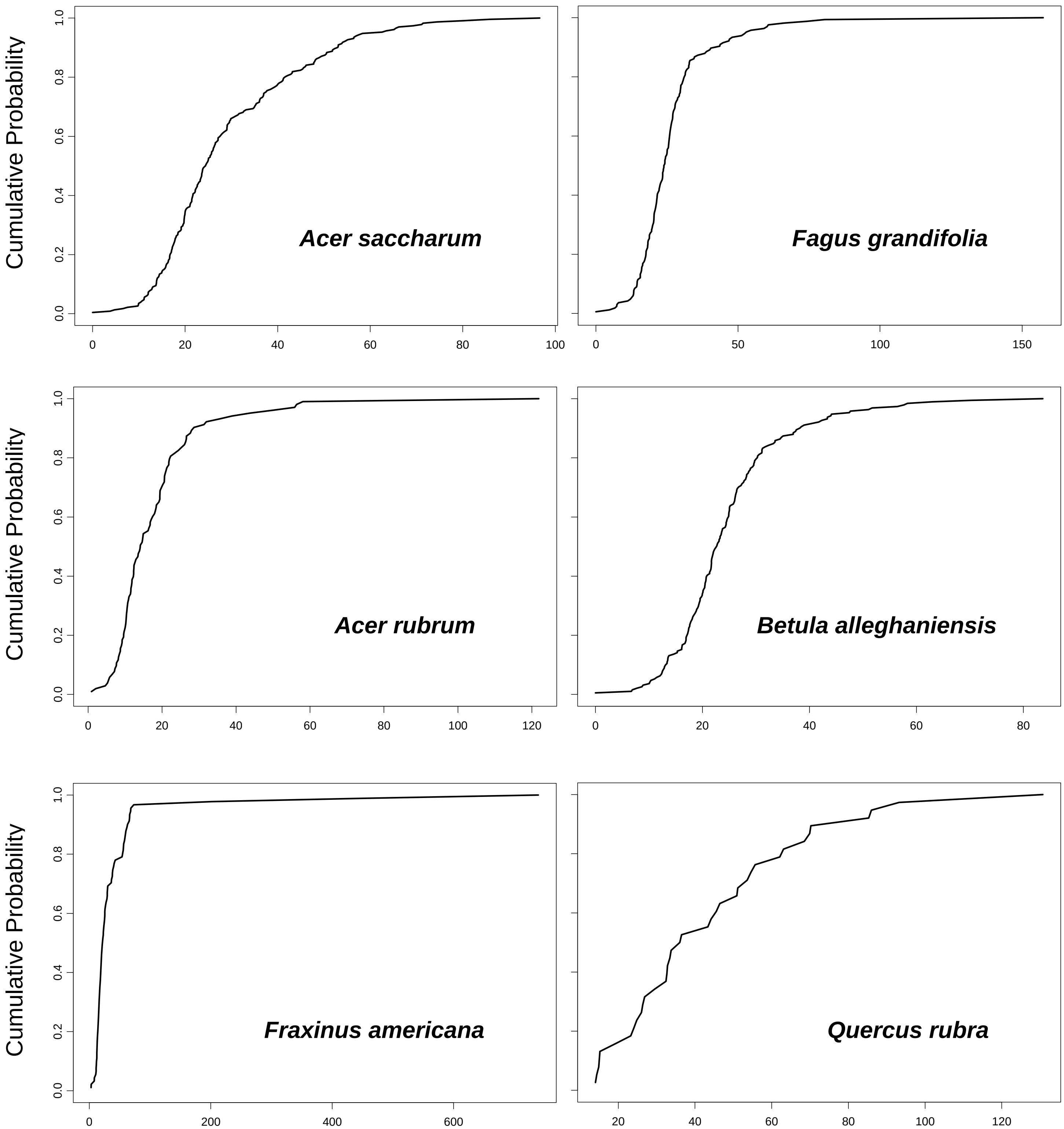


Figure 12. Cumulative probability diagrams for foliar aluminum in softwood species. X axis is aluminum concentration in mg/kg.

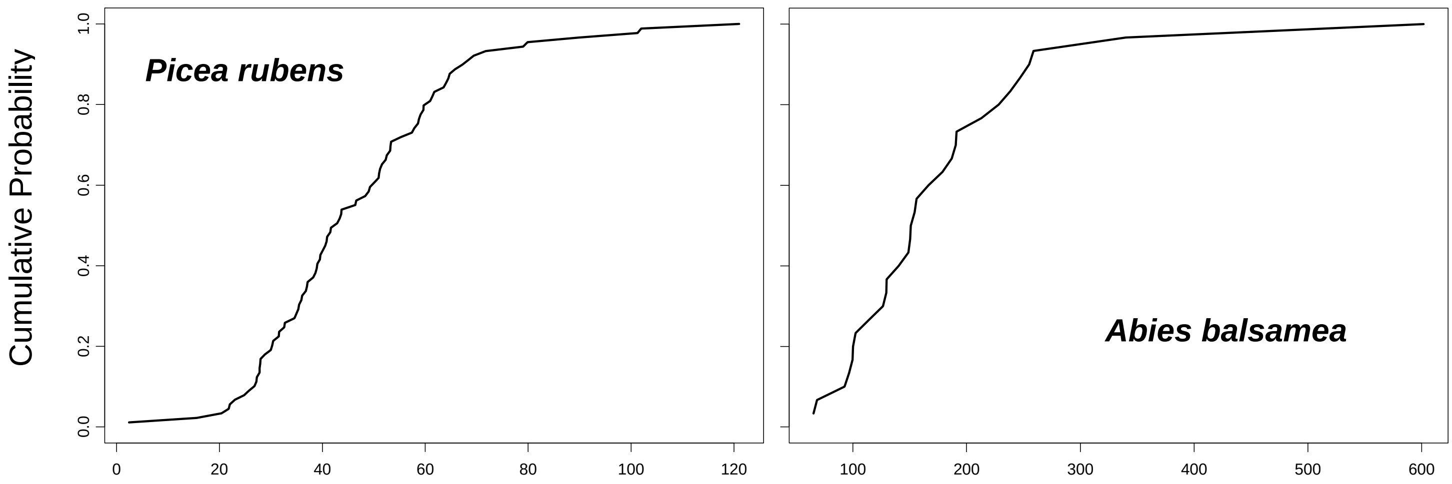


Figure 13. Cumulative probability diagrams for foliar strontium in hardwood species. X axis is strontium concentration in mg/kg.

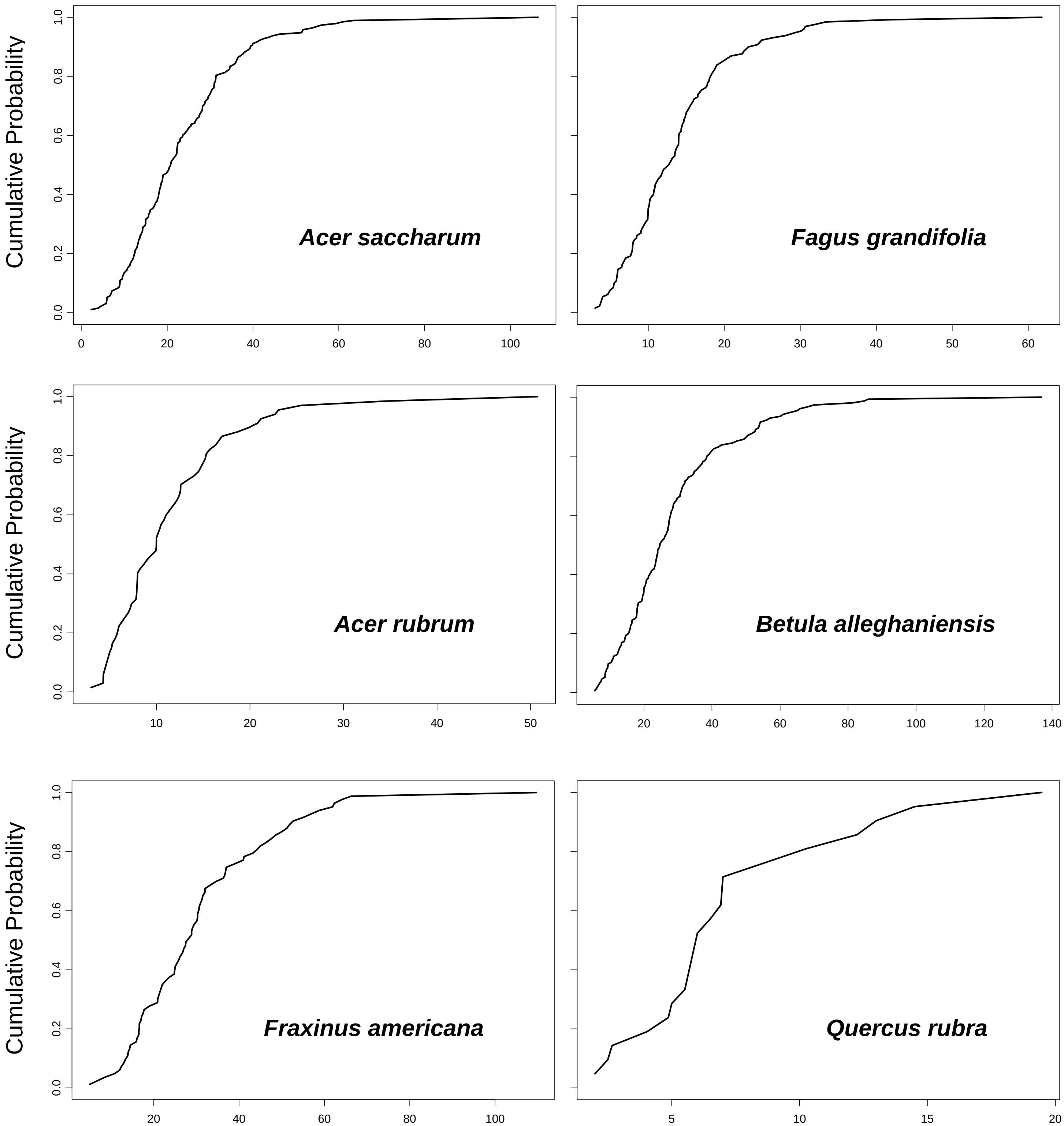


Figure 14. Cumulative probability diagrams for foliar strontium in softwood species. X axis is strontium concentration in mg/kg.

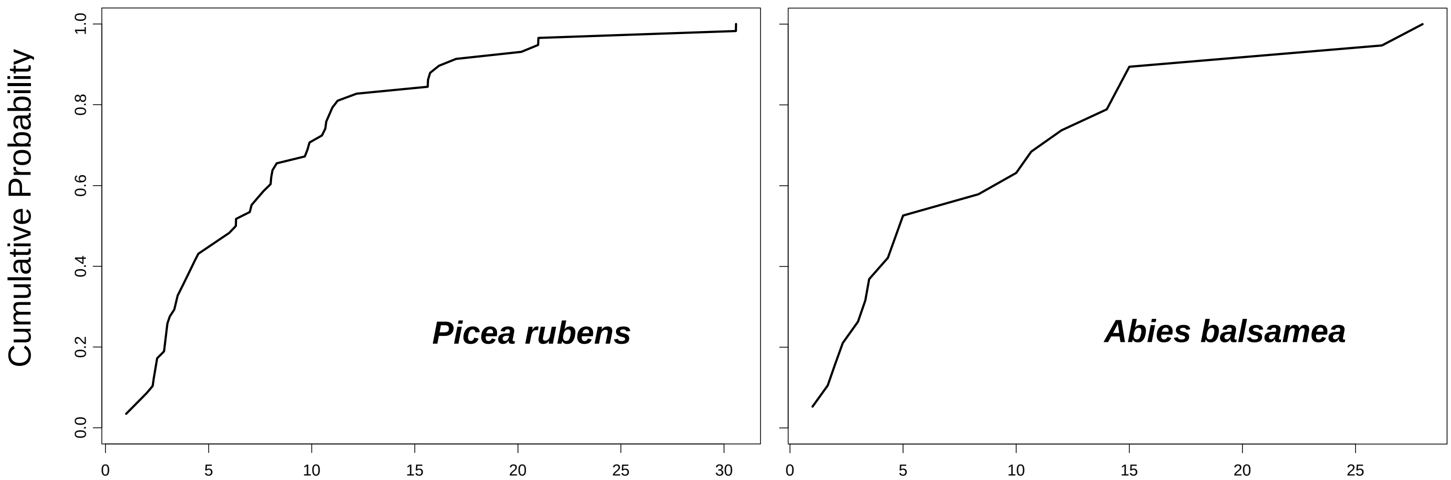


Figure 15. Cumulative probability diagrams for foliar cellulose in hardwood species. X axis is percent cellulose concentration.

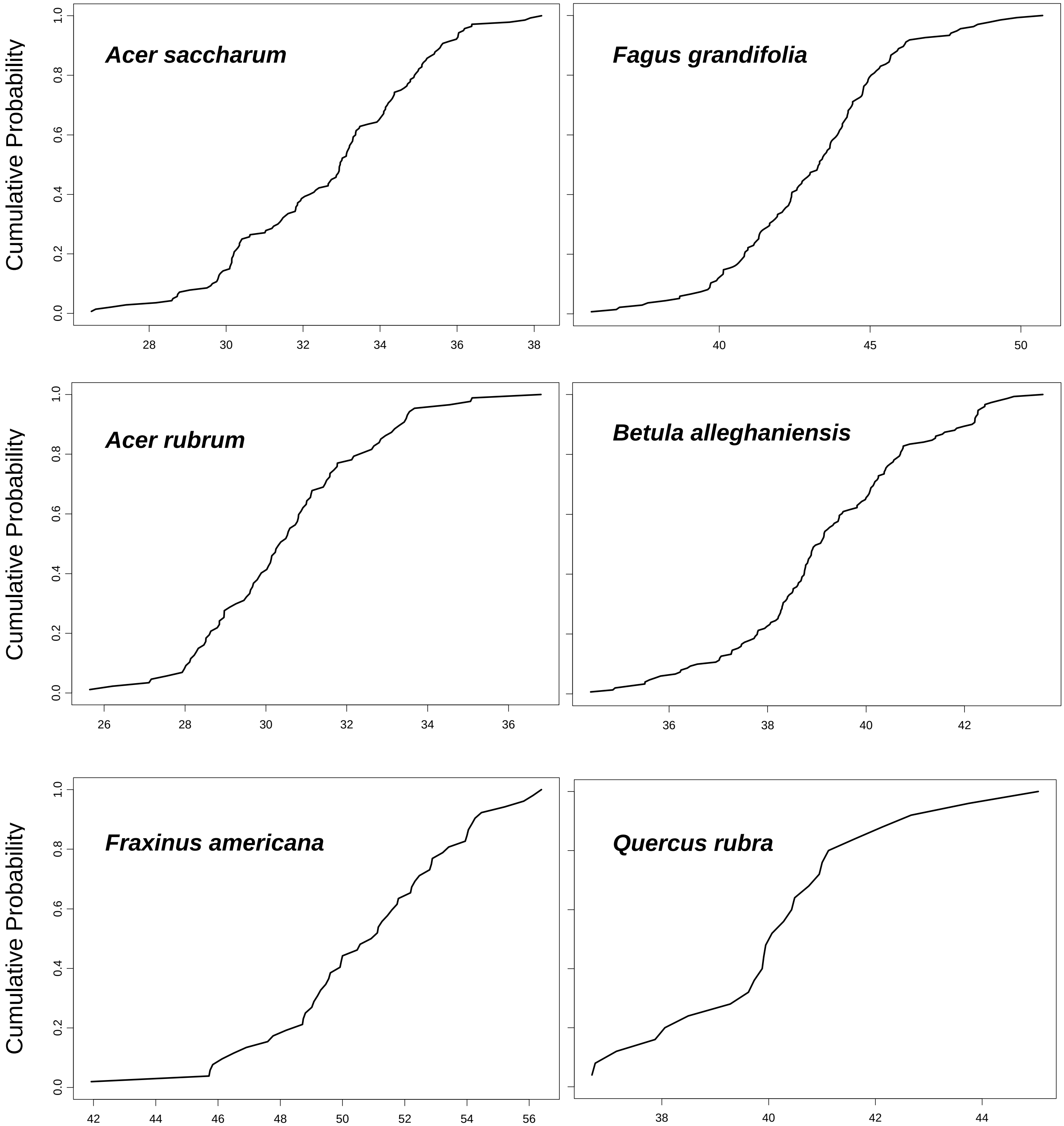


Figure 16. Cumulative probability diagrams for foliar cellulose in softwood species. X axis is percent cellulose concentration.

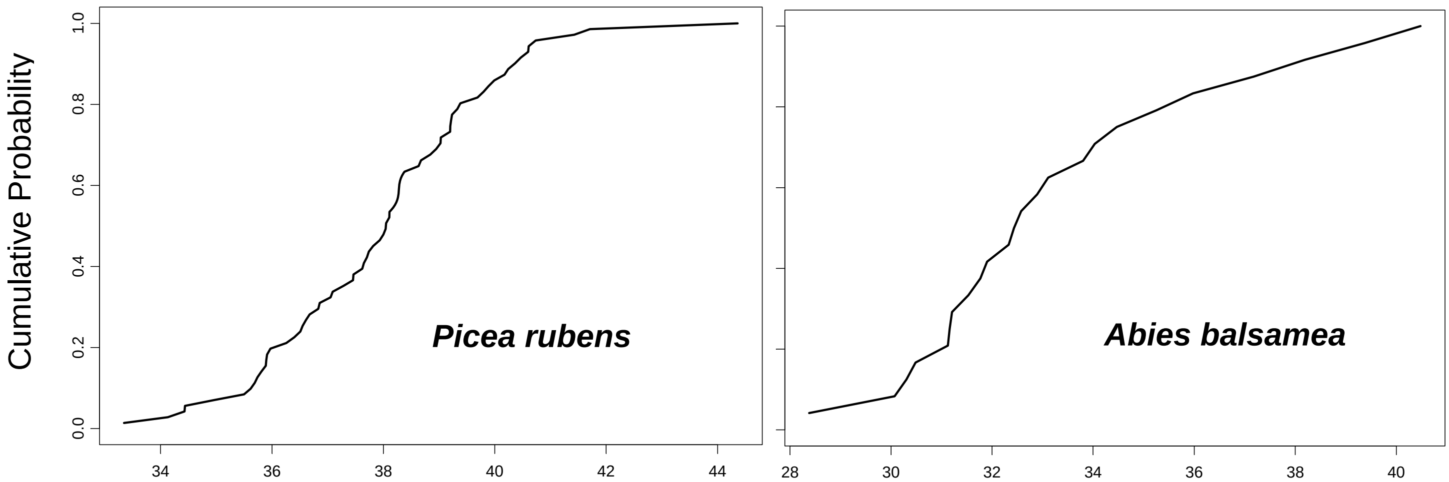


Figure 17. Cumulative probability diagrams for foliar lignin in hardwood species. X axis is percent lignin concentration.

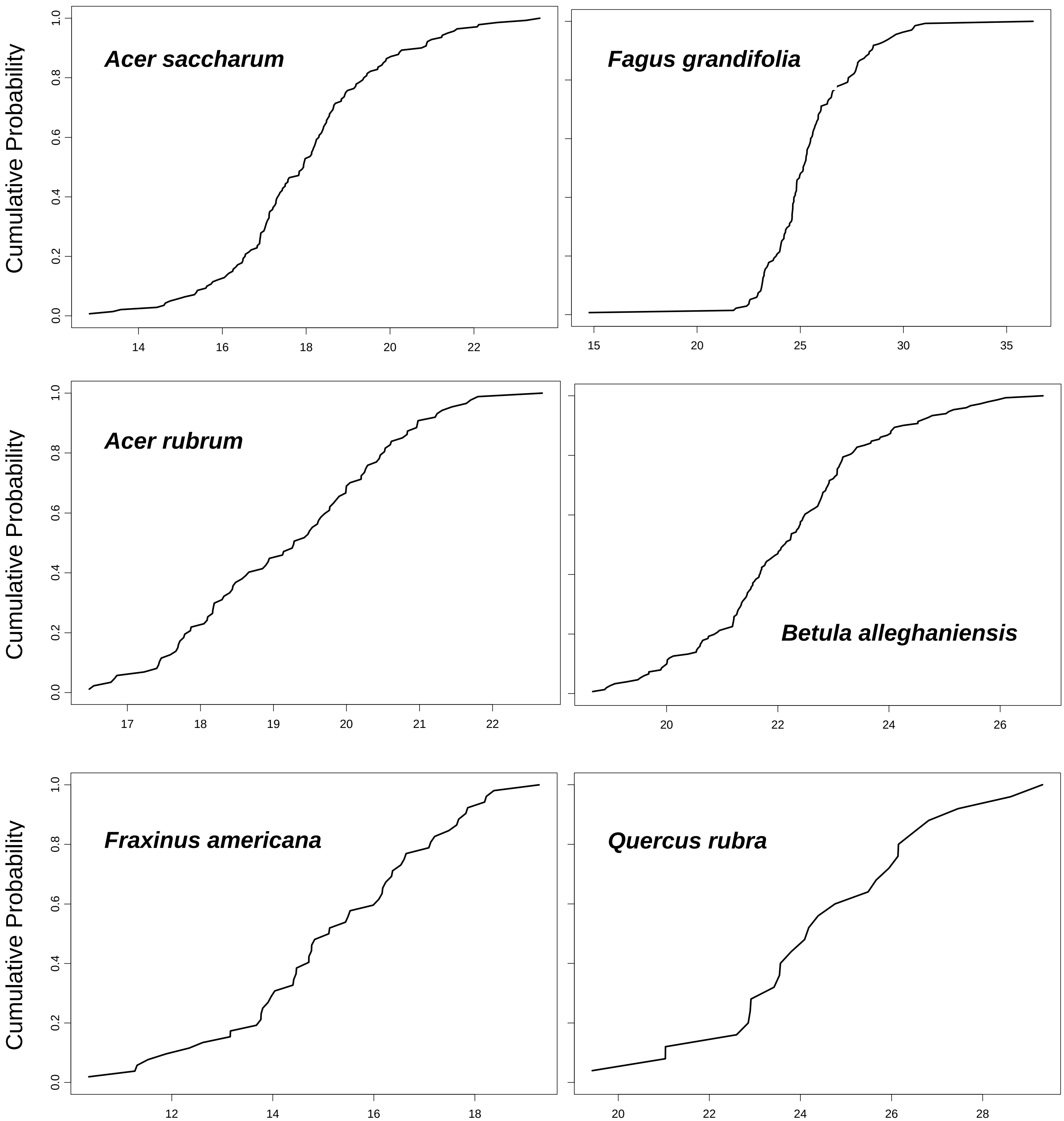
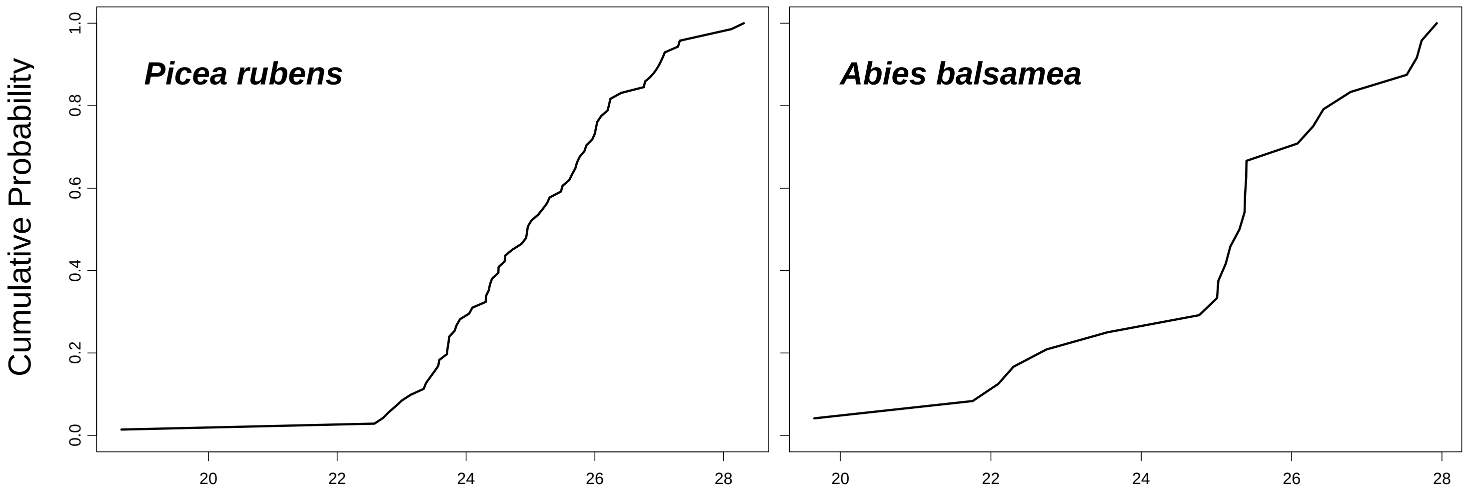


Figure 18. Cumulative probability diagrams for foliar lignin in softwood species. X axis is percent lignin concentration.



Appendix B-3: Foliar Chemistry Boxplots

Note that these vegetation boxplots were compiled with a slightly different dataset than was used for the rest of the summaries included in this document. A few data points were added for N, Ca, Mg, K, P and Al in *Acer s.*, *Acer r.*, *Betula a.*, *Picea r.* and *Abies b.*

Figure 19. Boxplots for foliar nitrogen in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

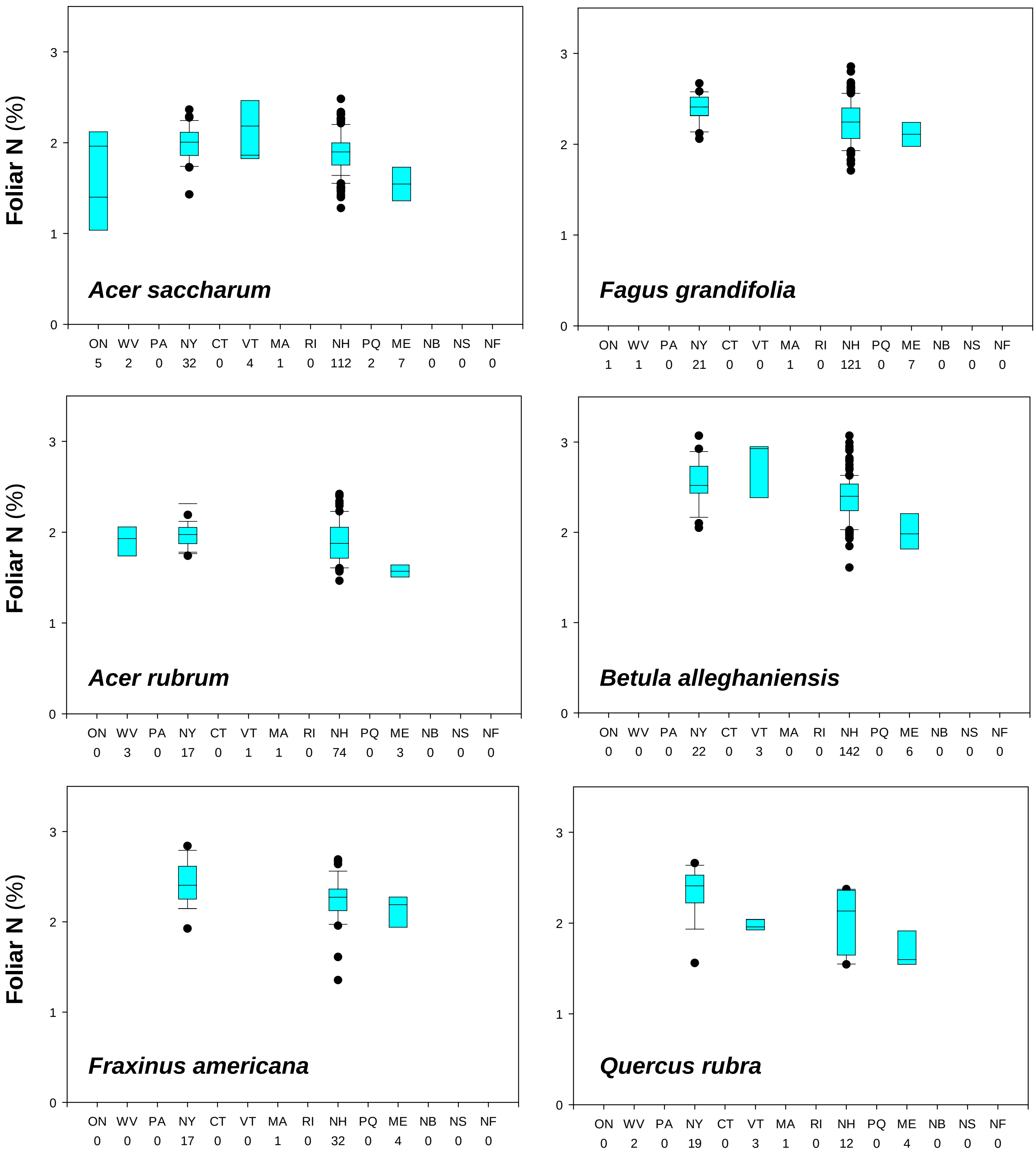


Figure 20. Boxplots for foliar nitrogen in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

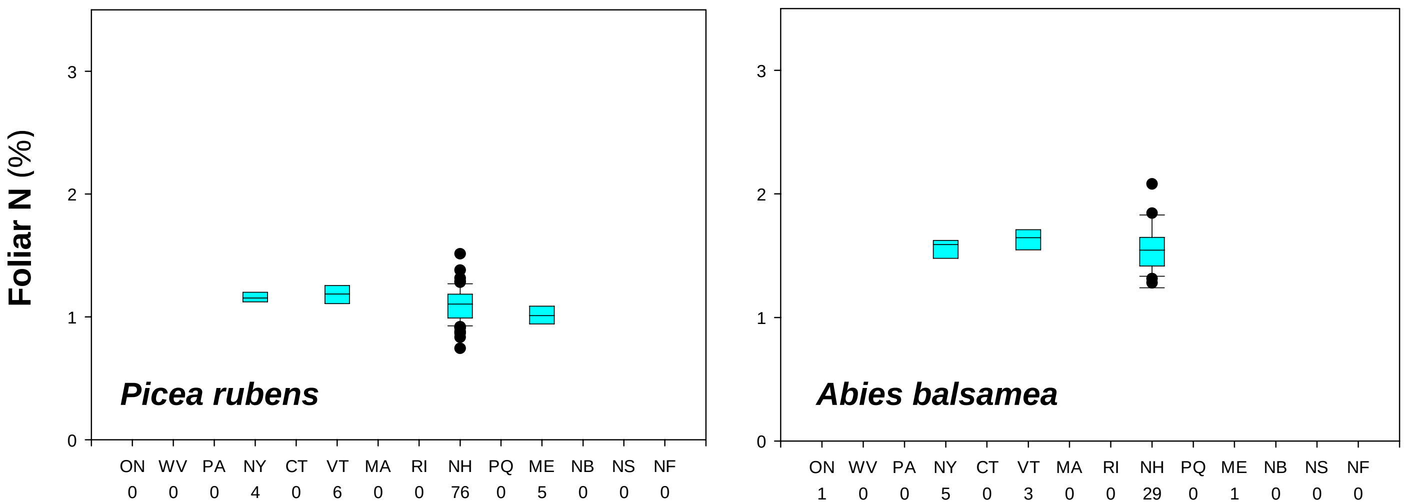


Figure 21. Boxplots for foliar calcium in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

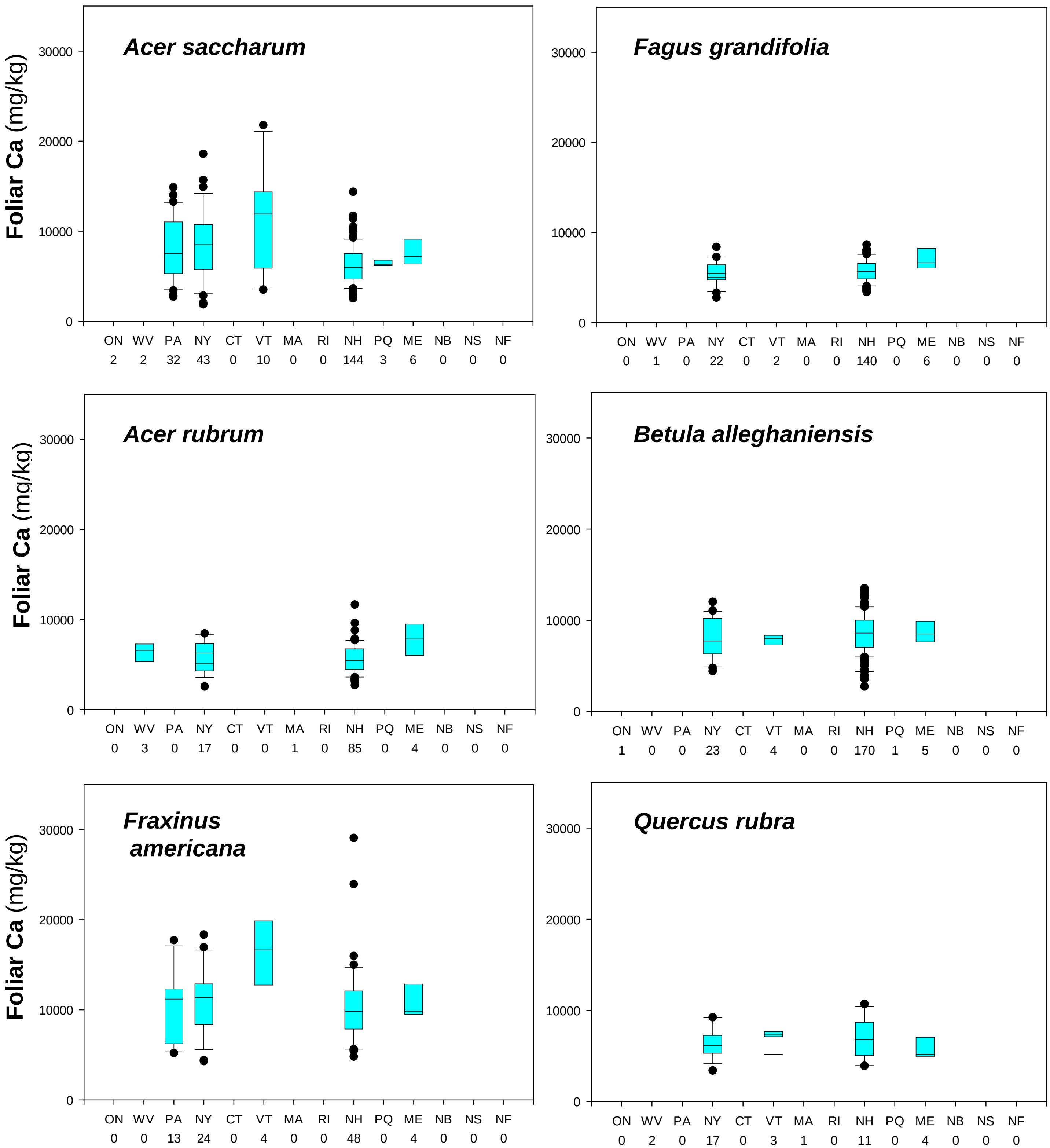


Figure 22. Boxplots for foliar calcium in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

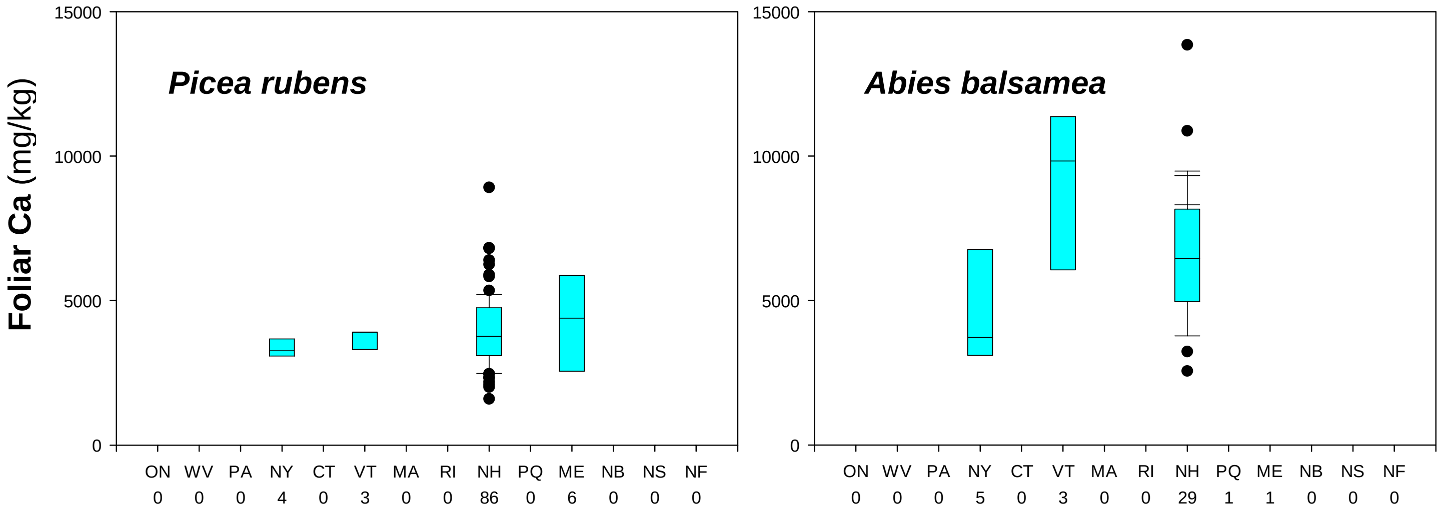


Figure 23. Boxplots for foliar magnesium in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

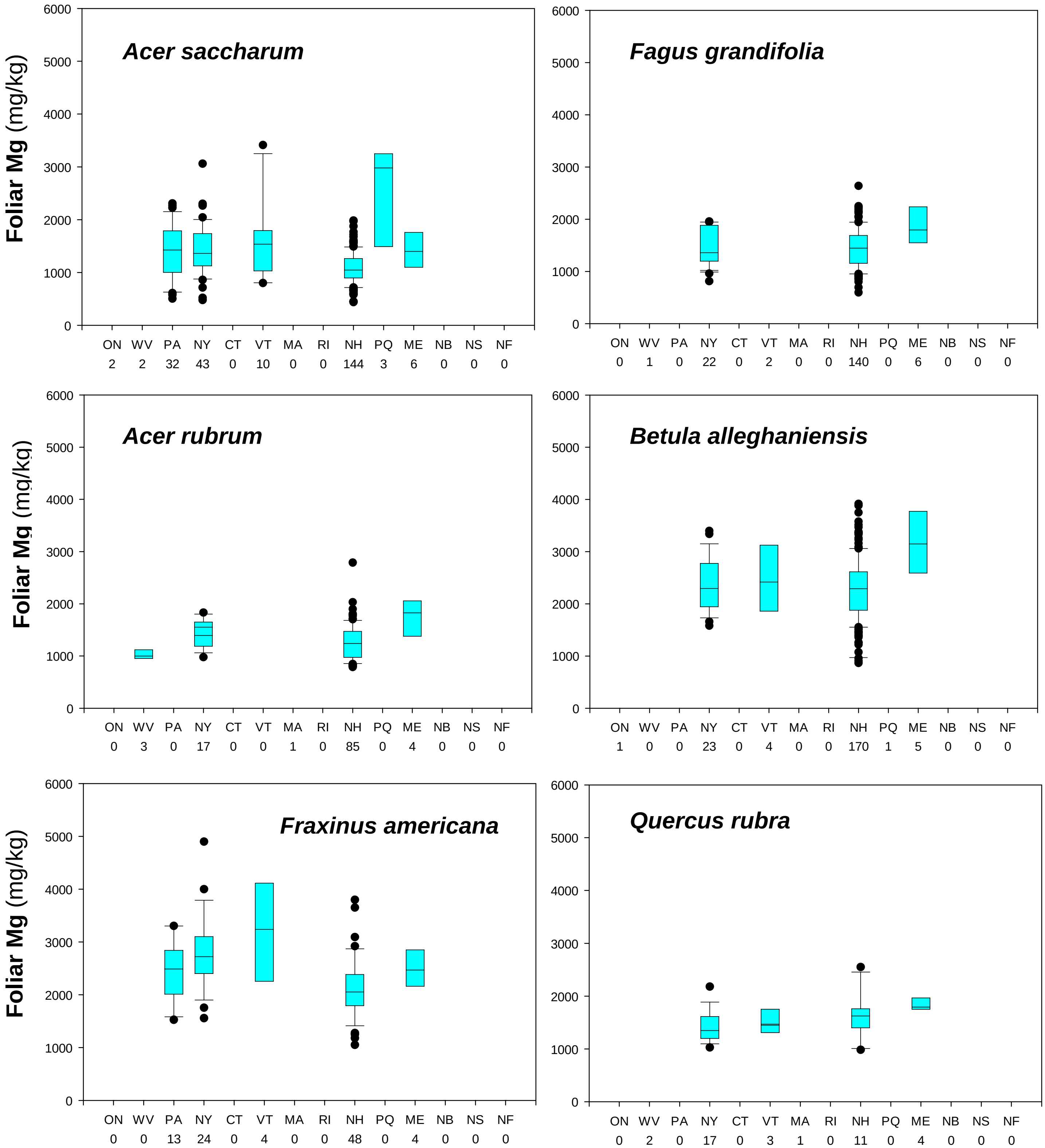


Figure 24. Boxplots for foliar magnesium in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

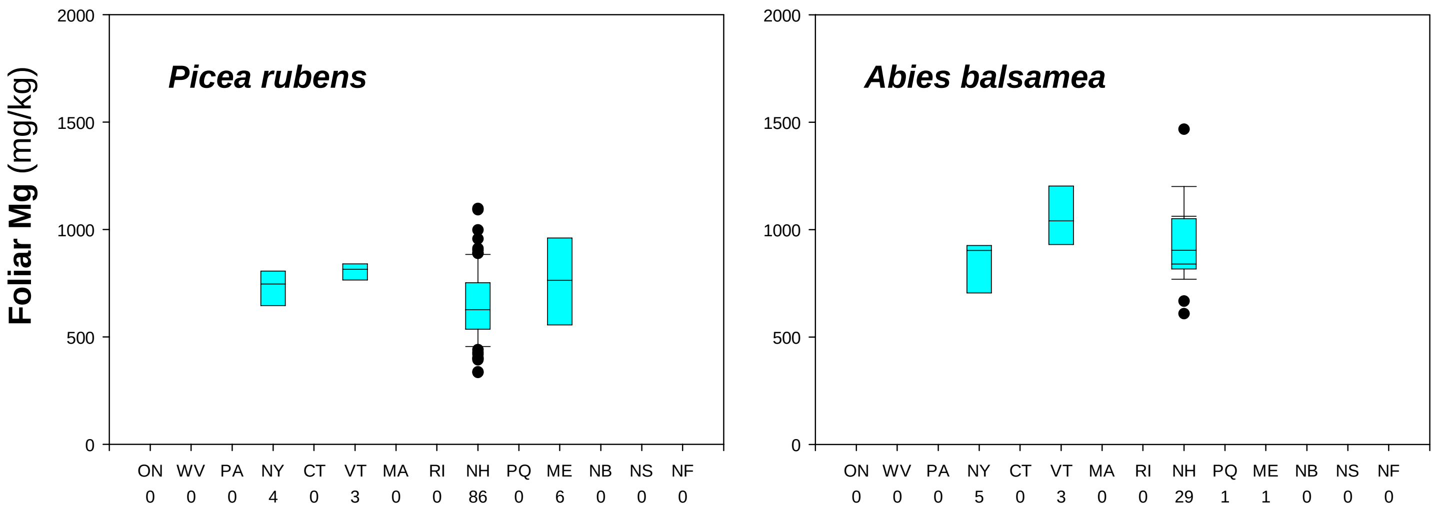


Figure 25. Boxplots for foliar potassium in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

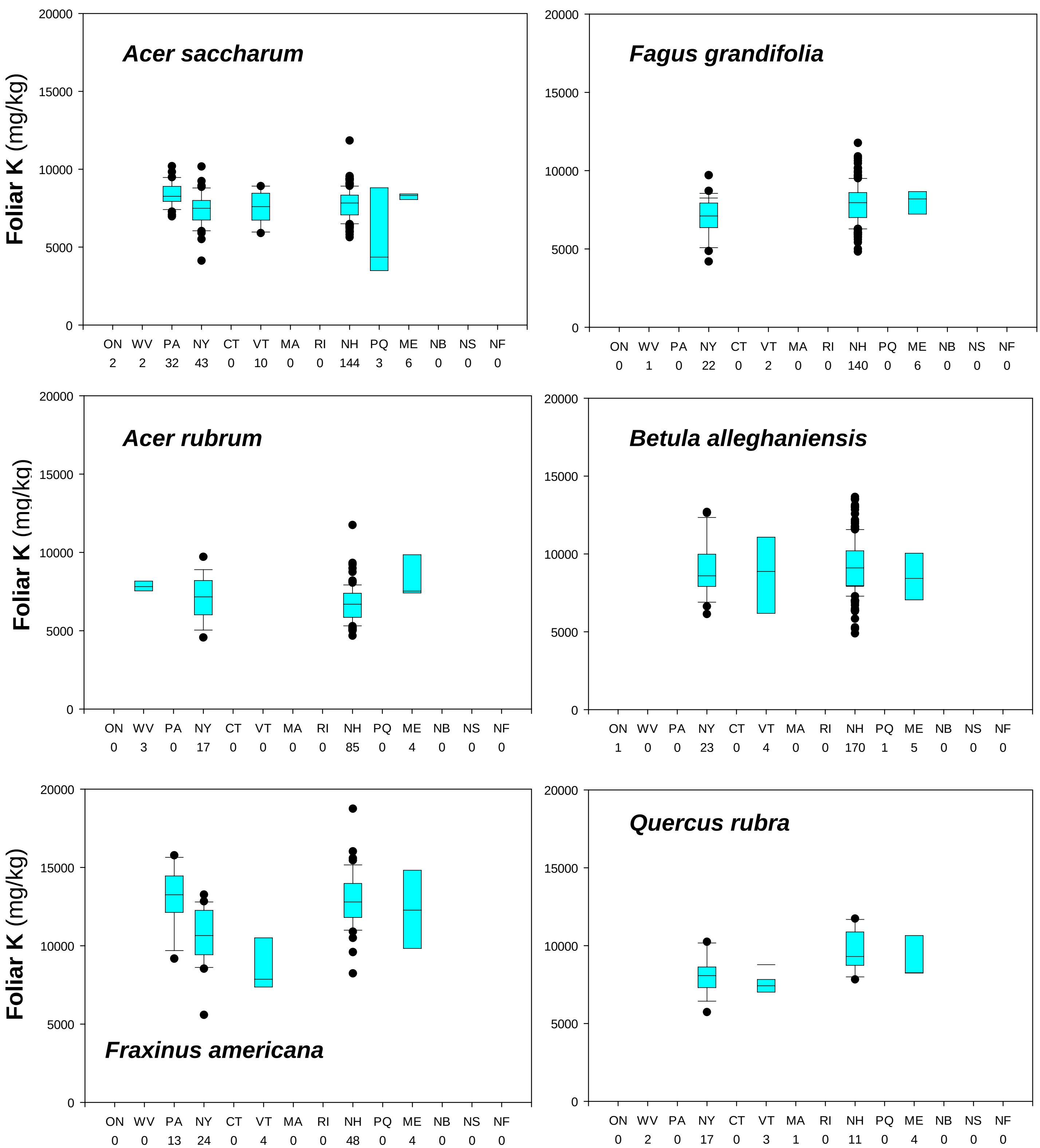


Figure 26. Boxplots for foliar potassium in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

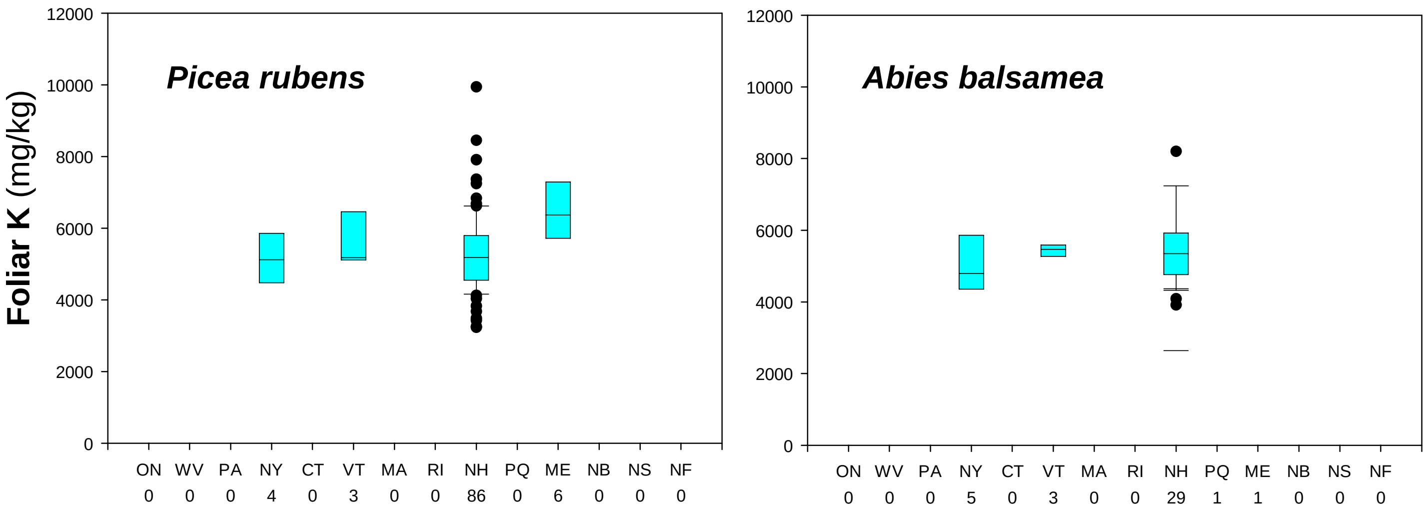


Figure 27. Boxplots for foliar phosphorus in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

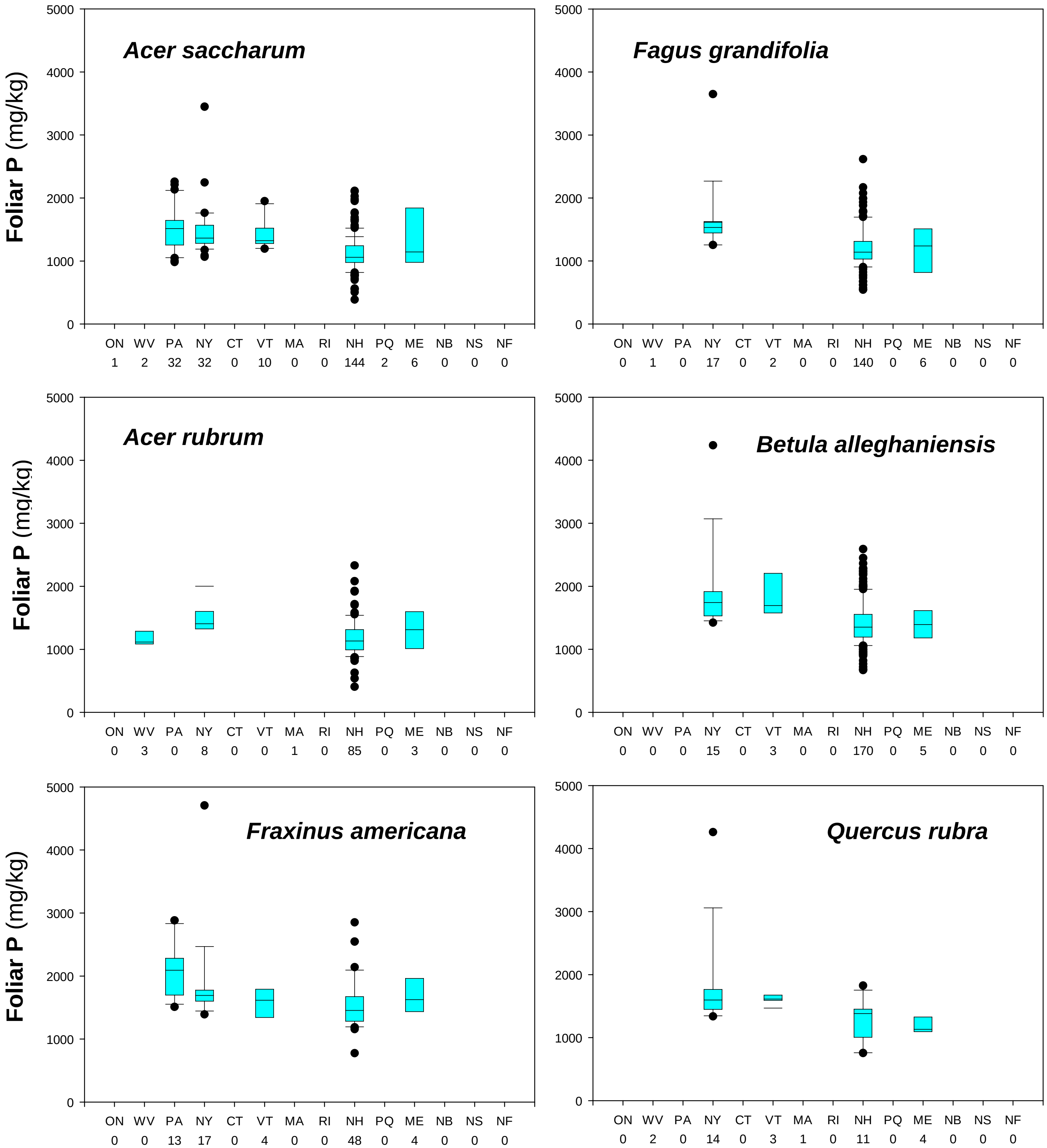


Figure 28. Boxplots for foliar phosphorus in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

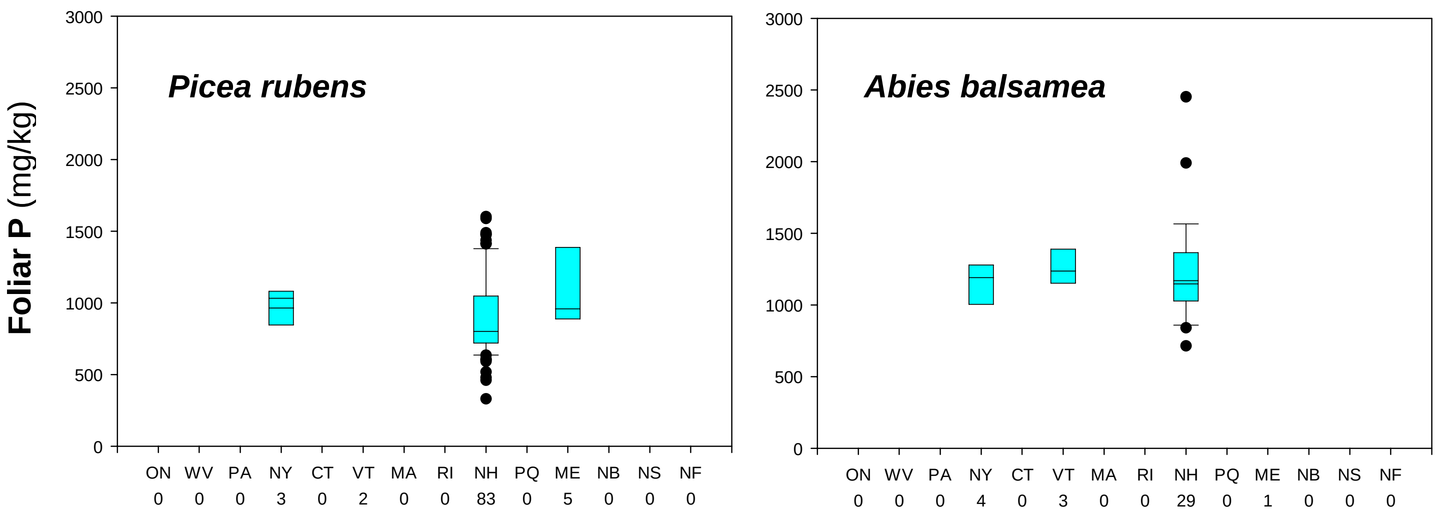


Figure 29. Boxplots for foliar aluminum in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot. Note that *Fraxinus americana* has a different Y-axis scale than the other species.

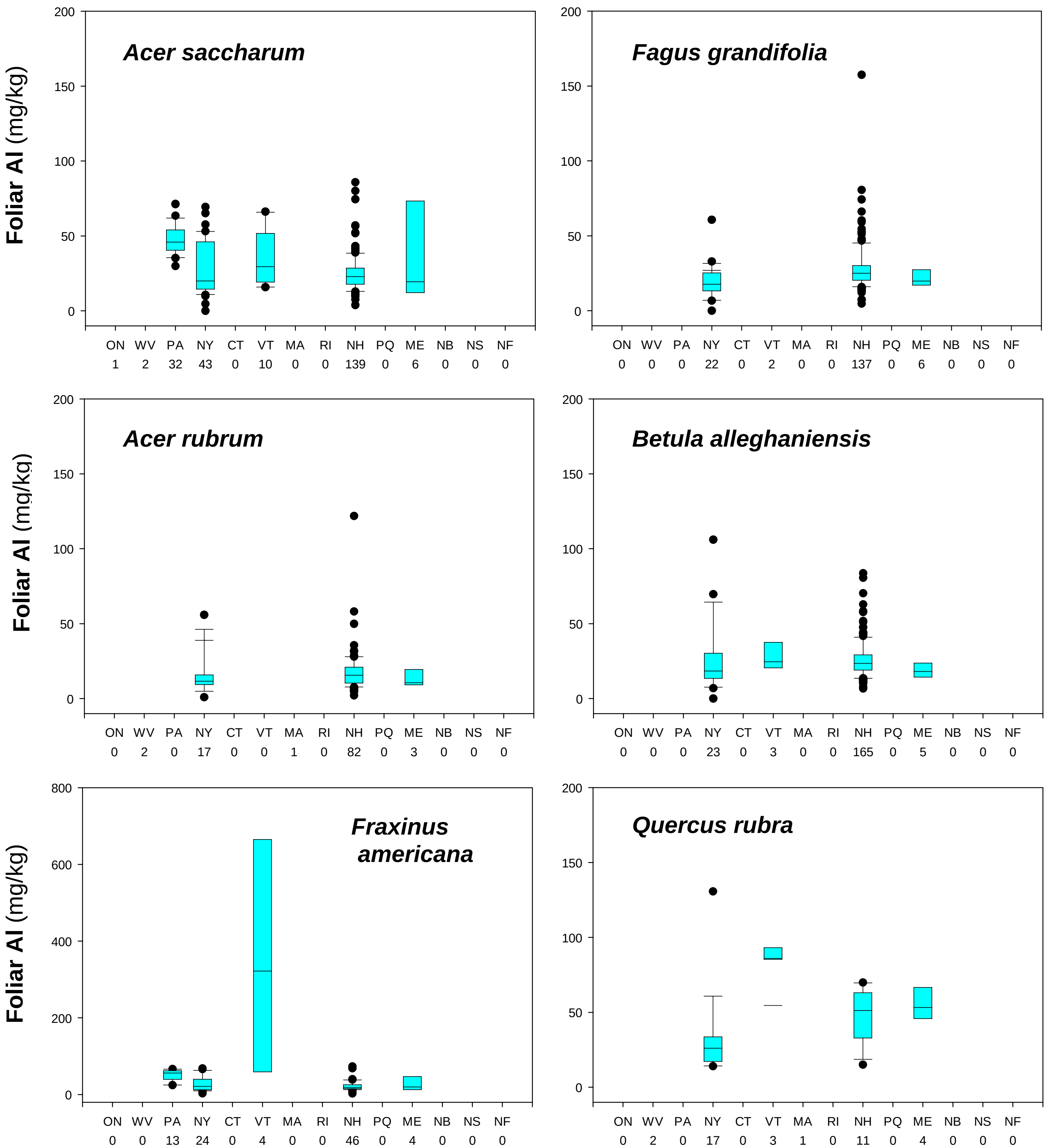


Figure 30. Boxplots for foliar aluminum in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot. Note the Y-axis scales are not the same.

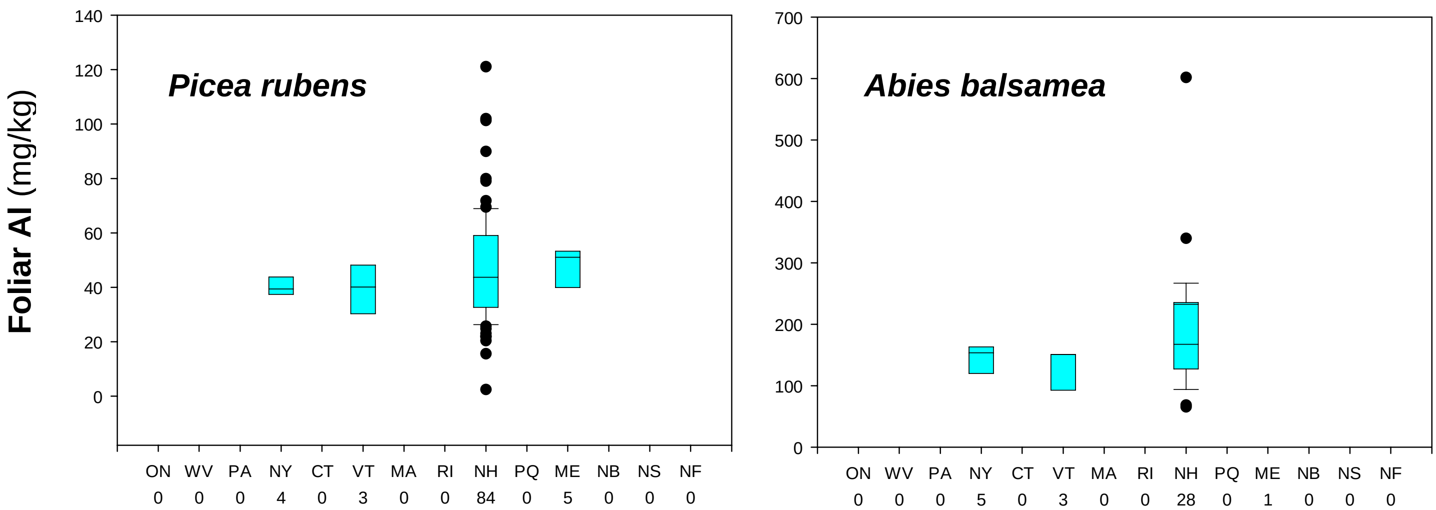


Figure 31. Boxplots for foliar manganese in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

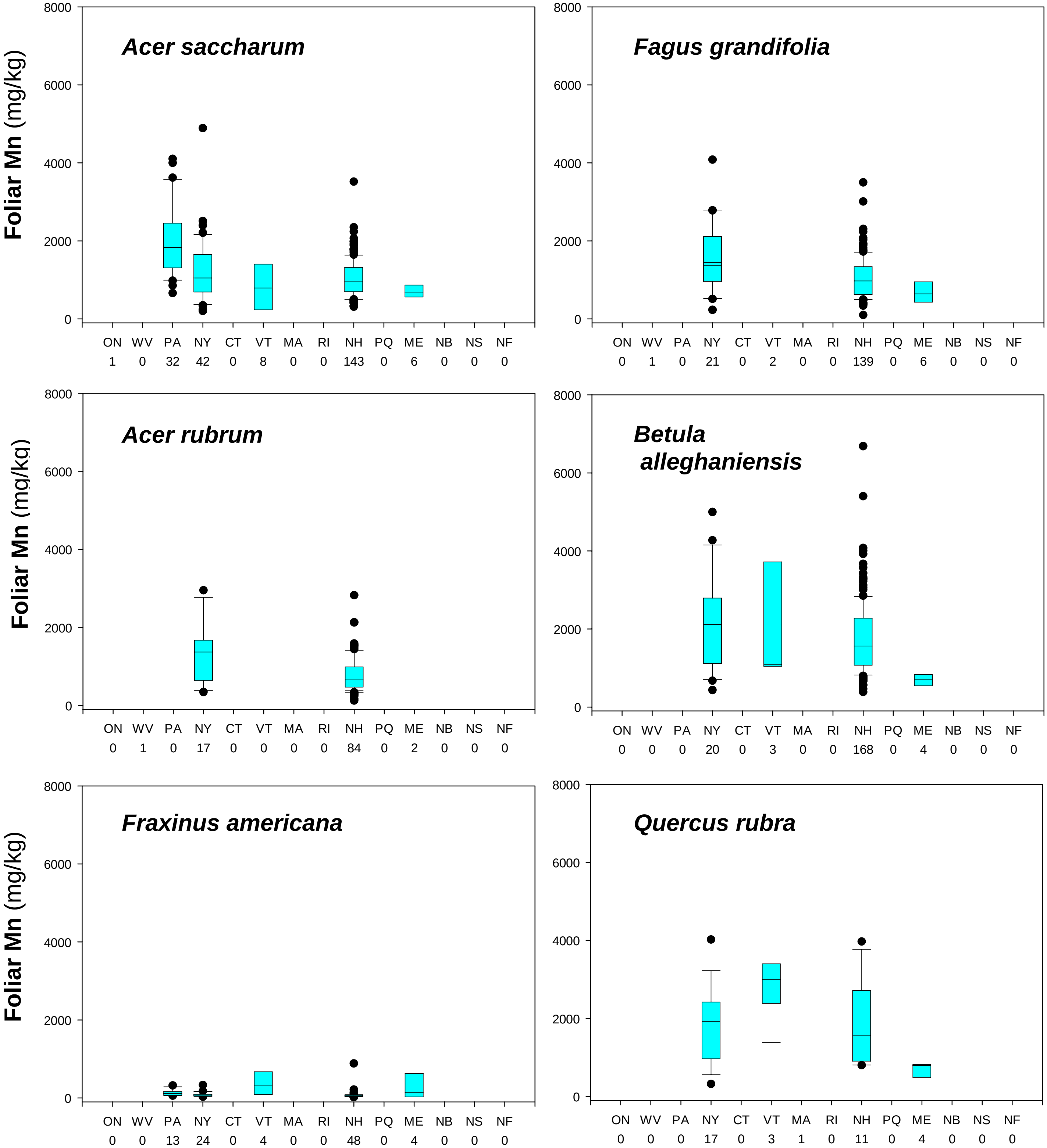


Figure 32. Boxplots for foliar manganese in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

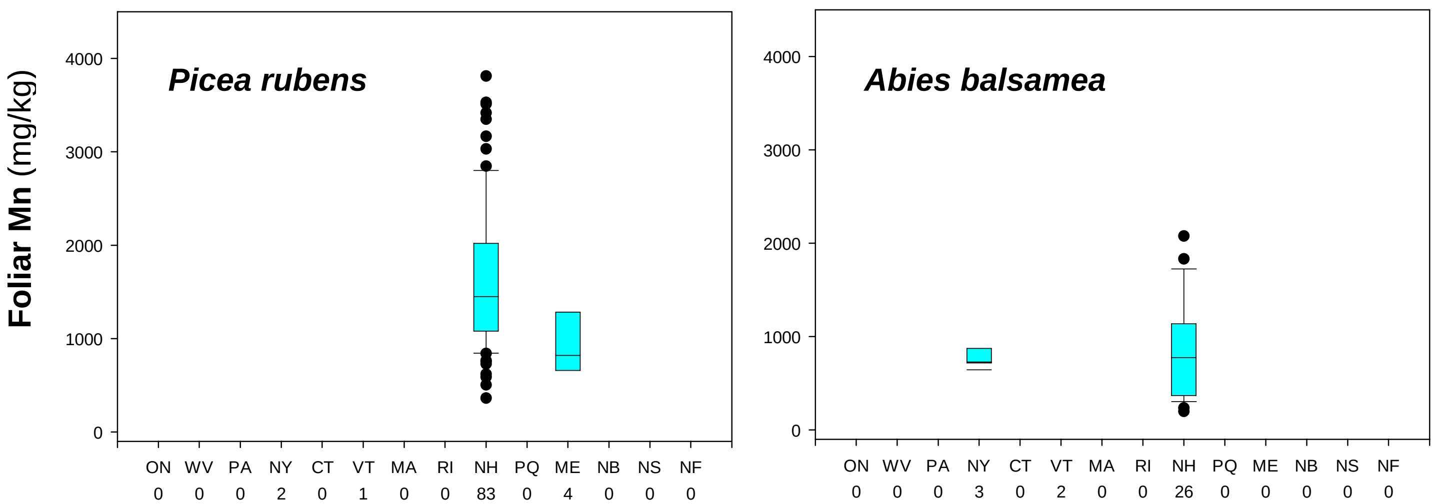


Figure 33. Boxplots for foliar strontium in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

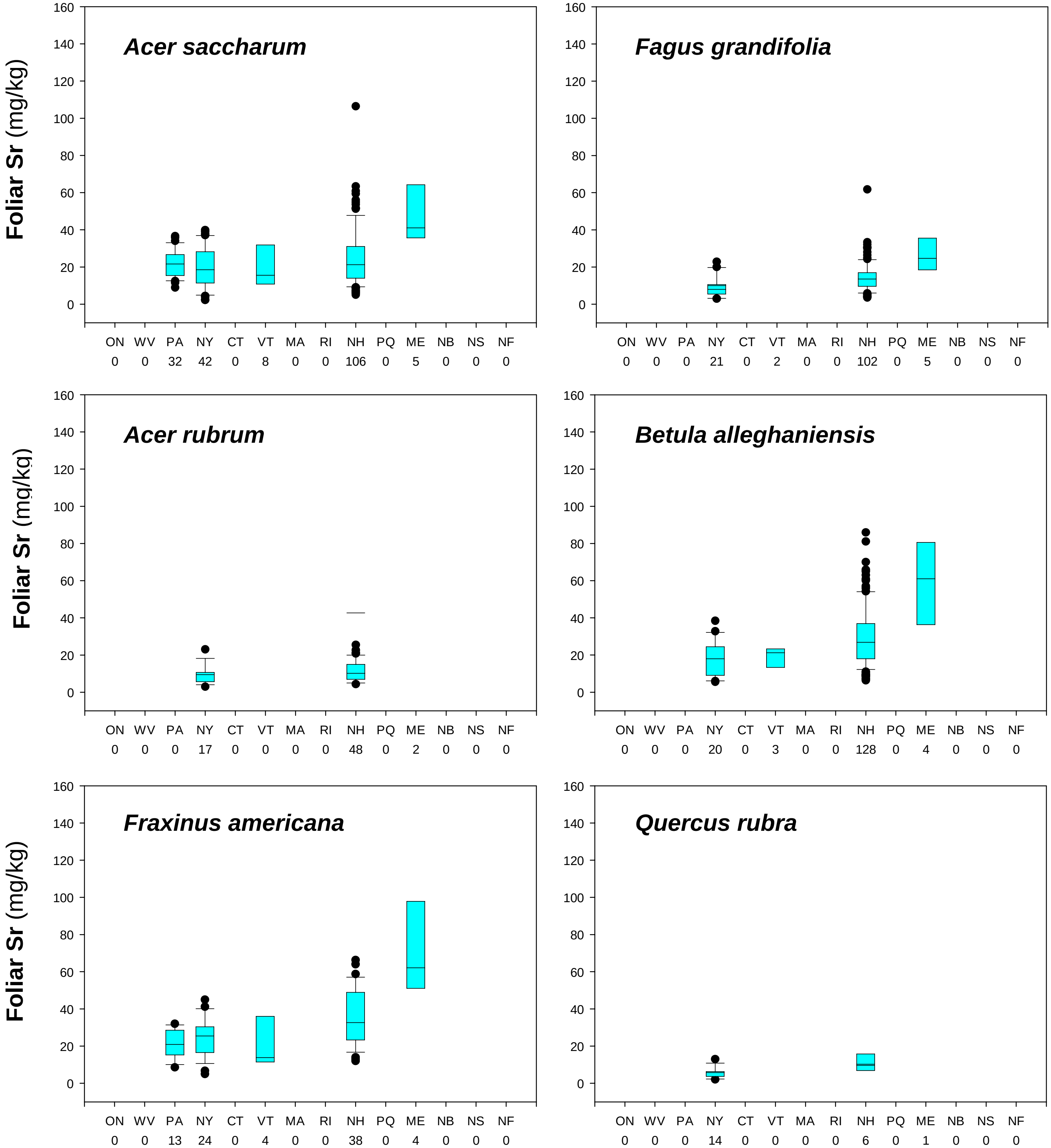


Figure 34. Boxplots for foliar strontium in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

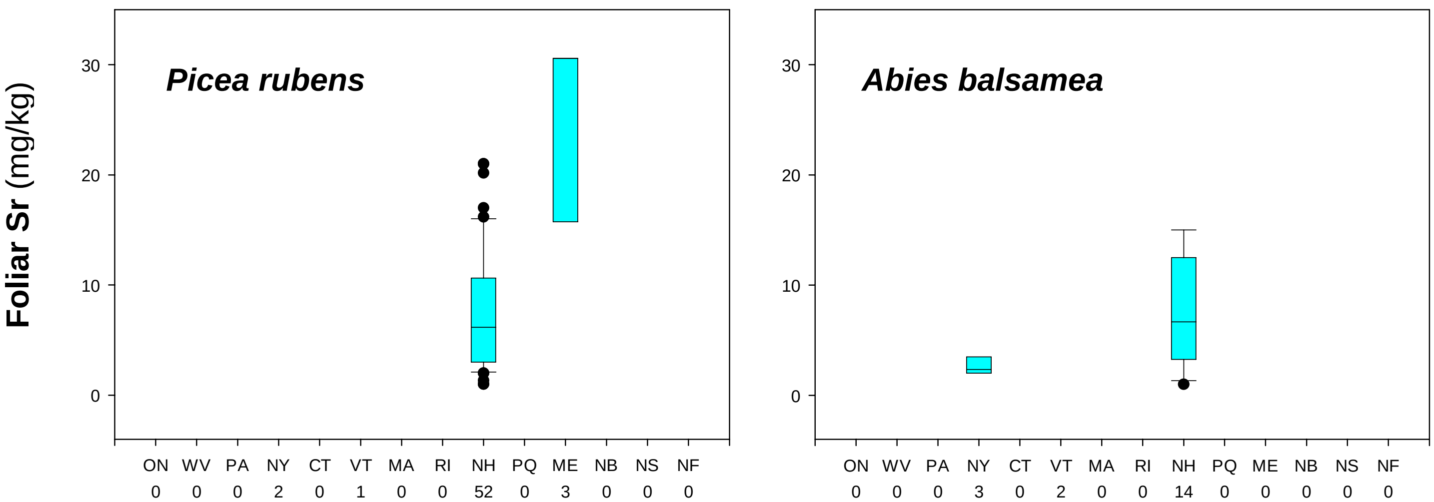


Figure 35. Boxplots for foliar cellulose in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

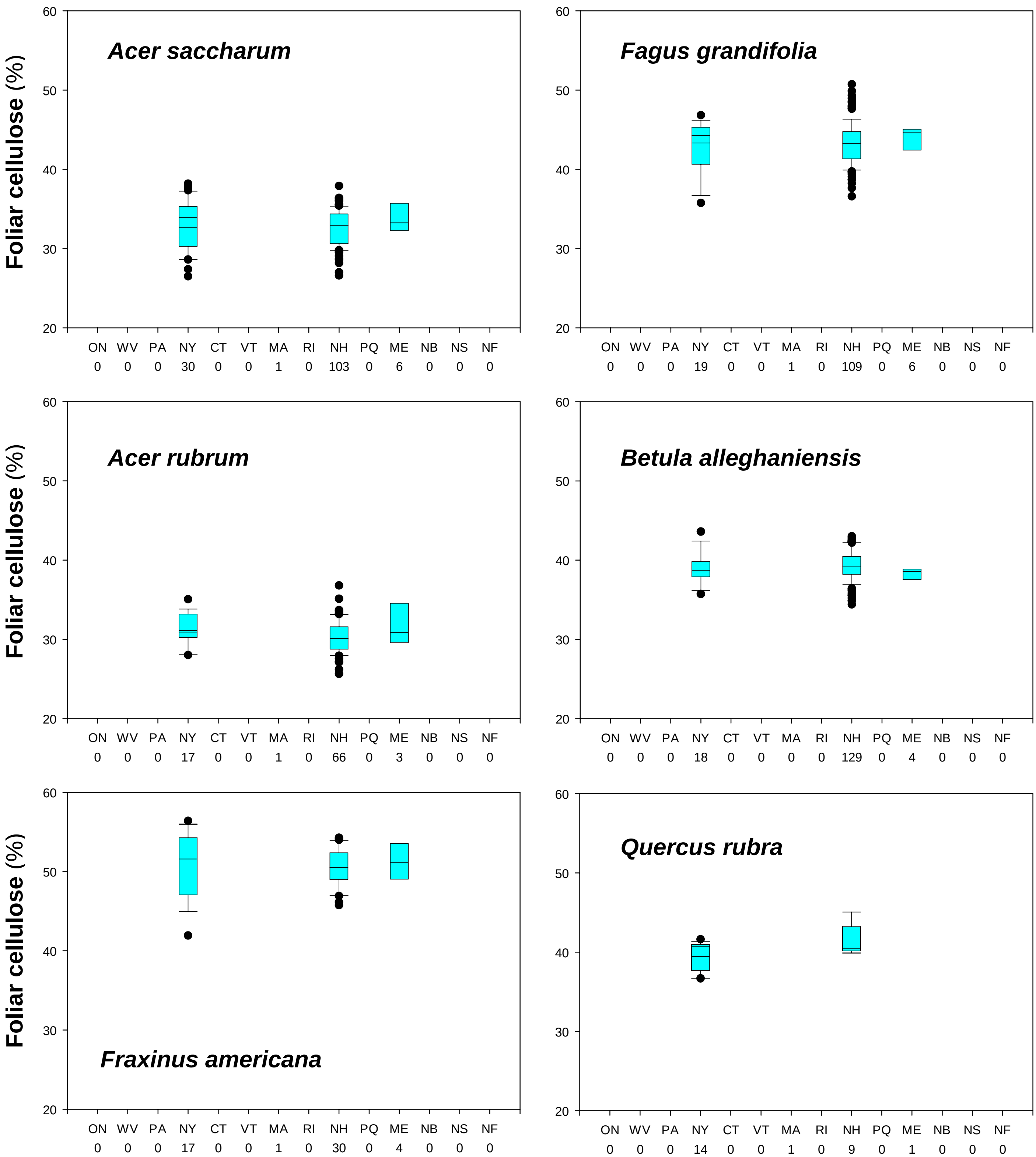


Figure 36. Boxplots for foliar cellulose in softwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

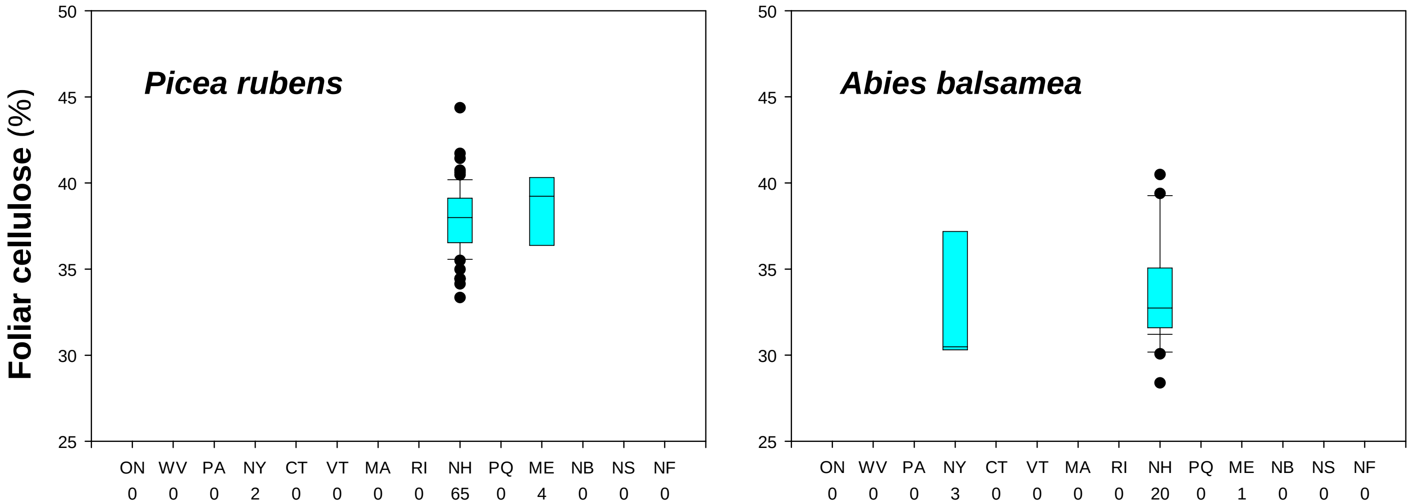


Figure 37. Boxplots for foliar lignin in hardwood species. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

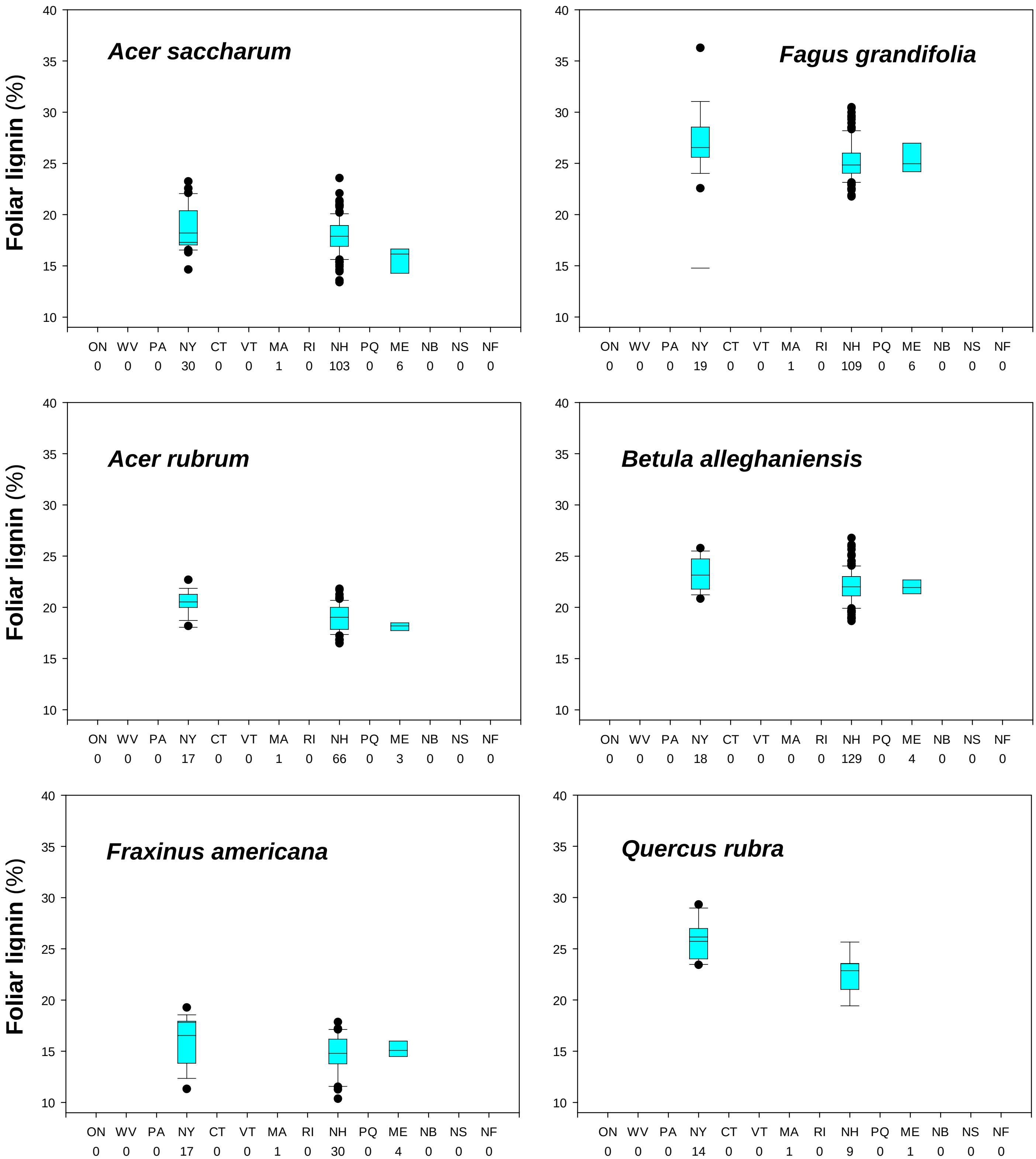
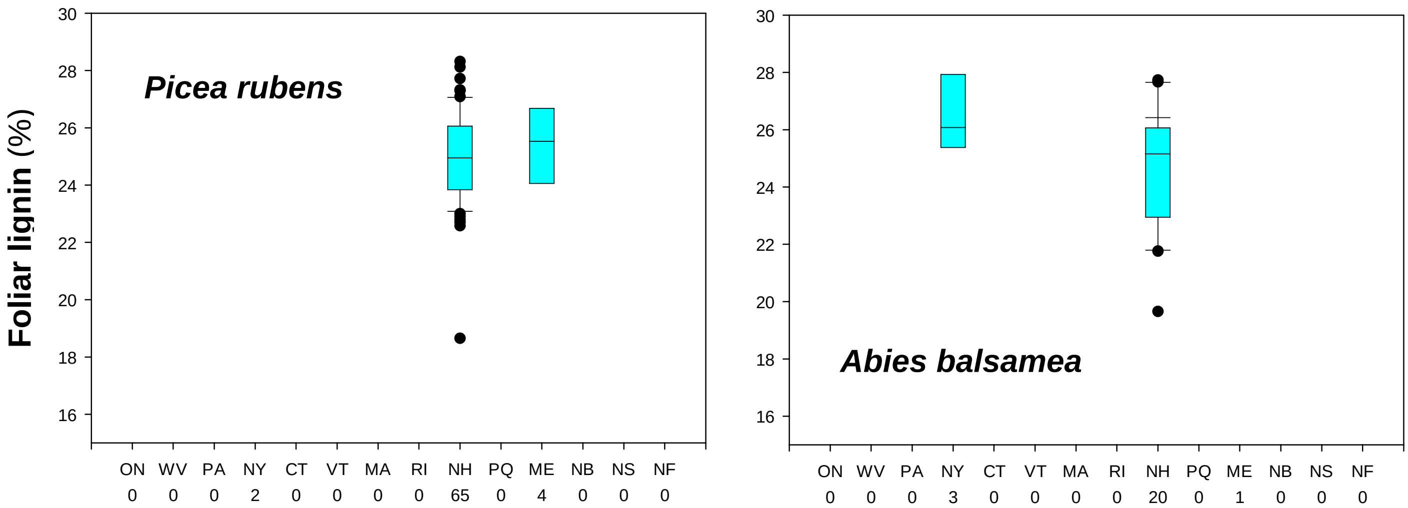
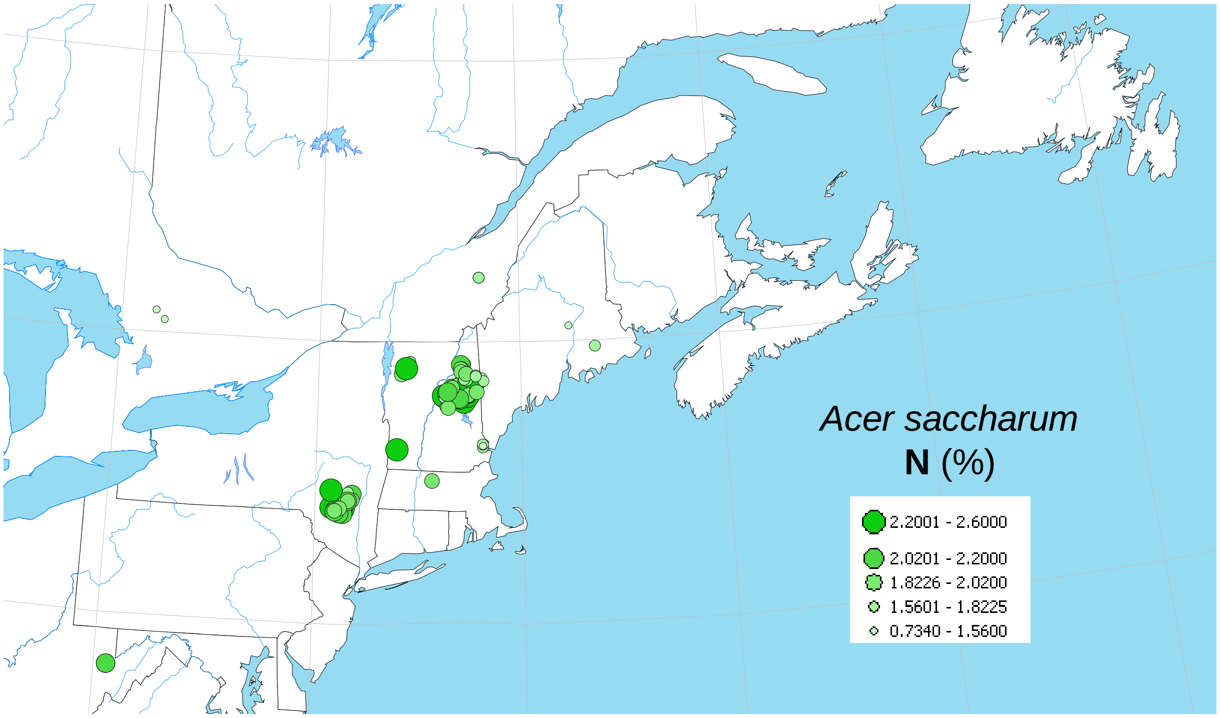


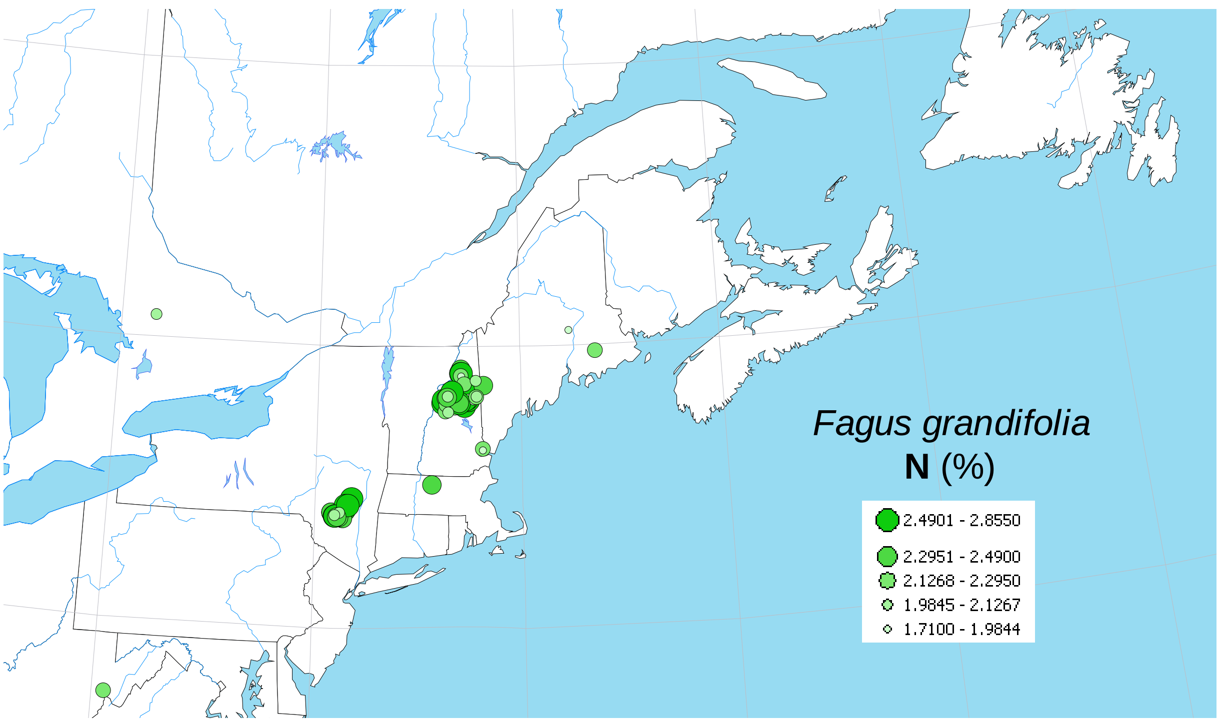
Figure 38. Boxplots for foliar lignin in softwood species. Box boundaries indicate 25^{th} and 75^{th} percentile, line in box indicates the median, whiskers represent 10^{th} and 90^{th} percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

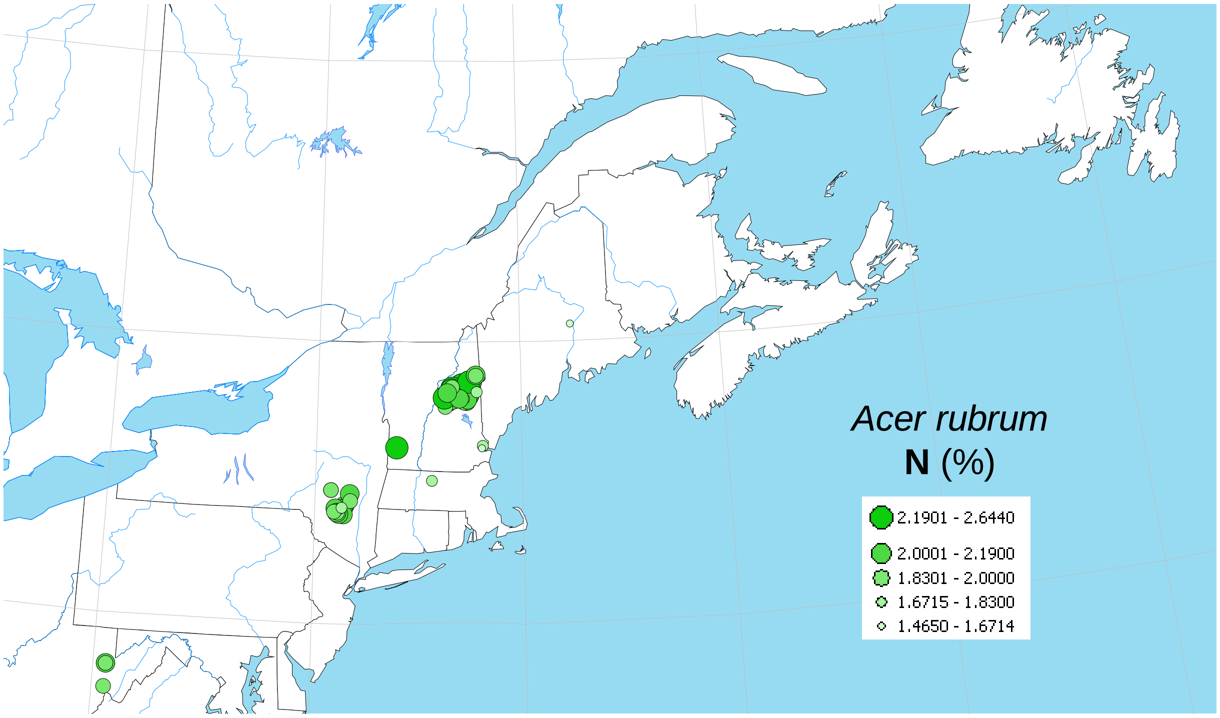


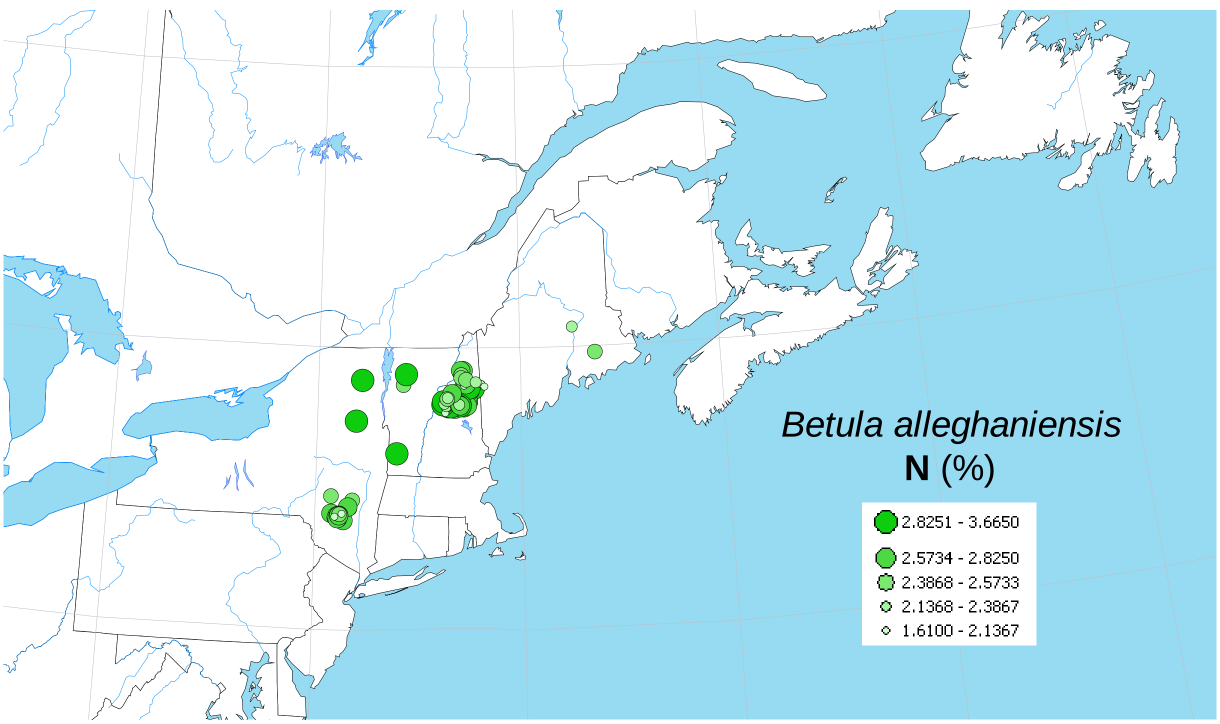
Appendix B-4: Foliar Chemistry Maps

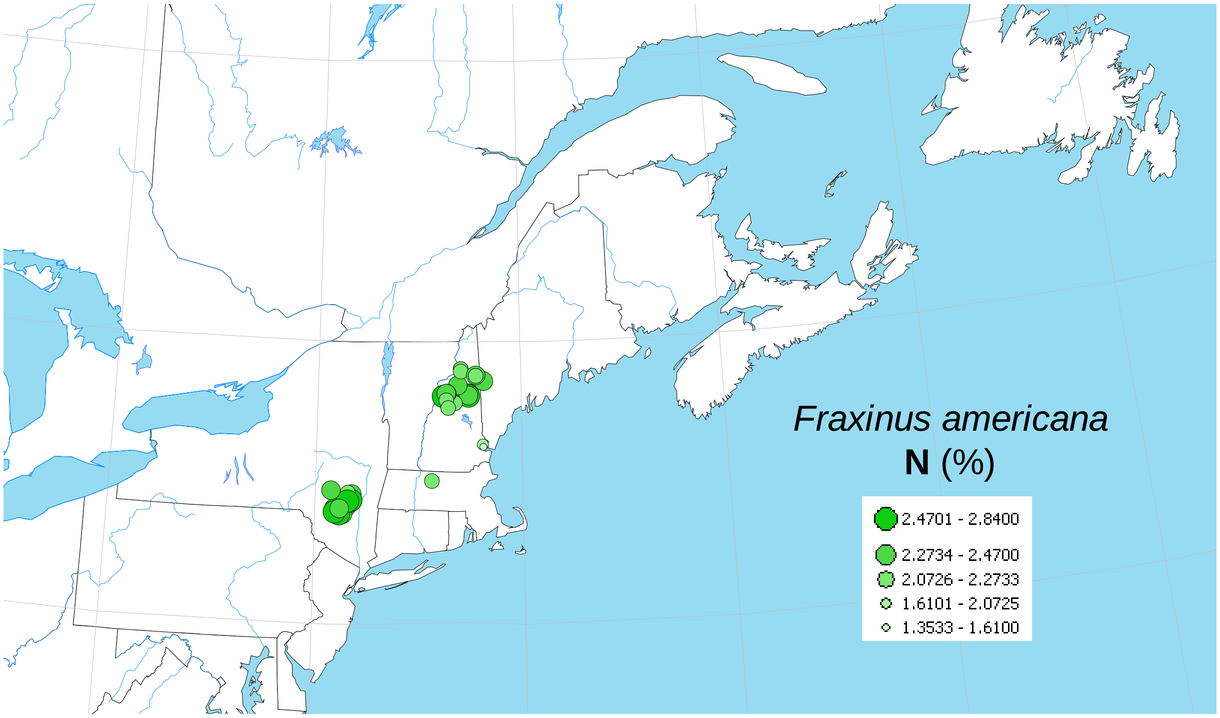
Figure 39. Maps for foliar nitrogen in hardwood species. (figure spans multiple pages)






Acer rubrum
N (%)
2.1901 - 2.6440
2.0001 - 2.1900
1.8301 - 2.0000
1.6715 - 1.8300
1.4650 - 1.6714


Betula alleghaniensis
N (%)
2.8251 - 3.6650
2.5734 - 2.8250
2.3868 - 2.5733
2.1368 - 2.3867
1.6100 - 2.1367


Fraxinus americana
N (%)
2.4701 - 2.8400
2.2734 - 2.4700
2.0726 - 2.2733
1.6101 - 2.0725
1.3533 - 1.6100

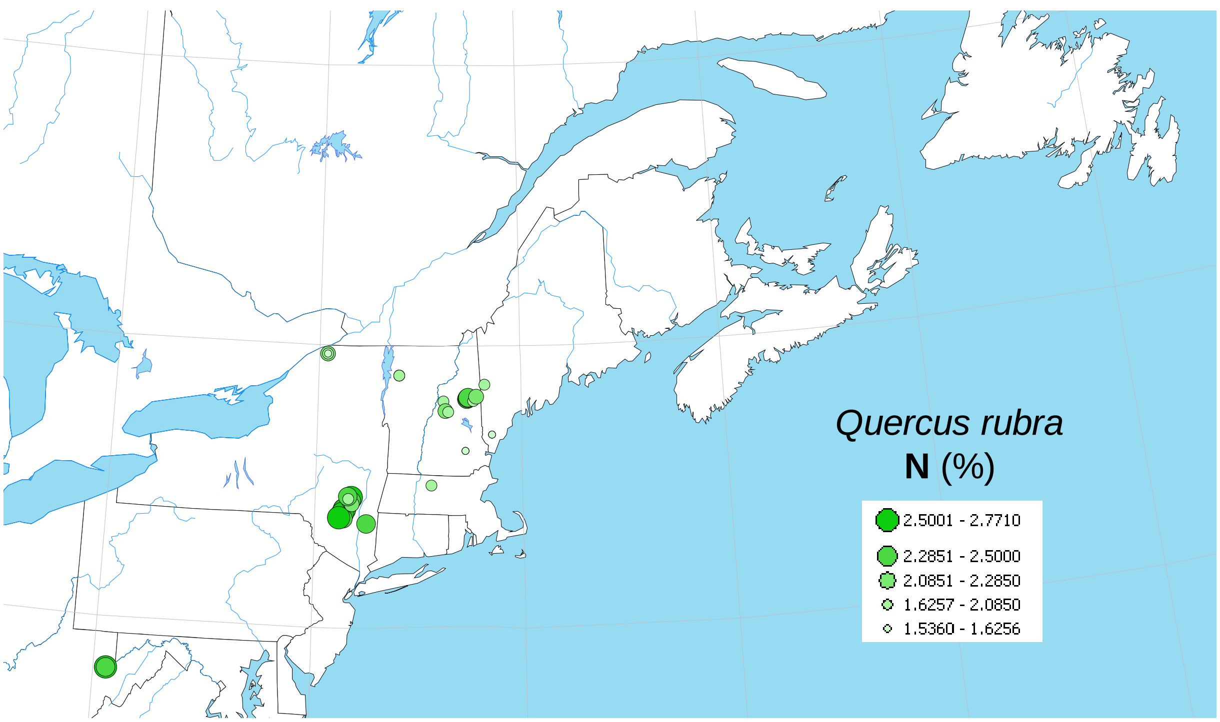
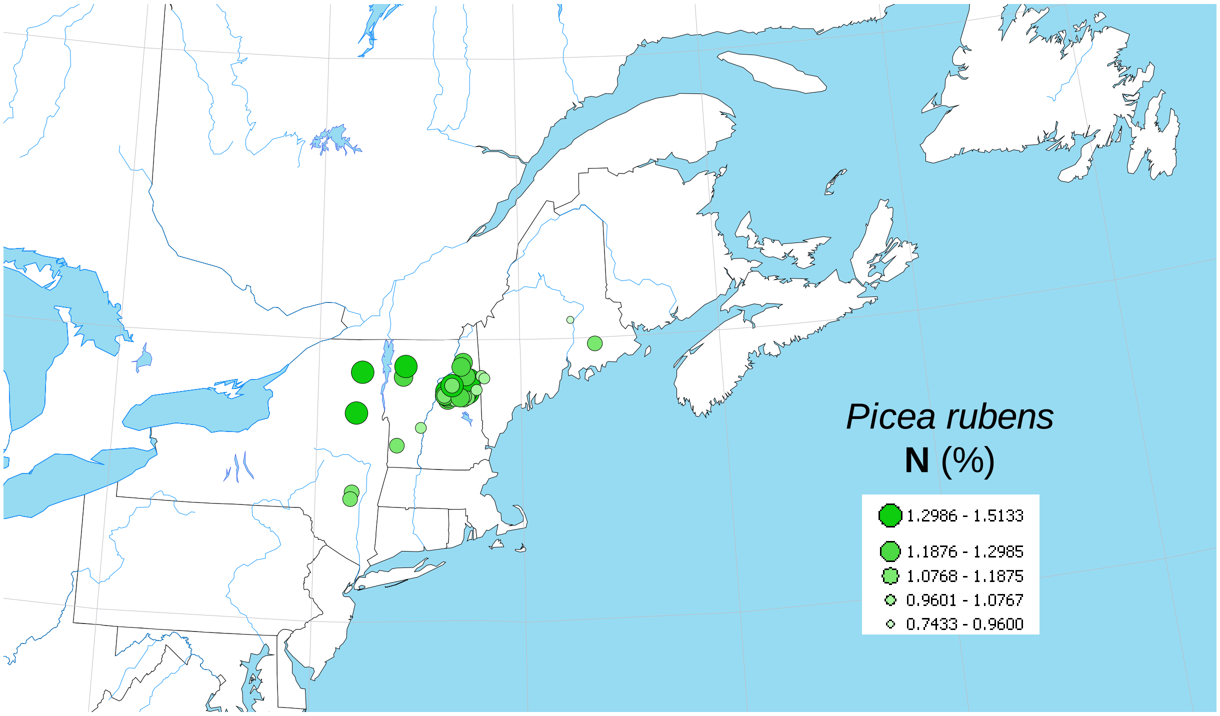

Quercus rubra
N (%)
2.5001 - 2.7710
2.2851 - 2.5000
2.0851 - 2.2850
1.6257 - 2.0850
1.5360 - 1.6256

Figure 40. Maps for foliar nitrogen in softwood species.



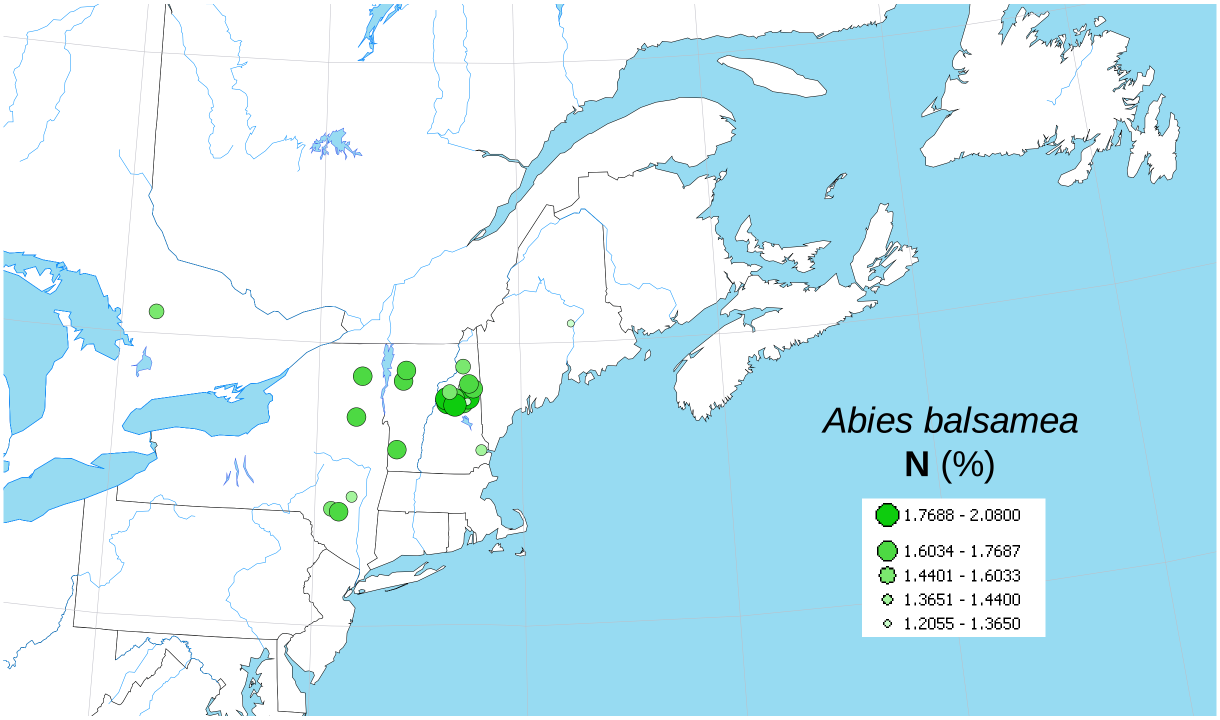
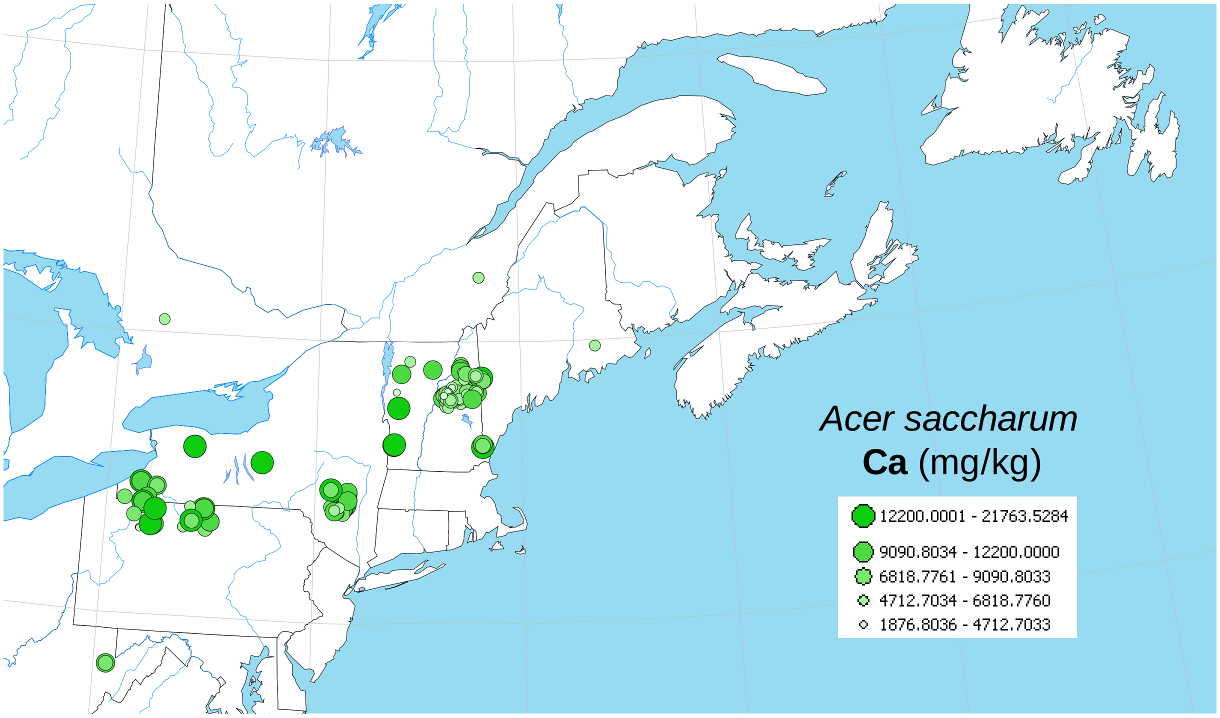
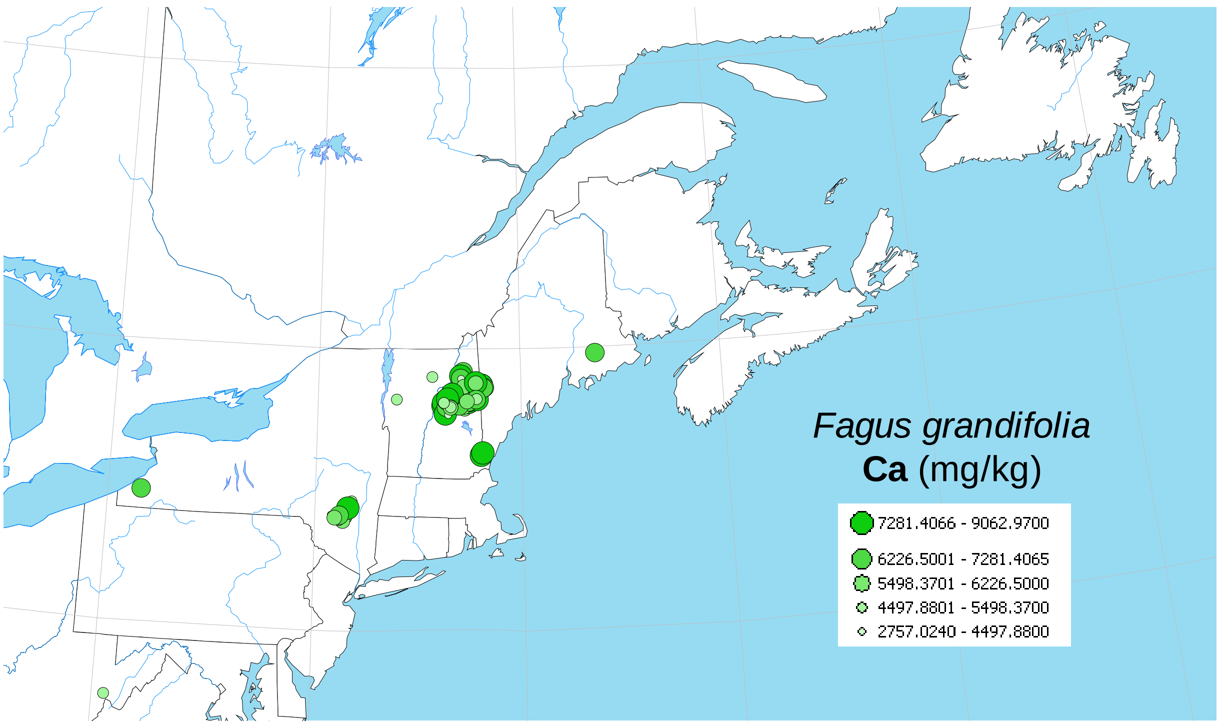
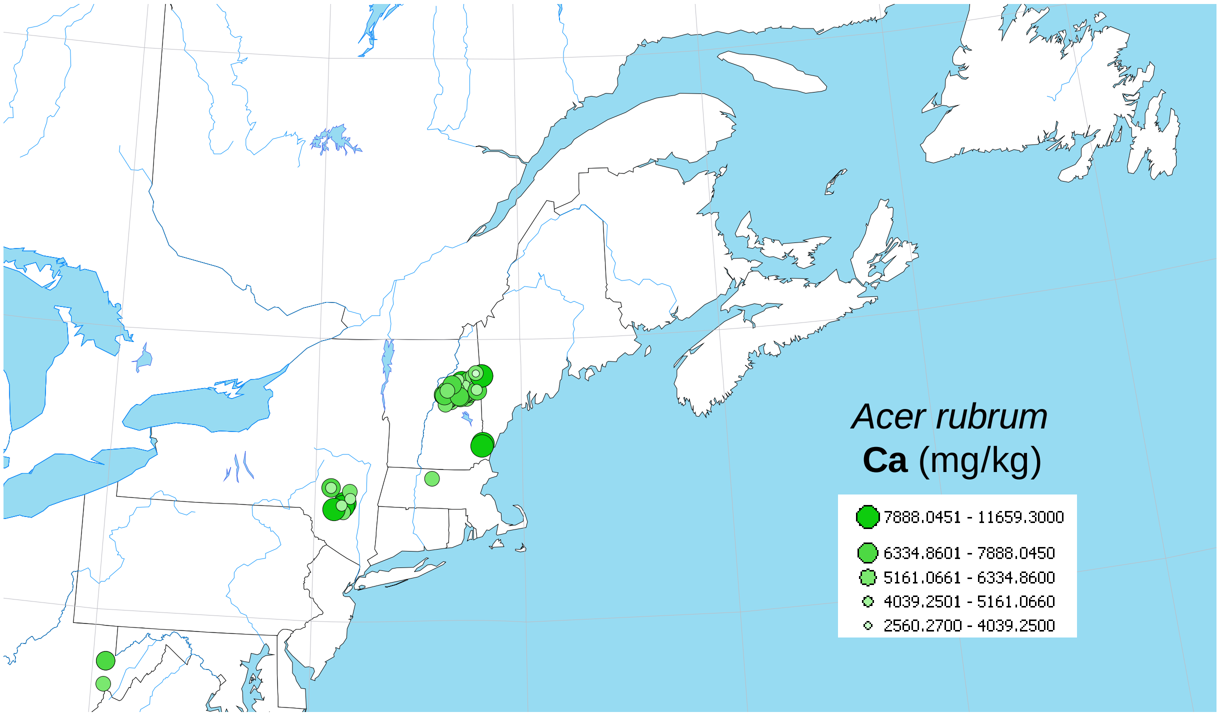
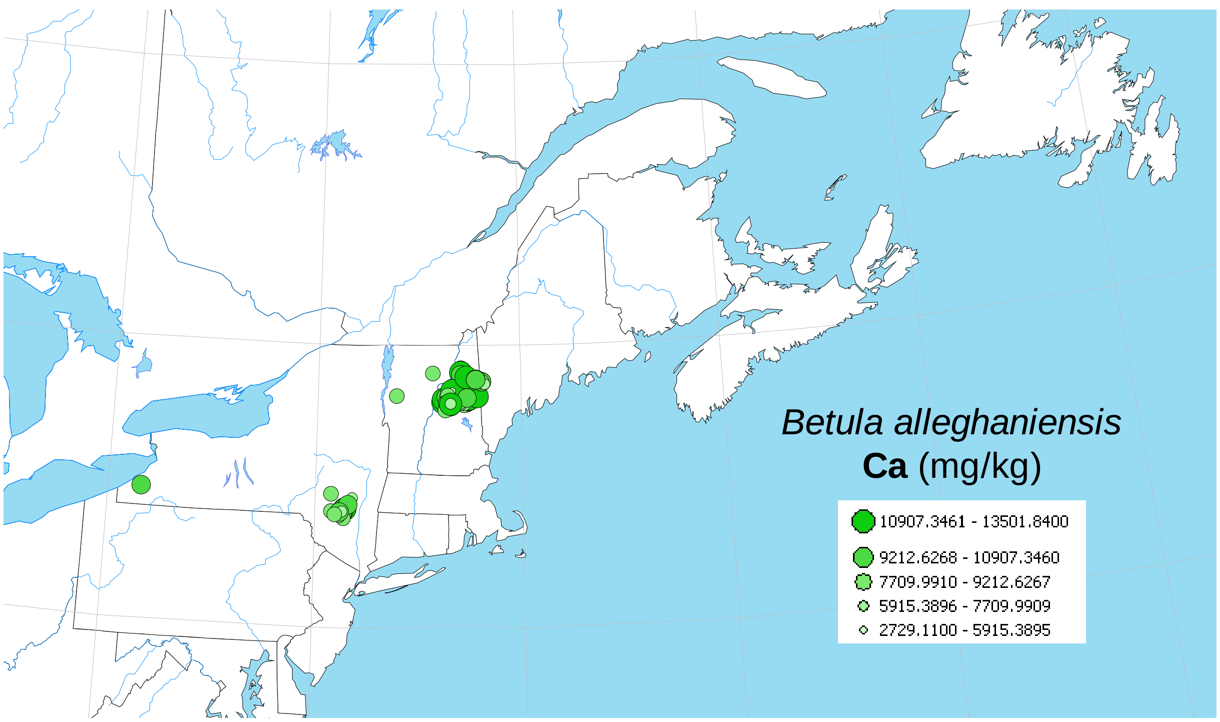


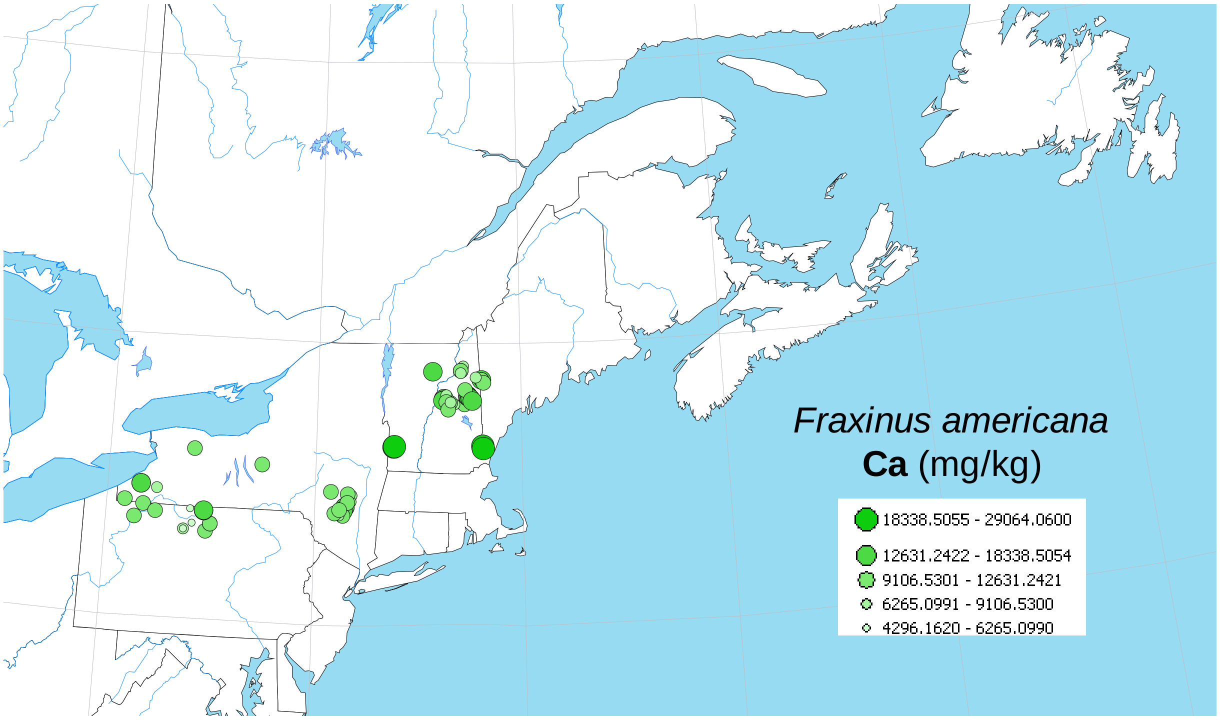
Figure 41. Maps for foliar calcium in hardwood species. (figure spans multiple pages)



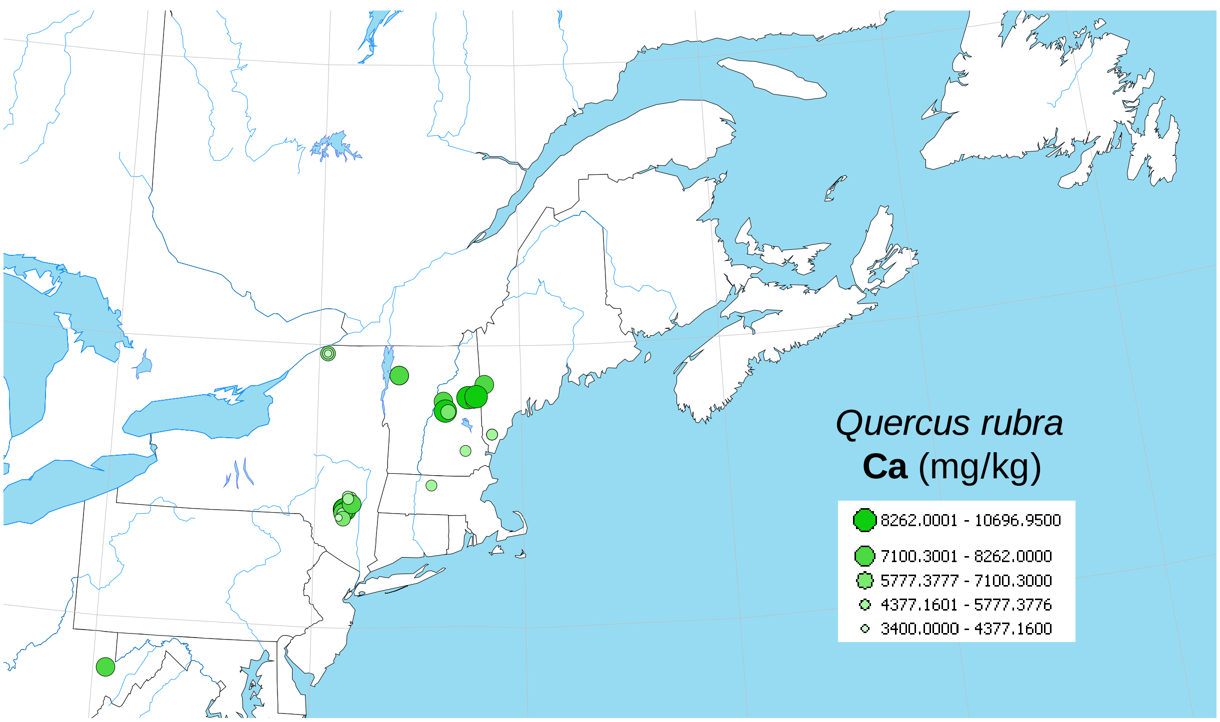



Acer rubrum
Ca (mg/kg)
7888.0451 - 11659.3000
6334.8601 - 7888.0450
5161.0661 - 6334.8600
4039.2501 - 5161.0660
2560.2700 - 4039.2500


Betula alleghaniensis
Ca (mg/kg)
10907.3461 - 13501.8400
9212.6268 - 10907.3460
7709.9910 - 9212.6267
5915.3896 - 7709.9909
2729.1100 - 5915.3895

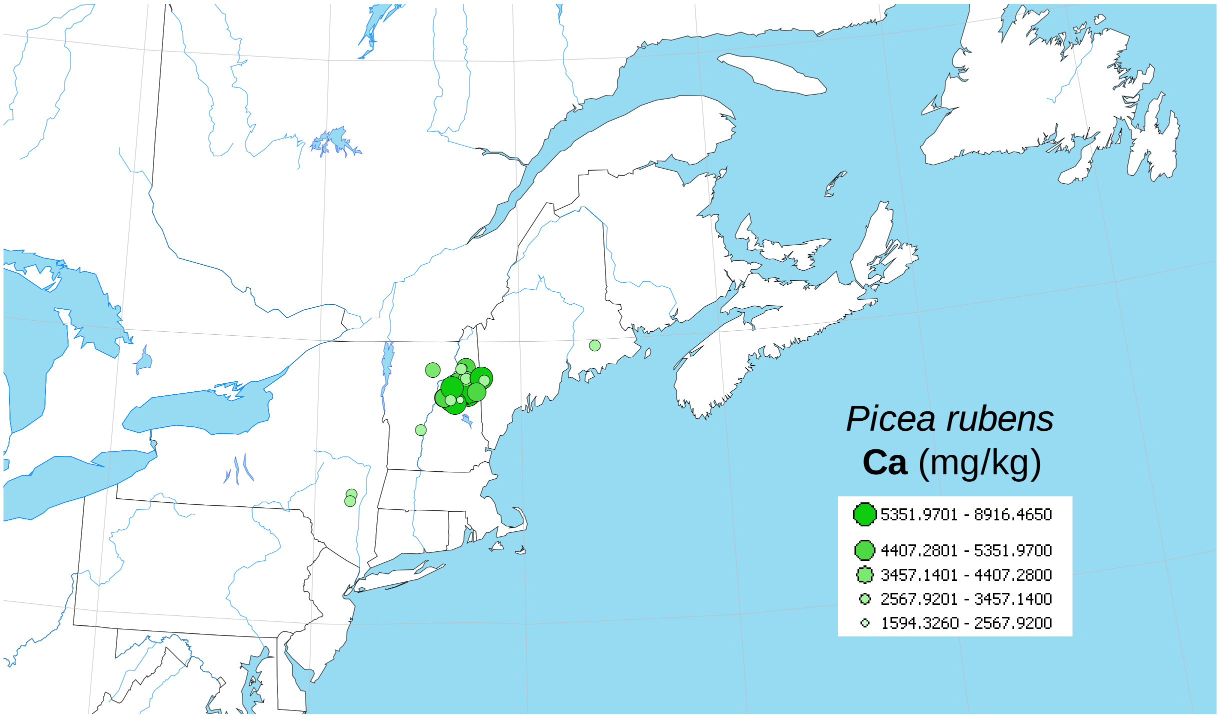


Fraxinus americana
Ca (mg/kg)
18338.5055 - 29064.0600
12631.2422 - 18338.5054
9106.5301 - 12631.2421
6265.0991 - 9106.5300
4296.1620 - 6265.0990



Quercus rubra
Ca (mg/kg)
8262.0001 - 10696.9500
7100.3001 - 8262.0000
5777.3777 - 7100.3000
4377.1601 - 5777.3776
3400.0000 - 4377.1600

Figure 42. Maps for foliar calcium in softwood species.



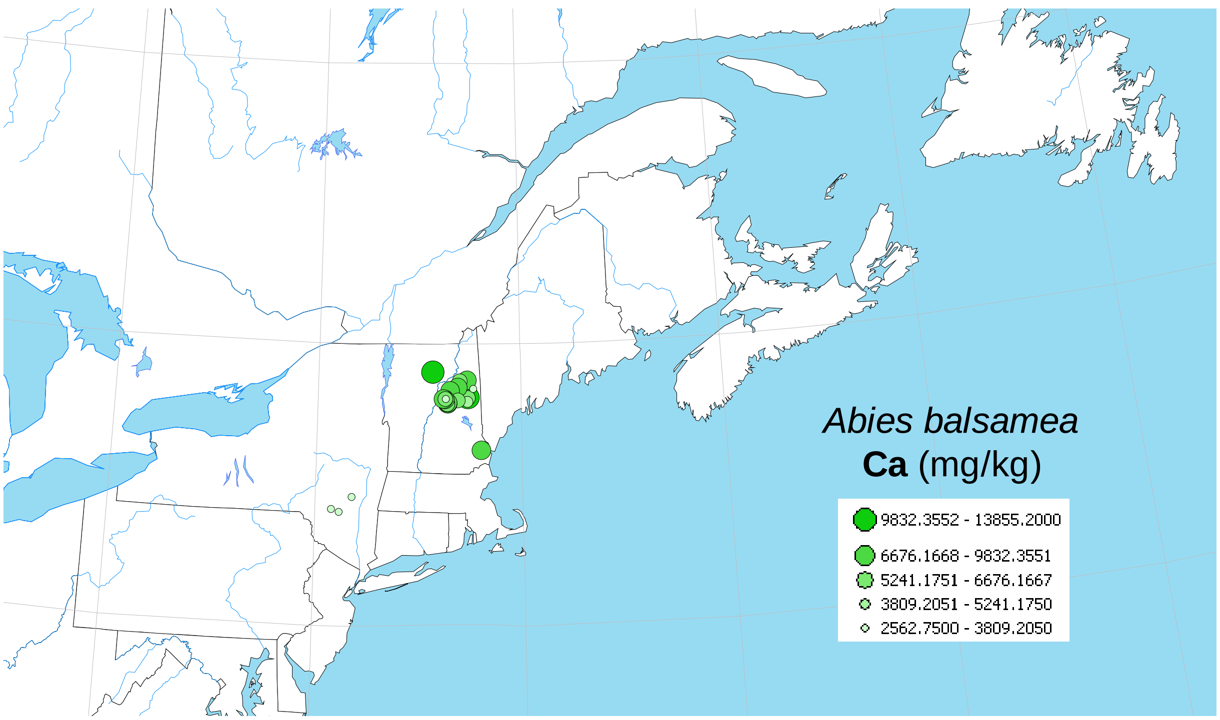
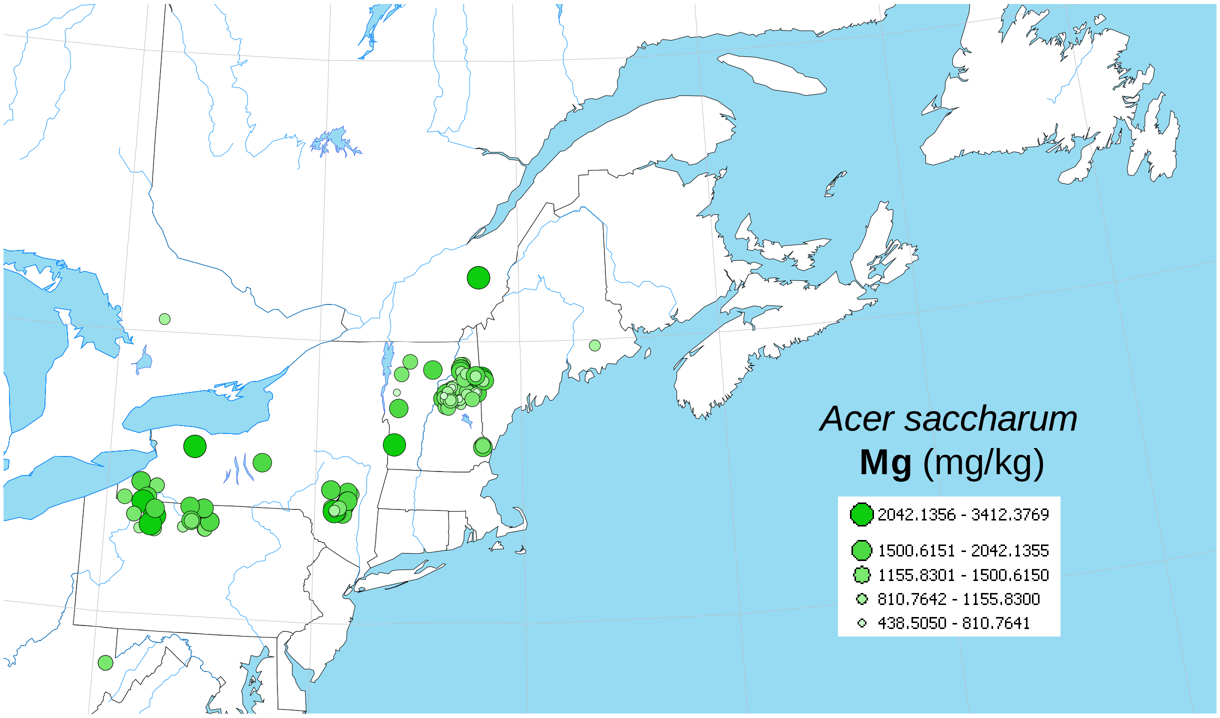
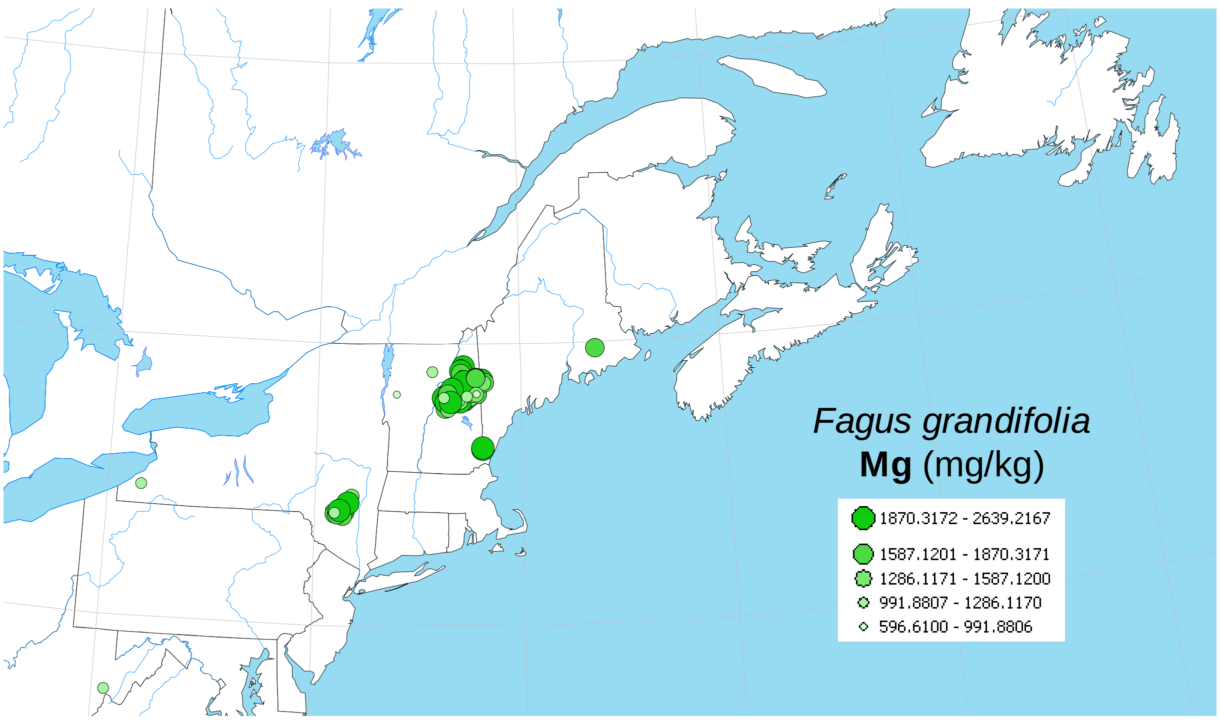
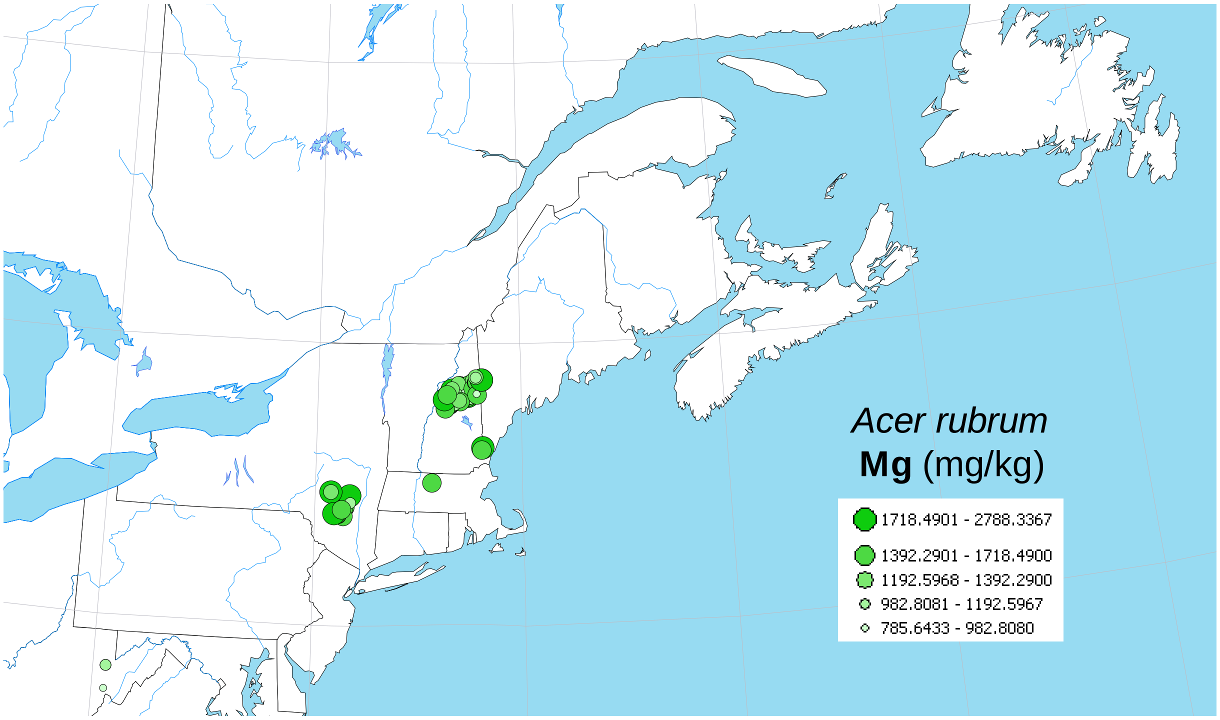
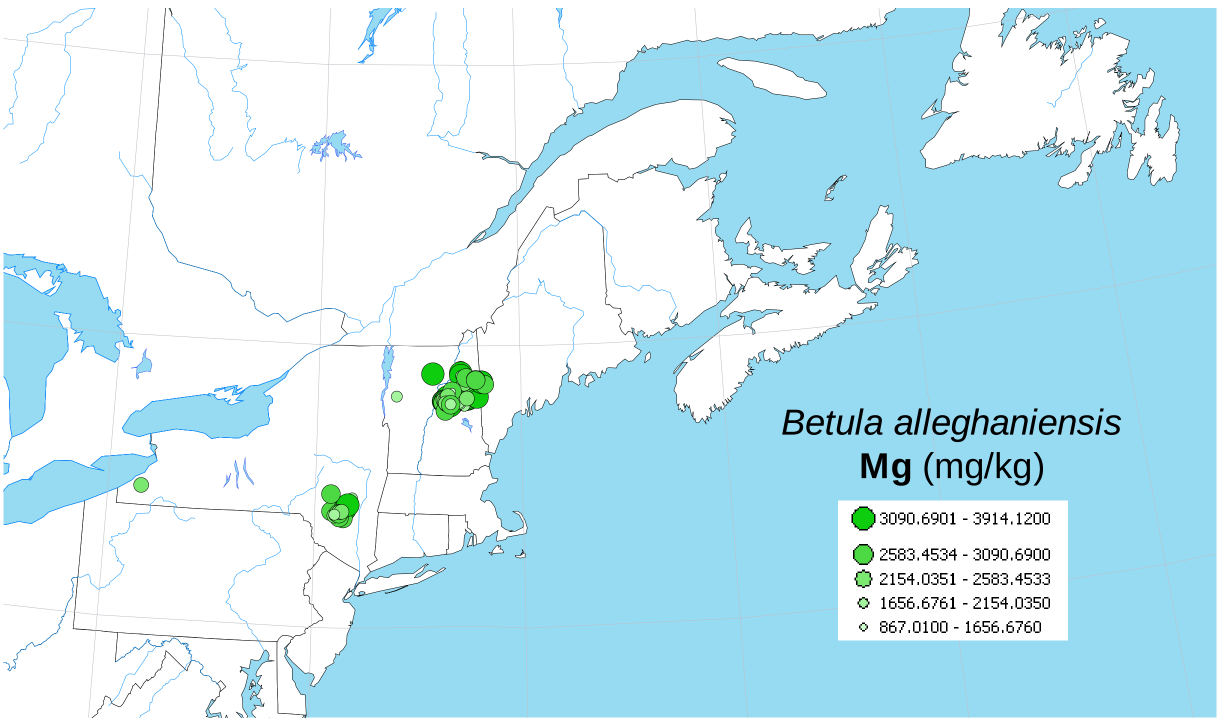


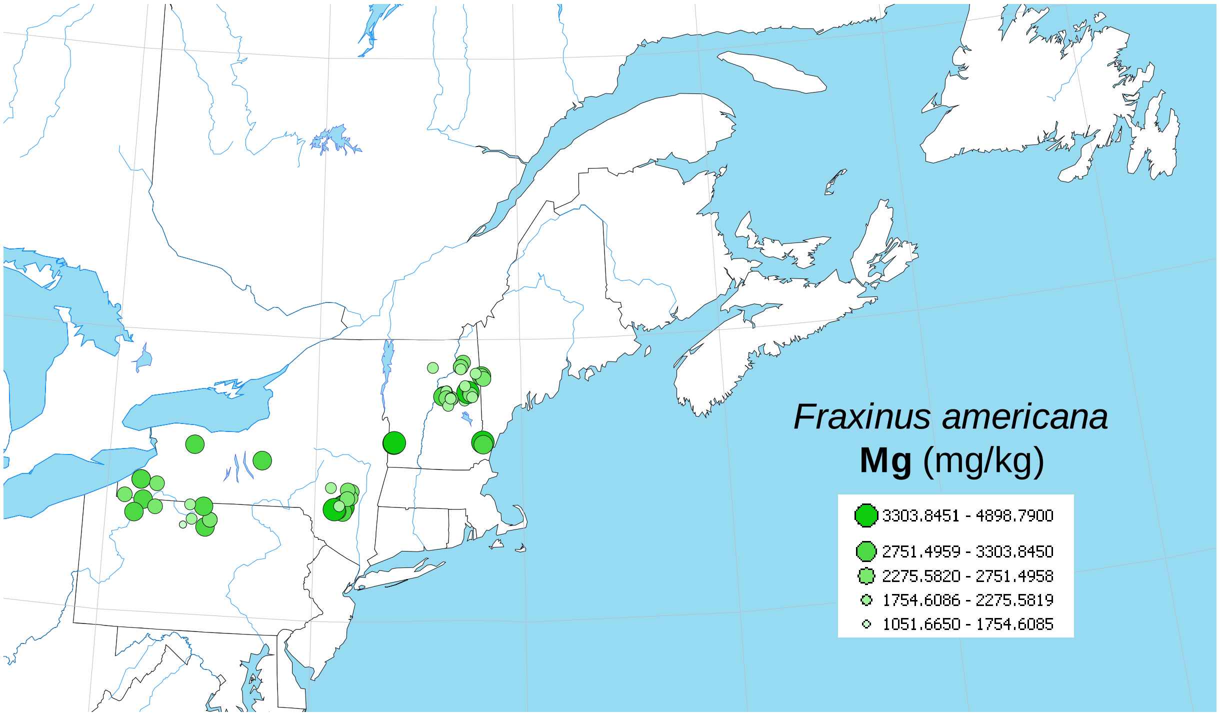
Figure 43. Maps for foliar magnesium in hardwood species. (figure spans multiple pages)






Acer rubrum
Mg (mg/kg)
1718.4901 - 2788.3367
1392.2901 - 1718.4900
1192.5968 - 1392.2900
982.8081 - 1192.5967
785.6433 - 982.8080


Betula alleghaniensis
Mg (mg/kg)
3090.6901 - 3914.1200
2583.4534 - 3090.6900
2154.0351 - 2583.4533
1656.6761 - 2154.0350
867.0100 - 1656.6760


Fraxinus americana
Mg (mg/kg)
3303.8451 - 4898.7900
2751.4959 - 3303.8450
2275.5820 - 2751.4958
1754.6086 - 2275.5819
1051.6650 - 1754.6085

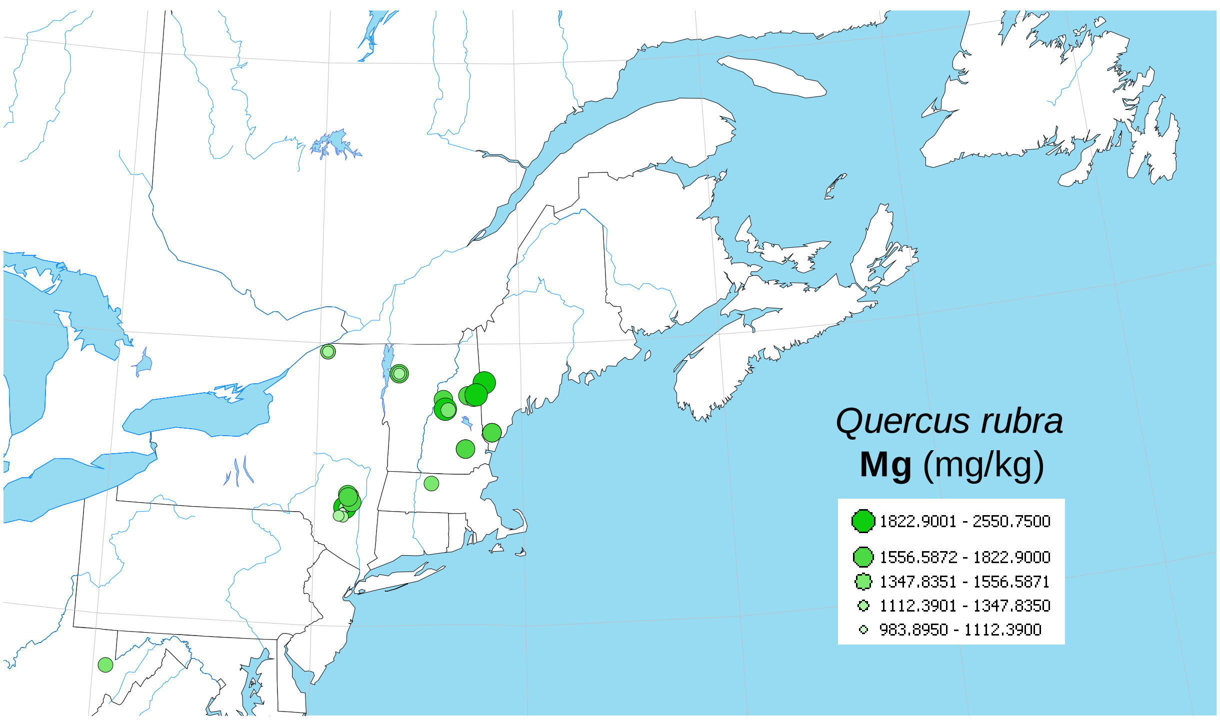
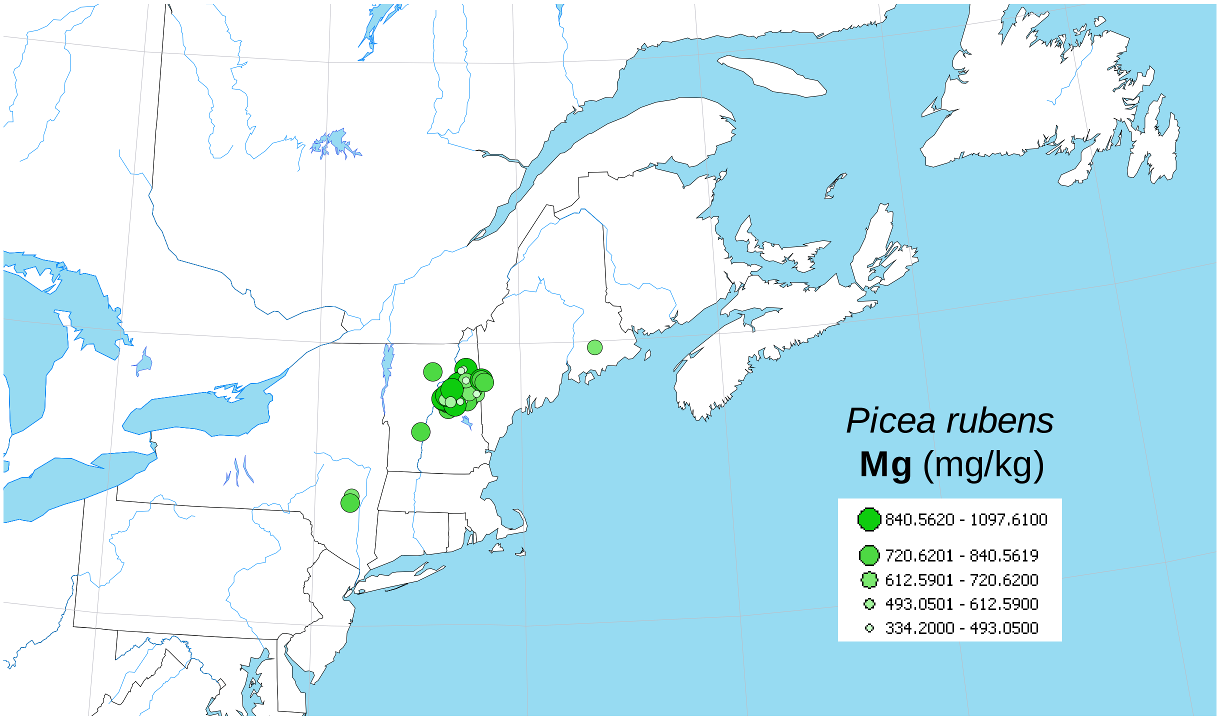

Quercus rubra
Mg (mg/kg)
1822.9001 - 2550.7500
1556.5872 - 1822.9000
1347.8351 - 1556.5871
1112.3901 - 1347.8350
983.8950 - 1112.3900

Figure 44. Maps for foliar magnesium in softwood species.



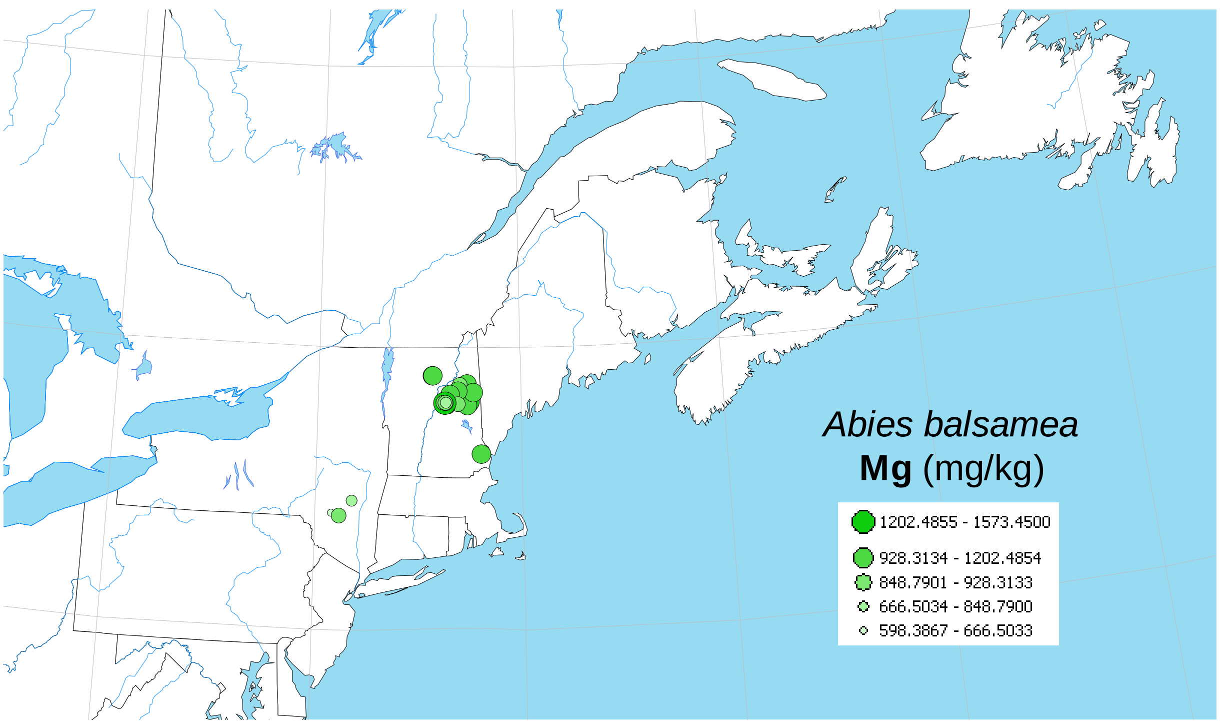
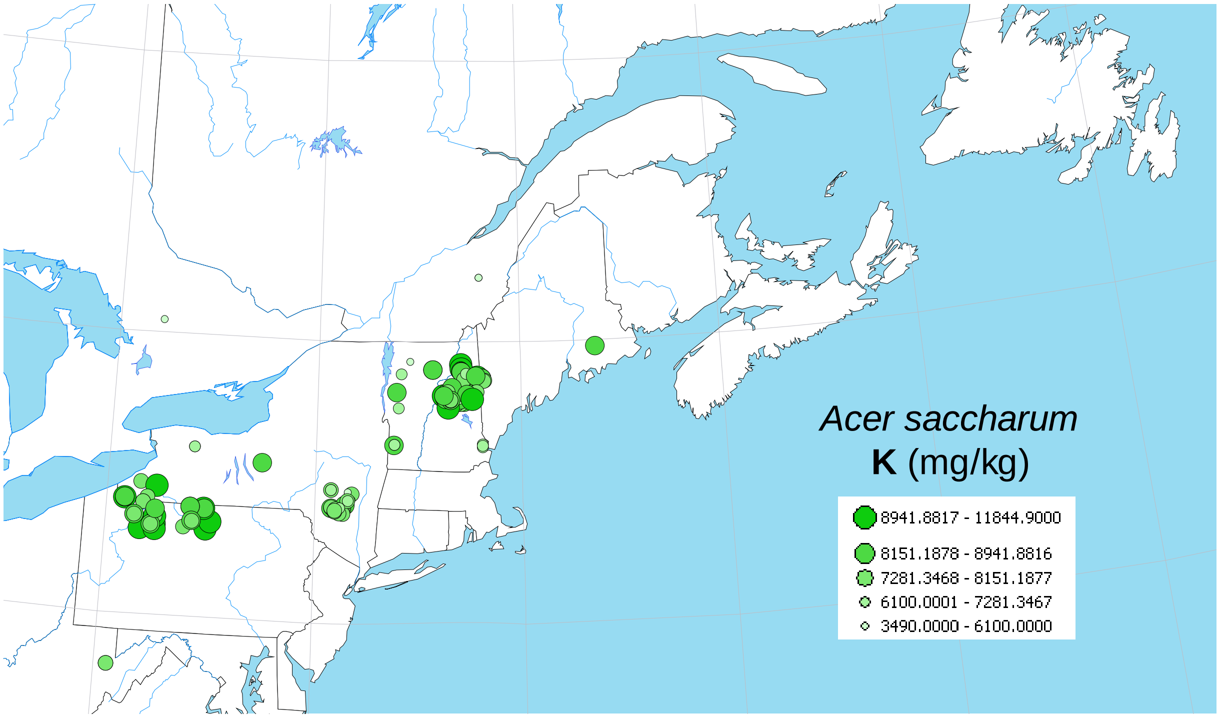
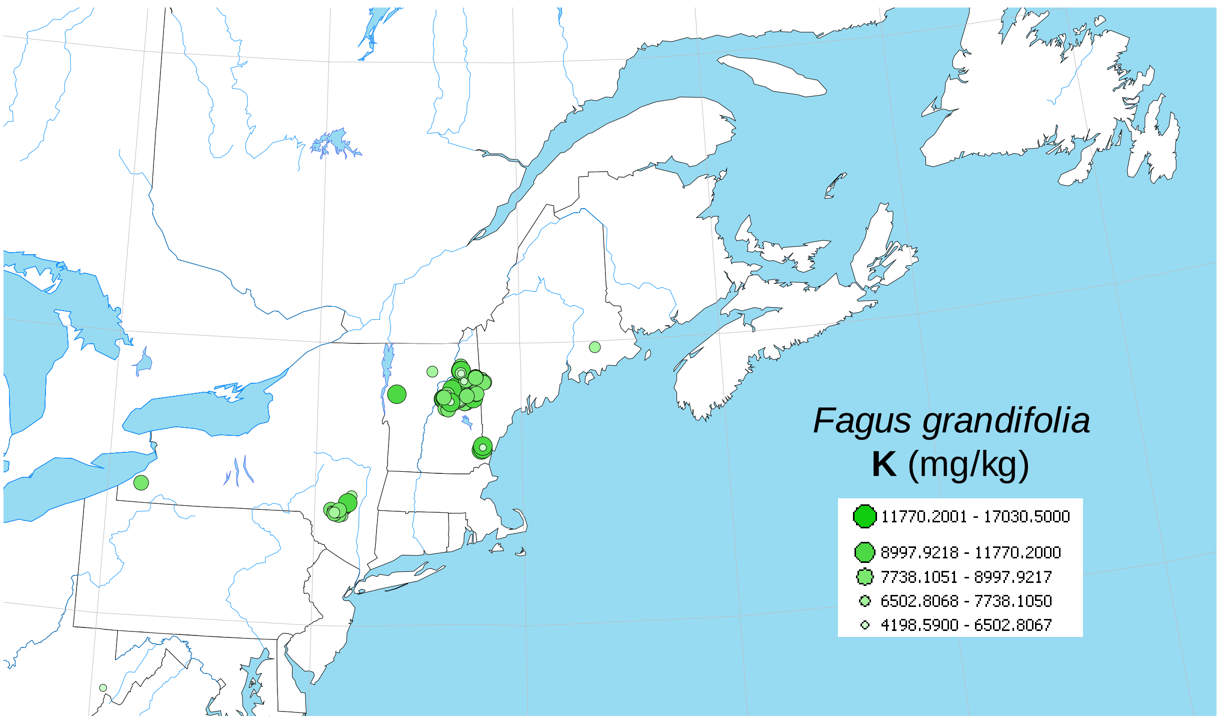
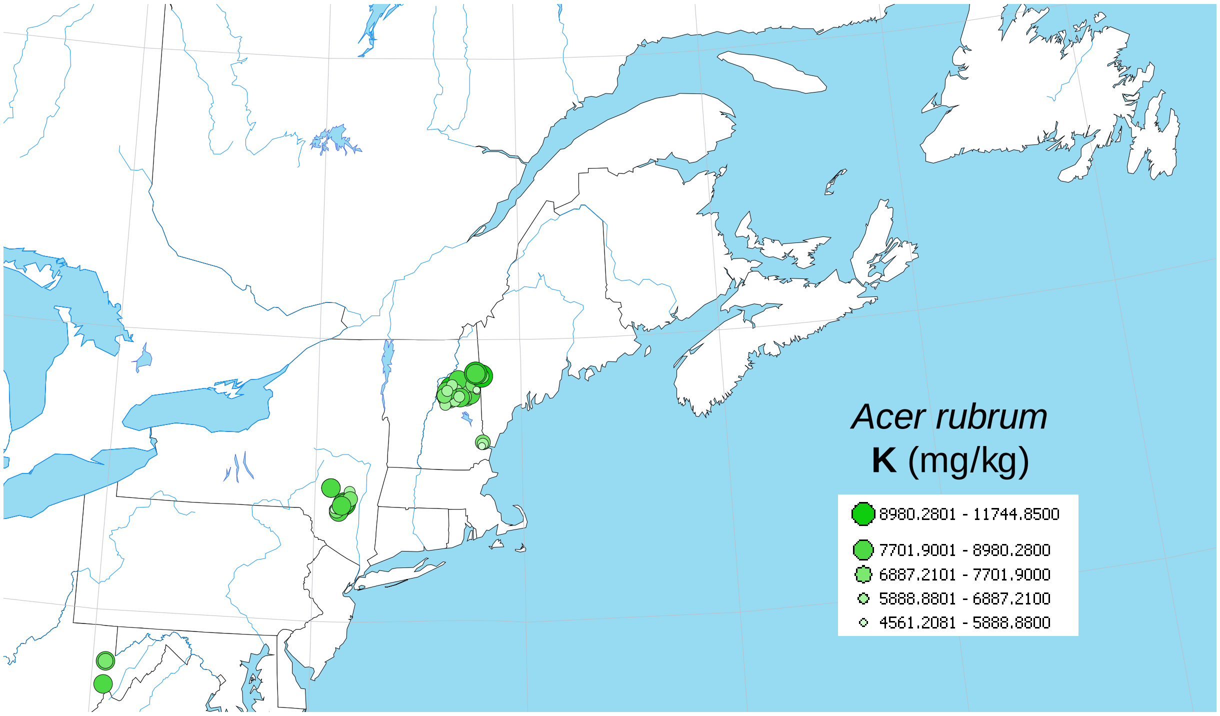
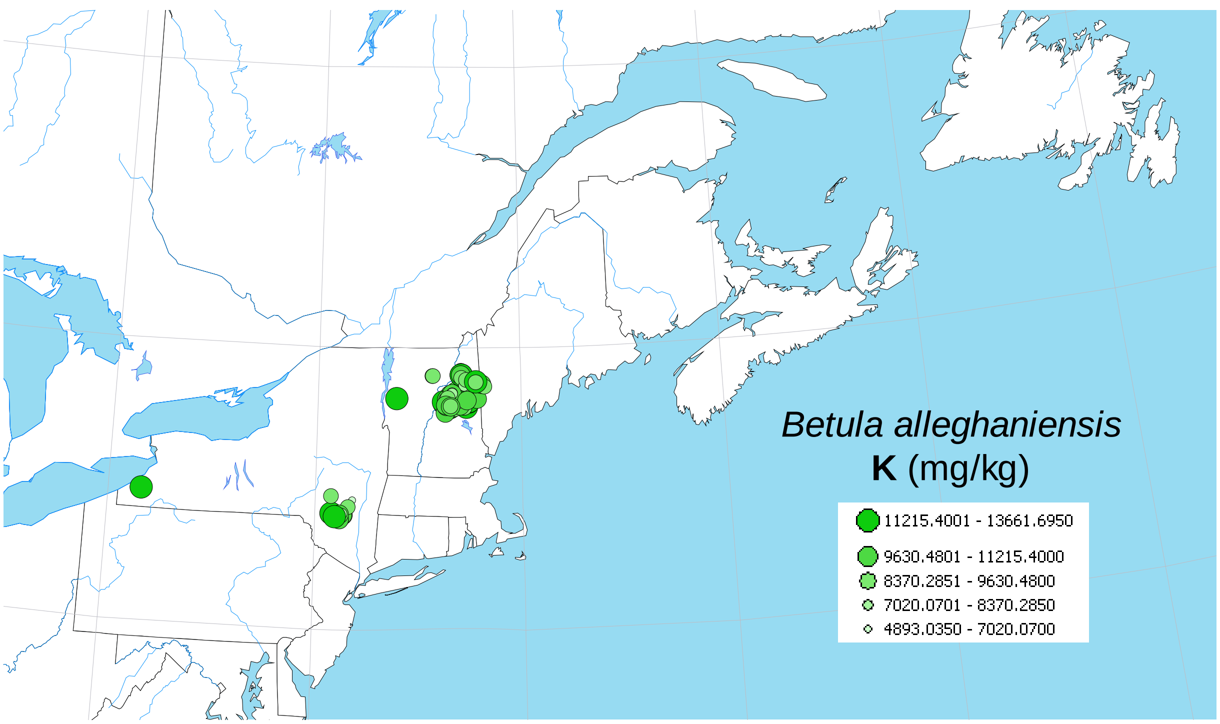


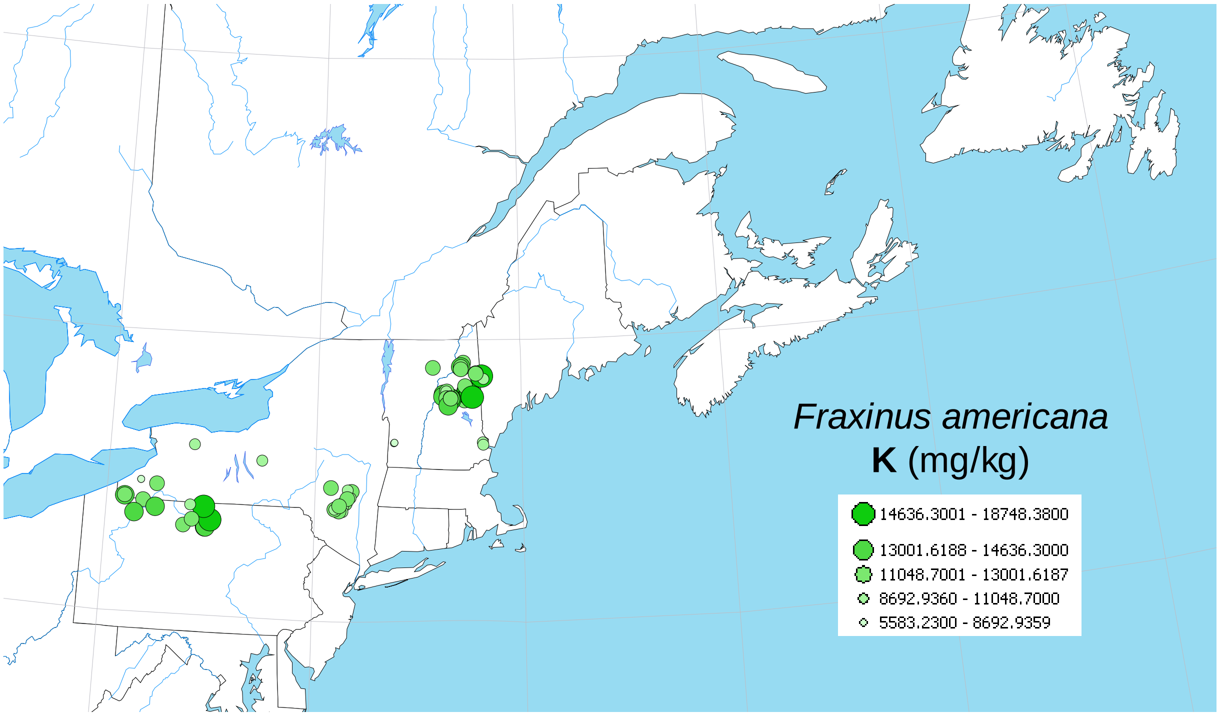
Figure 45. Maps for foliar potassium in hardwood species. (figure spans multiple pages)






Acer rubrum
K (mg/kg)
8980.2801 - 11744.8500
7701.9001 - 8980.2800
6887.2101 - 7701.9000
5888.8801 - 6887.2100
4561.2081 - 5888.8800


Betula alleghaniensis
K (mg/kg)
11215.4001 - 13661.6950
9630.4801 - 11215.4000
8370.2851 - 9630.4800
7020.0701 - 8370.2850
4893.0350 - 7020.0700


Fraxinus americana
K (mg/kg)
14636.3001 - 18748.3800
13001.6188 - 14636.3000
11048.7001 - 13001.6187
8692.9360 - 11048.7000
5583.2300 - 8692.9359

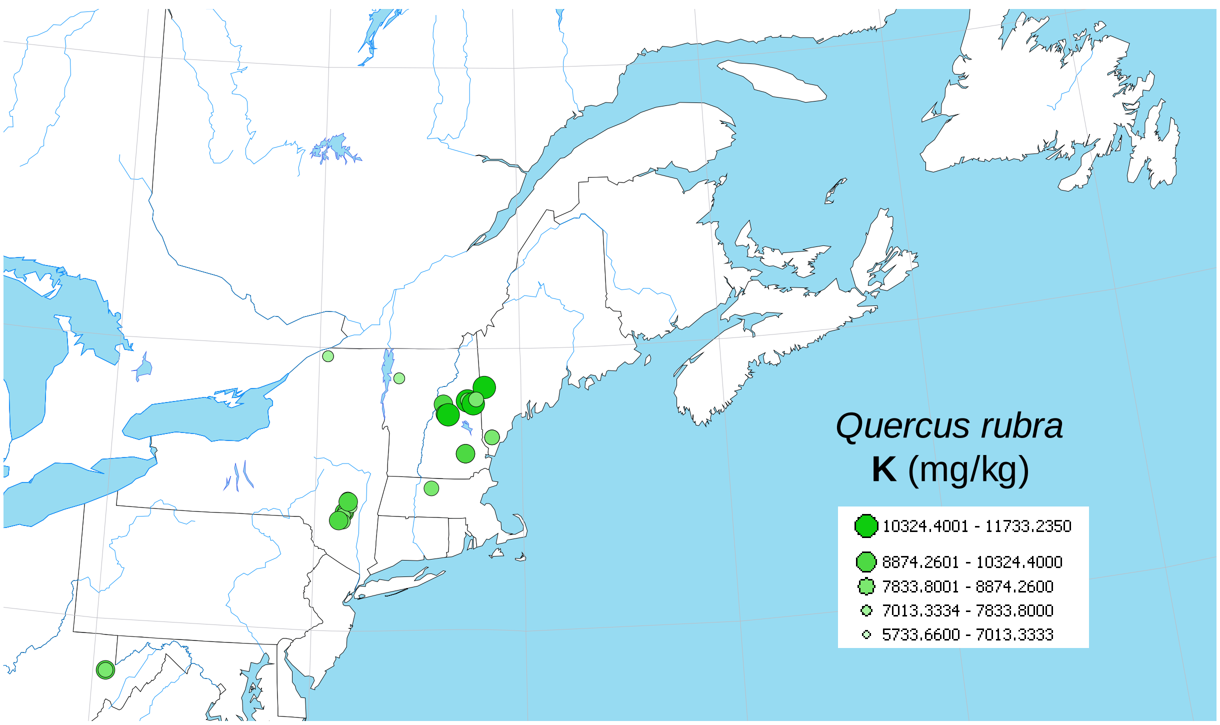
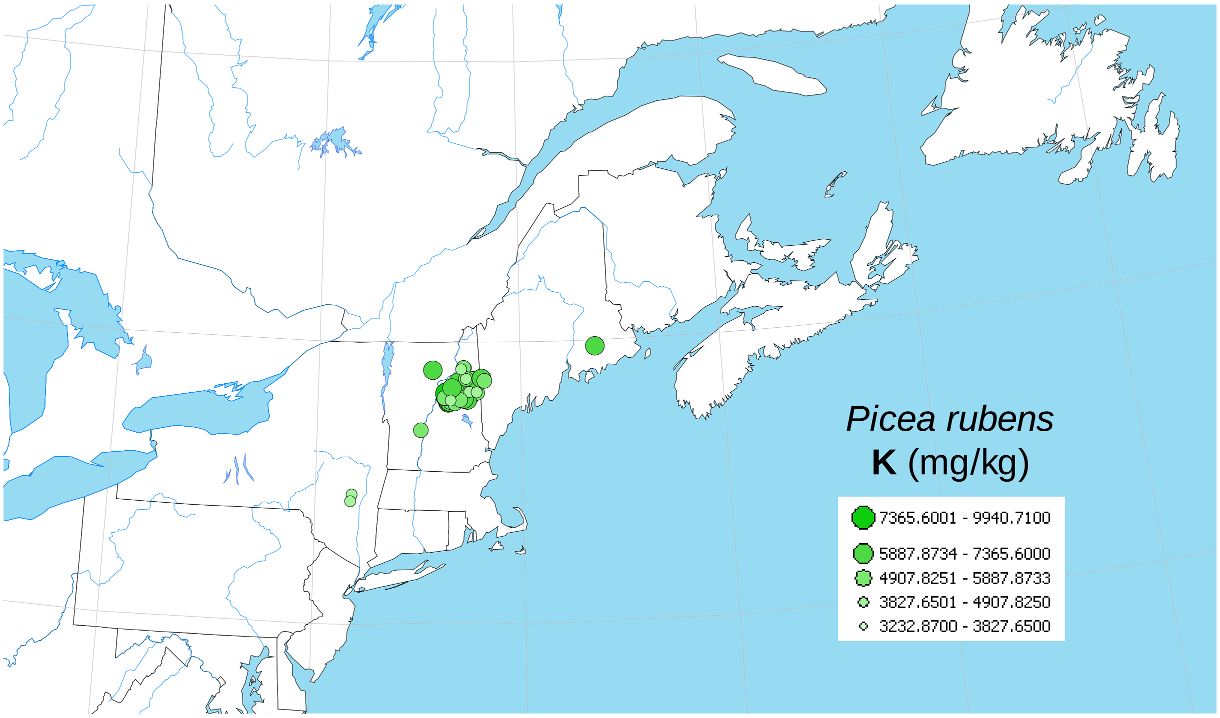

Quercus rubra
K (mg/kg)
10324.4001 - 11733.2350
8874.2601 - 10324.4000
7833.8001 - 8874.2600
7013.3334 - 7833.8000
5733.6600 - 7013.3333

Figure 46. Maps for foliar potassium in softwood species.



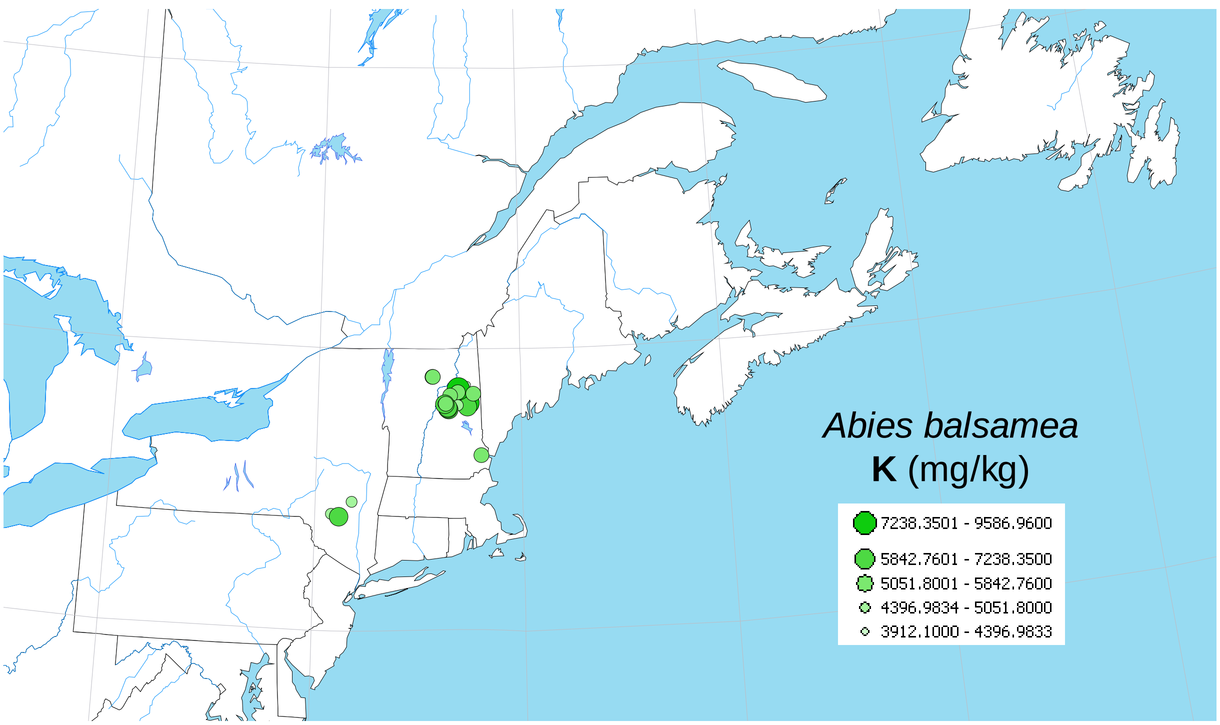
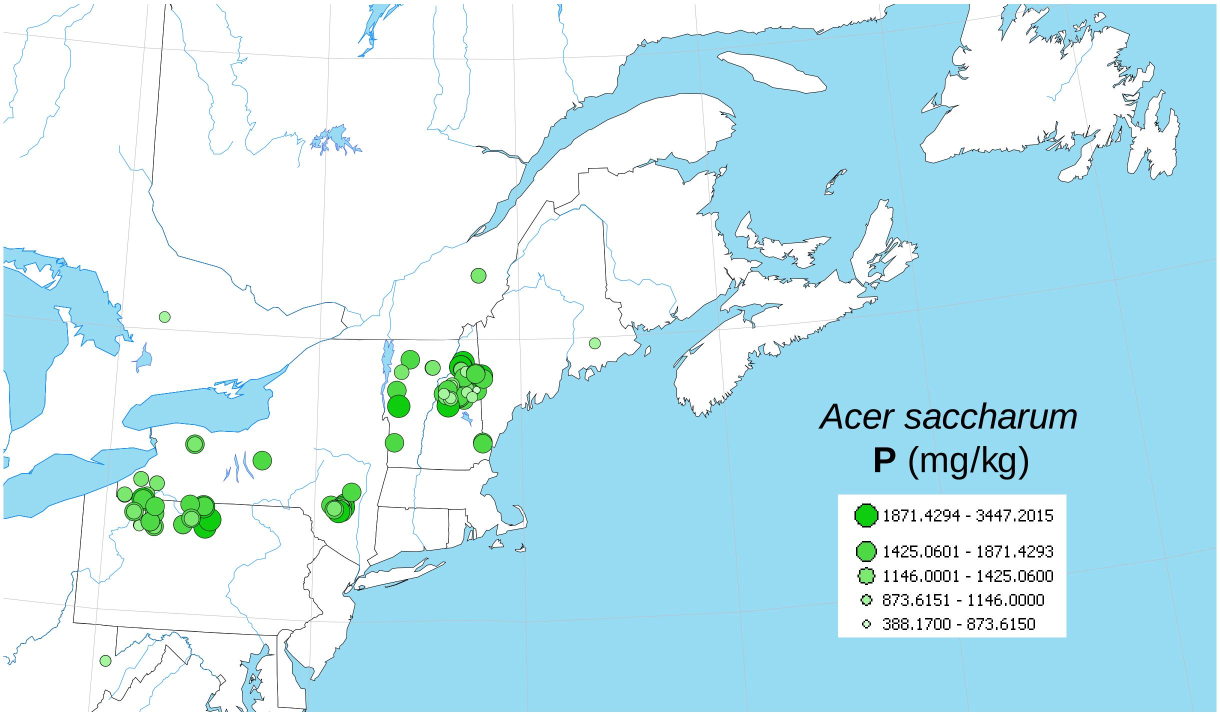
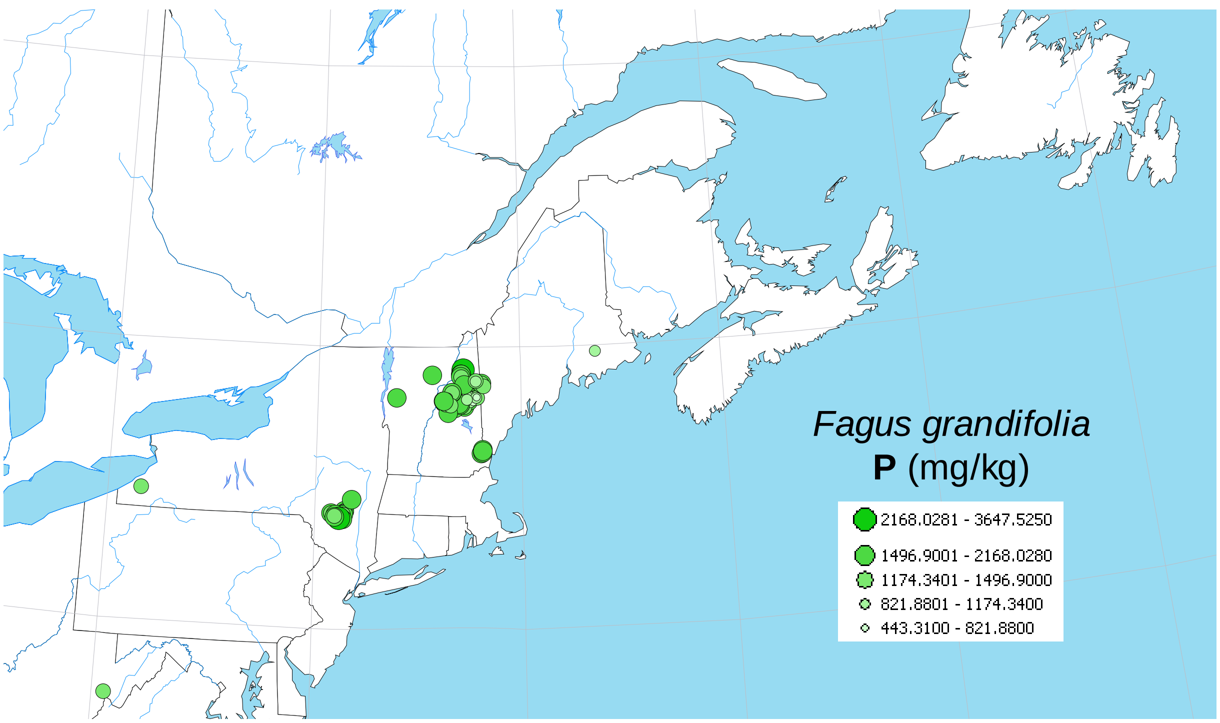
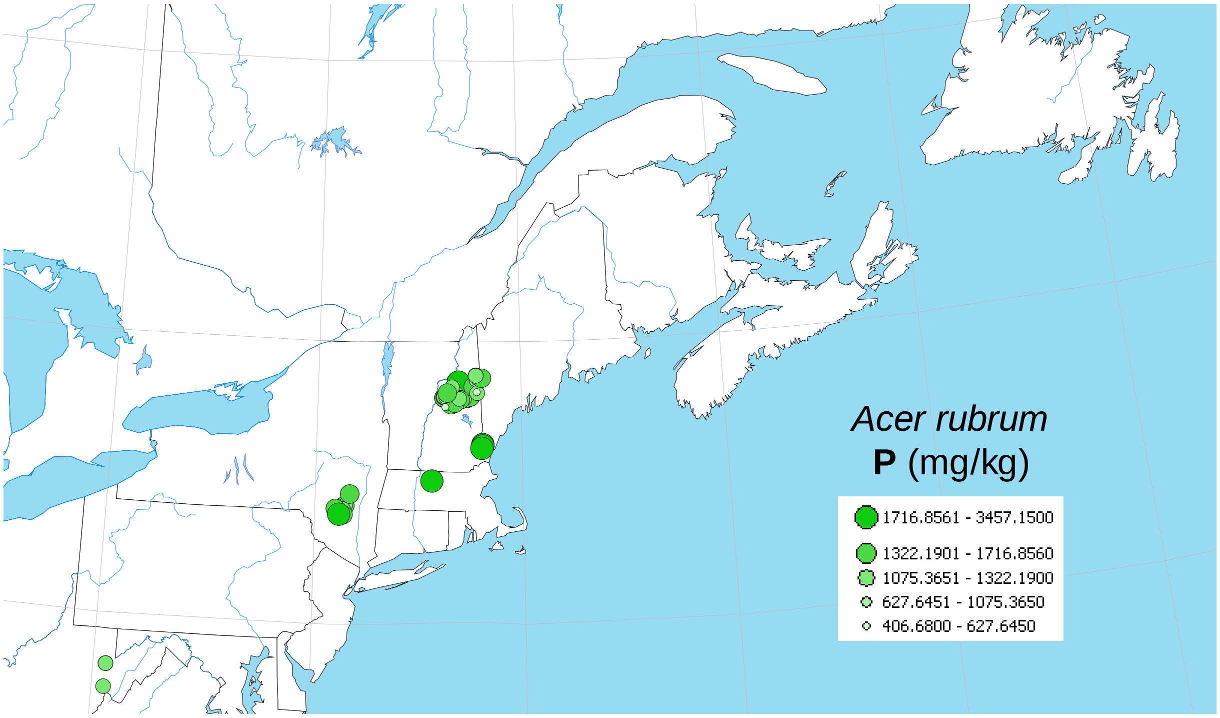
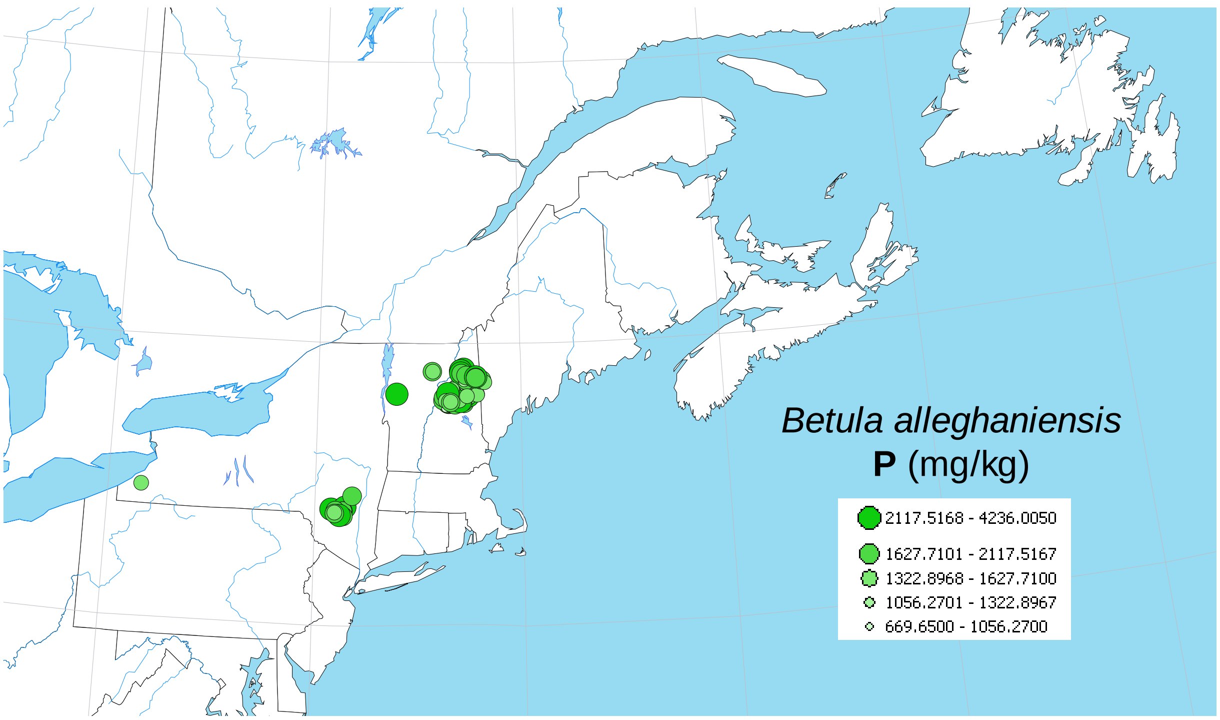


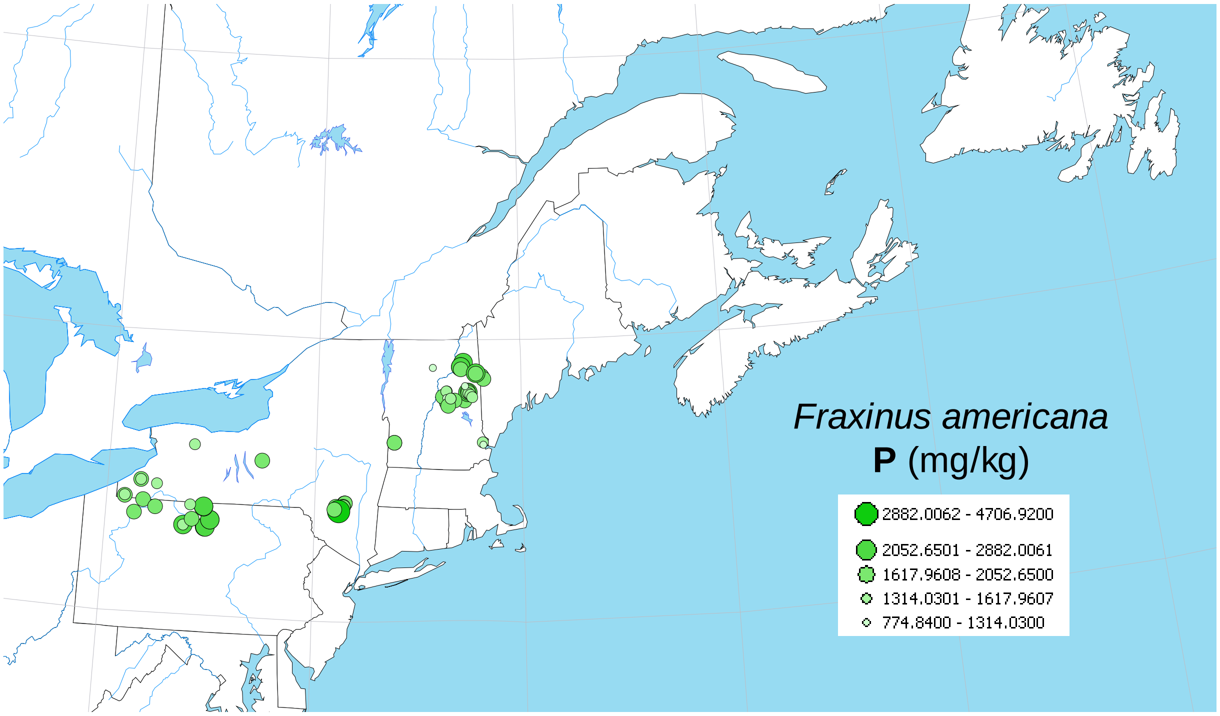
Figure 47. Maps for foliar phosphorus in hardwood species. (figure spans multiple pages)






Acer rubrum
P (mg/kg)
1716.8561 - 3457.1500
1322.1901 - 1716.8560
1075.3651 - 1322.1900
627.6451 - 1075.3650
406.6800 - 627.6450


Betula alleghaniensis
P (mg/kg)
2117.5168 - 4236.0050
1627.7101 - 2117.5167
1322.8968 - 1627.7100
1056.2701 - 1322.8967
669.6500 - 1056.2700


Fraxinus americana
P (mg/kg)
2882.0062 - 4706.9200
2052.6501 - 2882.0061
1617.9608 - 2052.6500
1314.0301 - 1617.9607
774.8400 - 1314.0300

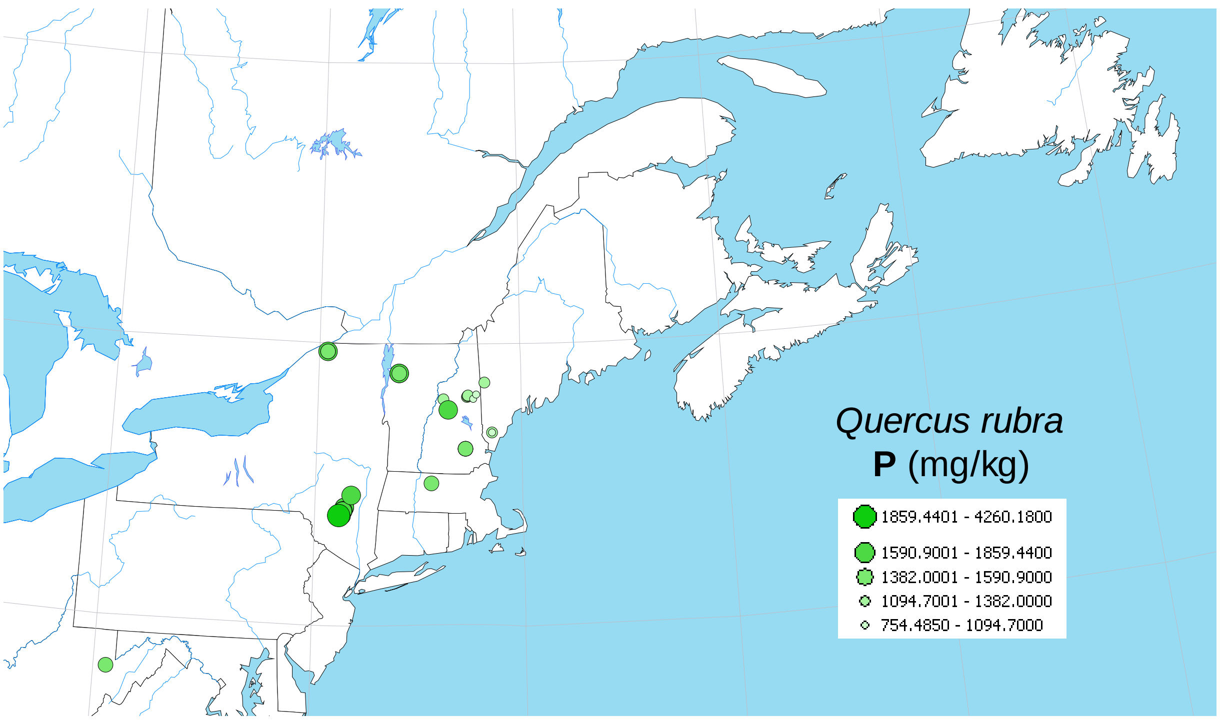
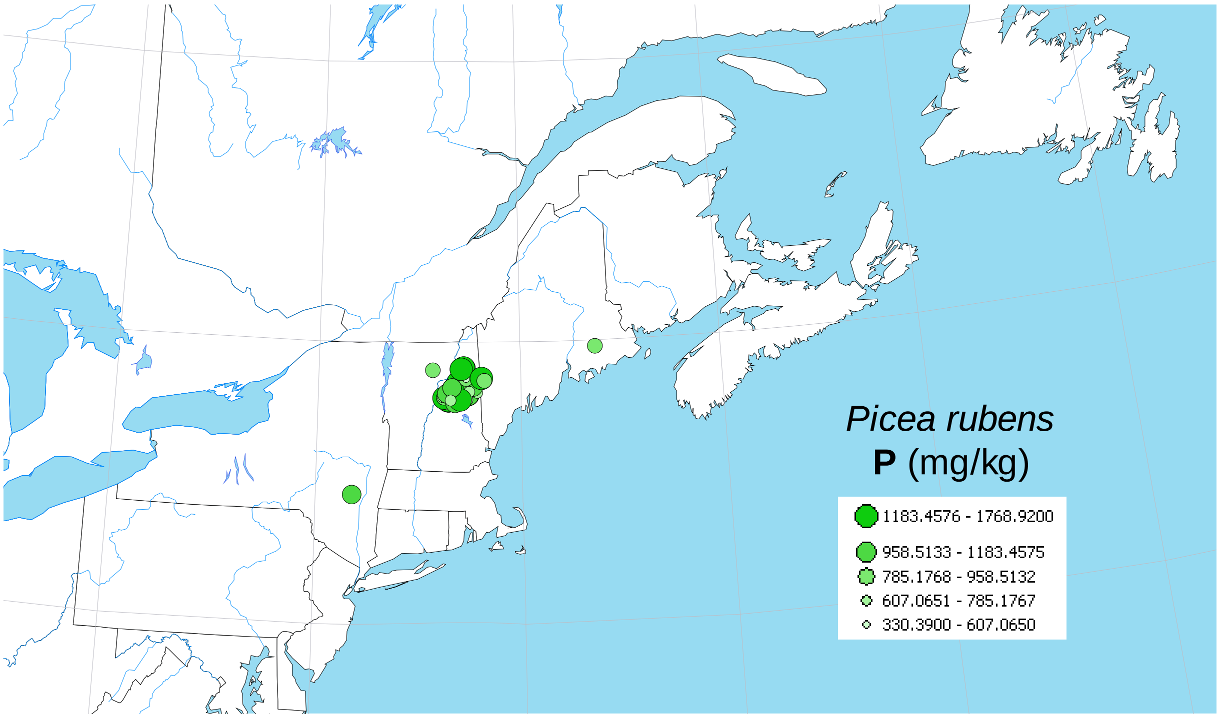

Quercus rubra
P (mg/kg)
1859.4401 - 4260.1800
1590.9001 - 1859.4400
1382.0001 - 1590.9000
1094.7001 - 1382.0000
754.4850 - 1094.7000

Figure 48. Maps for foliar phosphorus in softwood species.



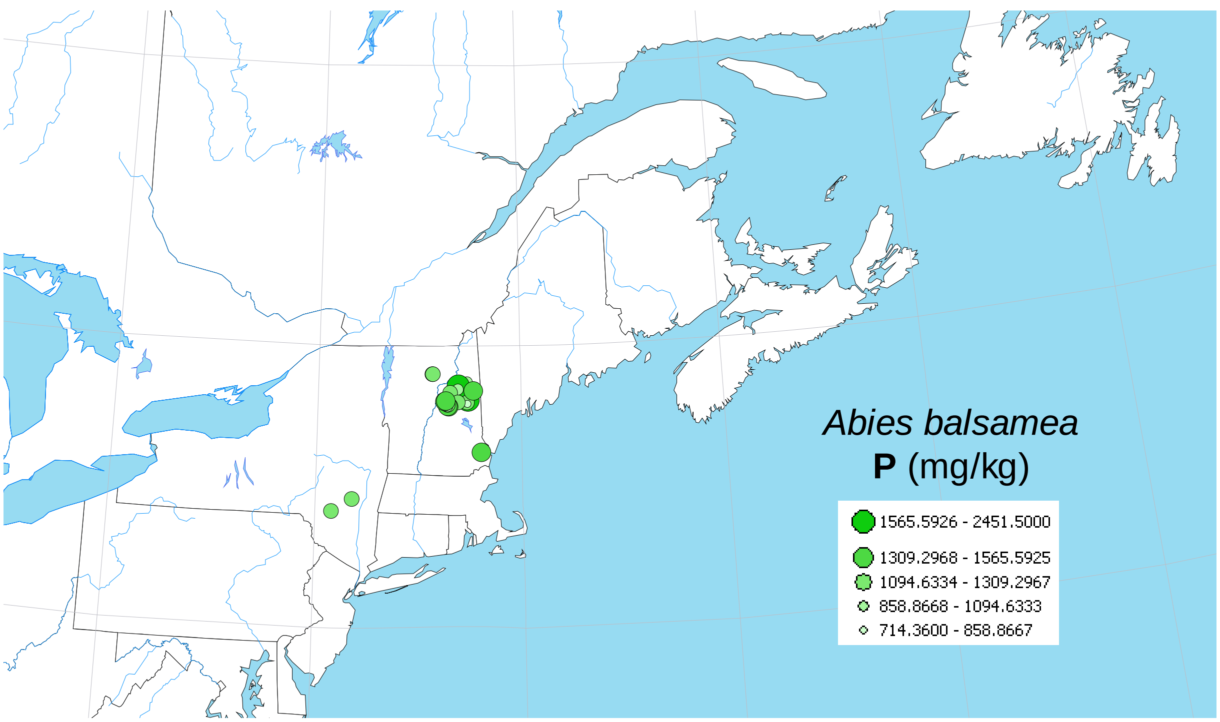
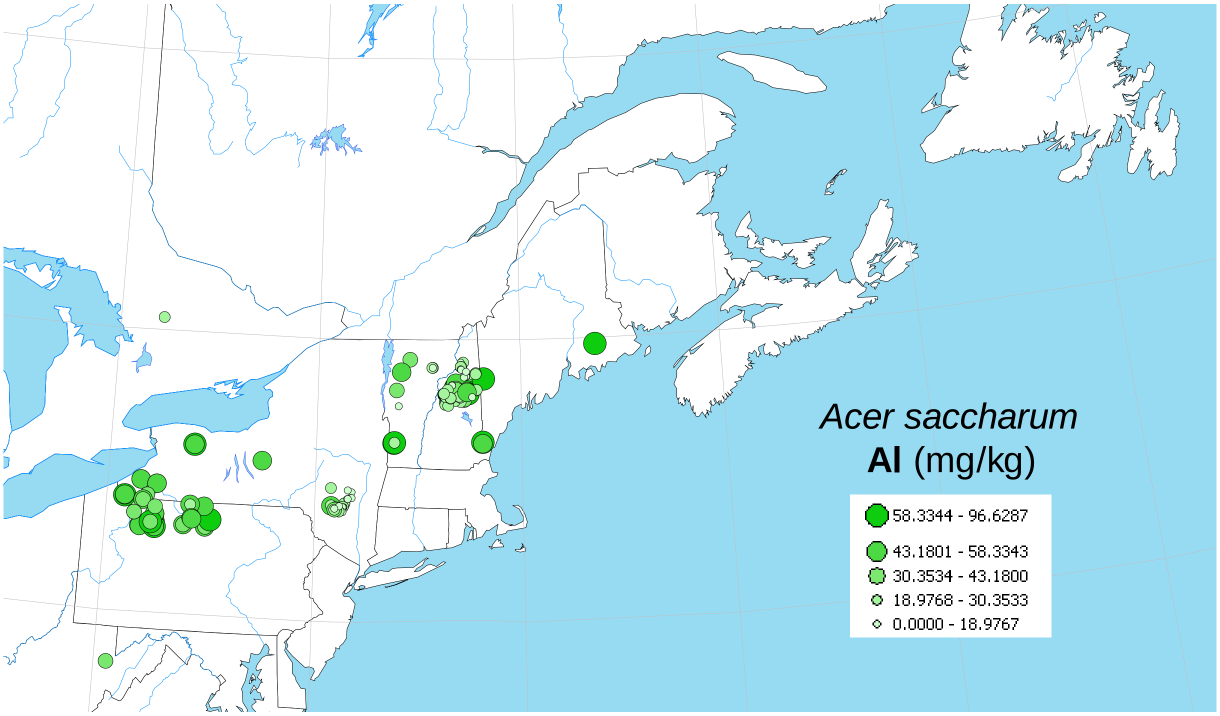
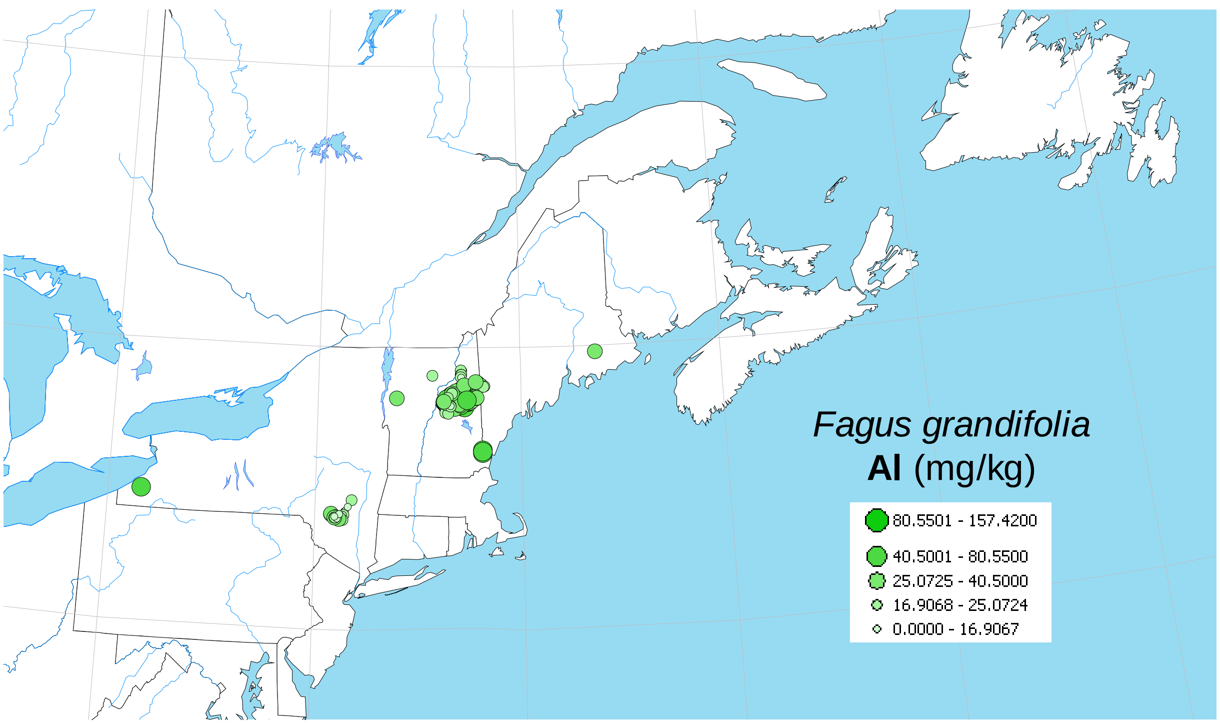
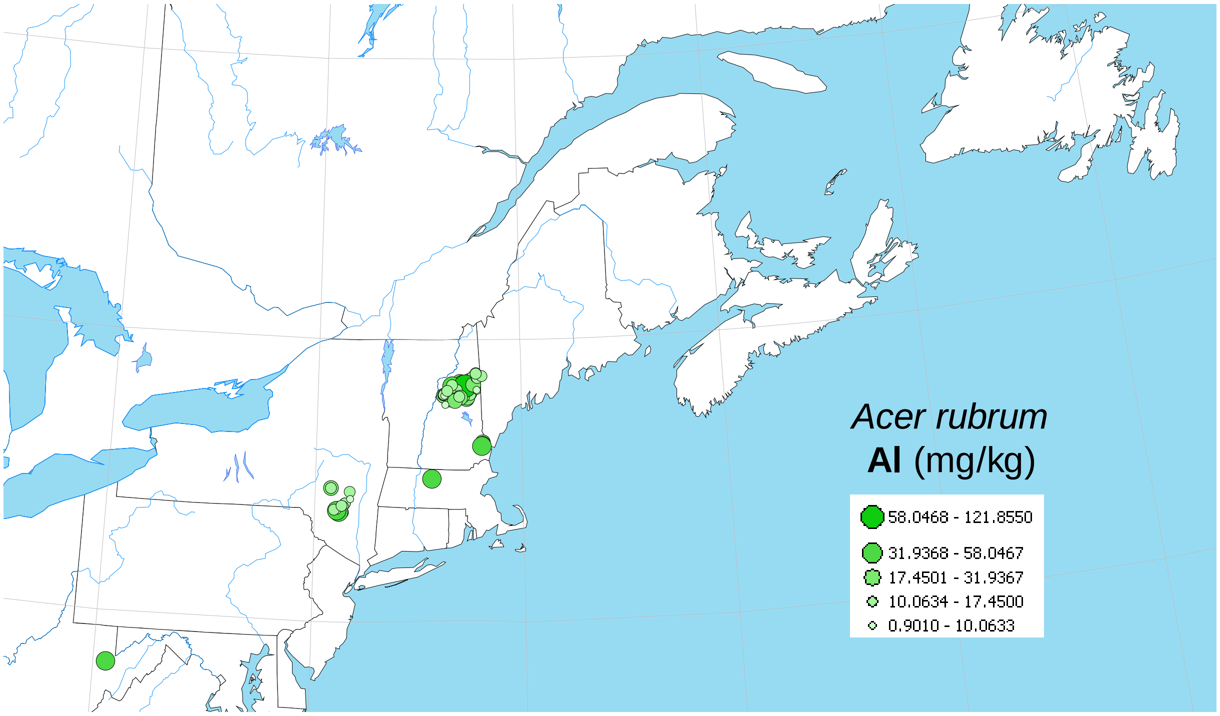
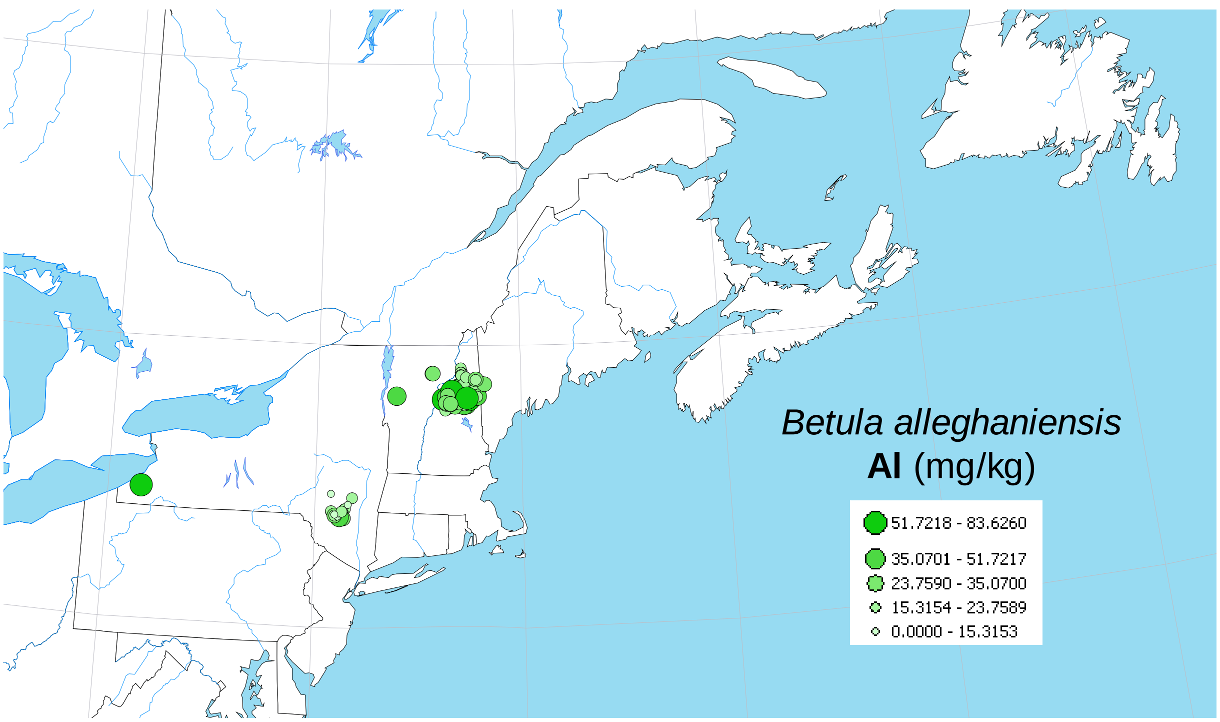


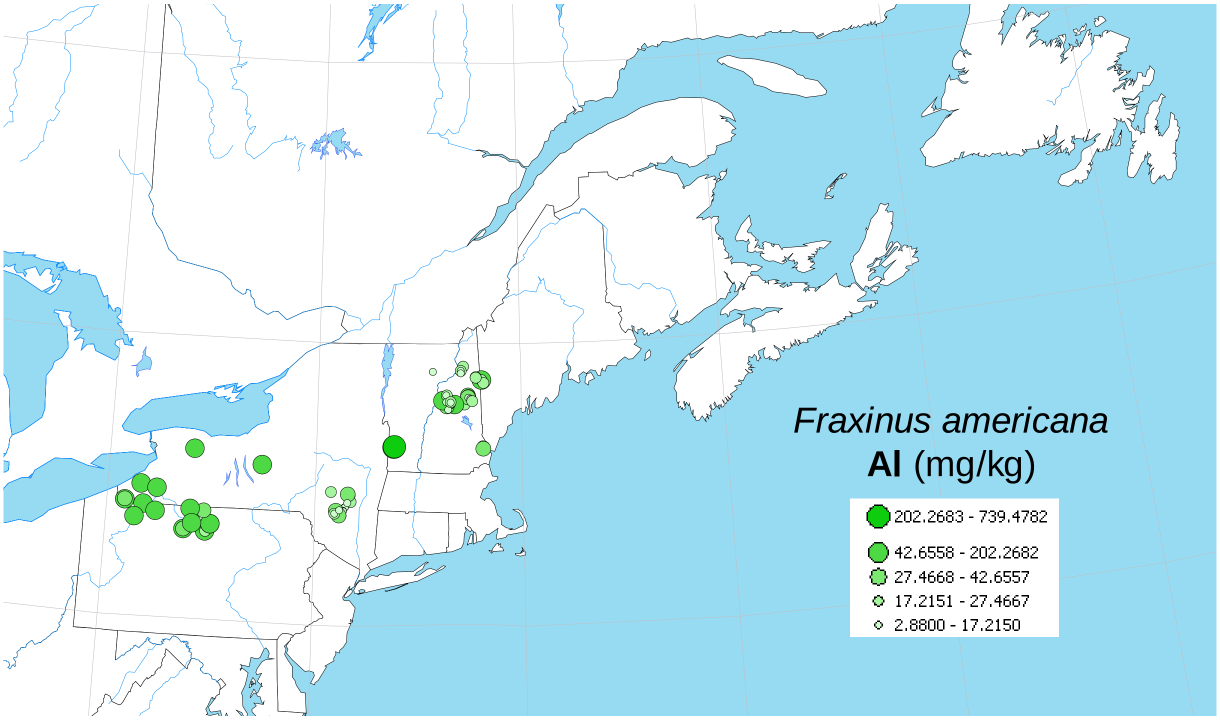
Figure 49. Maps for foliar aluminum in hardwood species. (figure spans multiple pages)






Acer rubrum
Al (mg/kg)
58.0468 - 121.8550
31.9368 - 58.0467
17.4501 - 31.9367
10.0634 - 17.4500
0.9010 - 10.0633


Betula alleghaniensis
Al (mg/kg)
51.7218 - 83.6260
35.0701 - 51.7217
23.7590 - 35.0700
15.3154 - 23.7589
0.0000 - 15.3153


Fraxinus americana
Al (mg/kg)
202.2683 - 739.4782
42.6558 - 202.2682
27.4668 - 42.6557
17.2151 - 27.4667
2.8800 - 17.2150

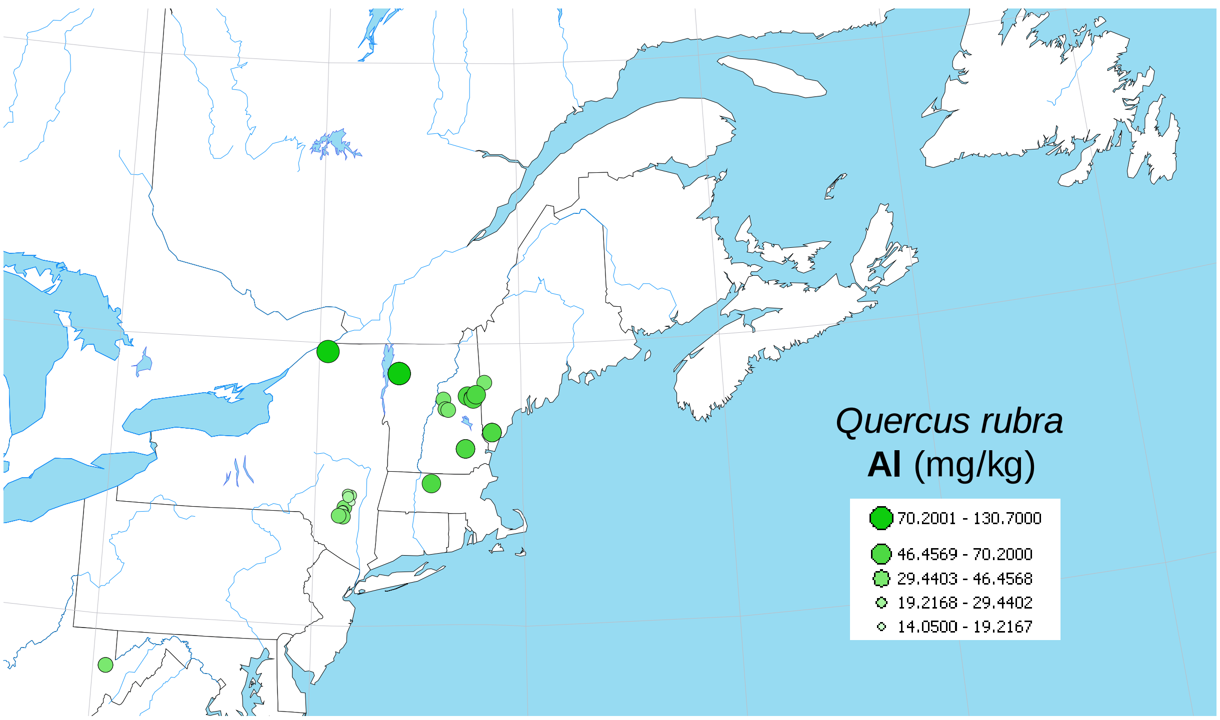
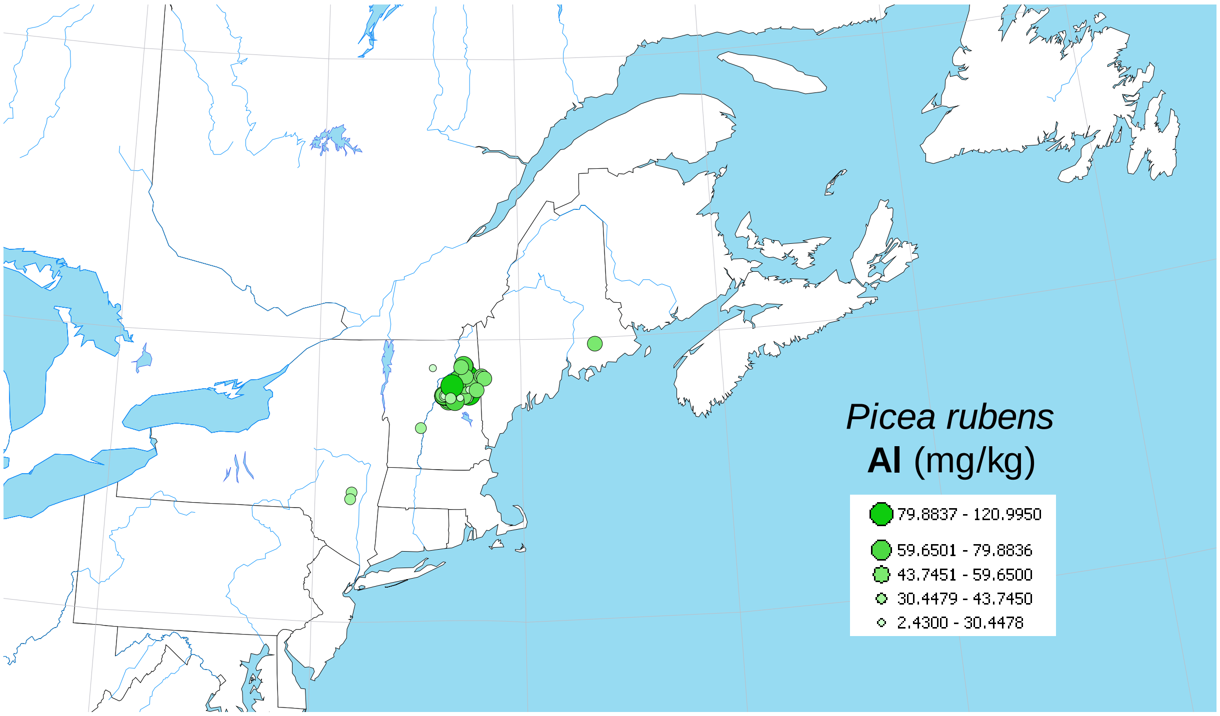

Quercus rubra
Al (mg/kg)
70.2001 - 130.7000
46.4569 - 70.2000
29.4403 - 46.4568
19.2168 - 29.4402
14.0500 - 19.2167

Figure 50. Maps for foliar aluminum in softwood species.



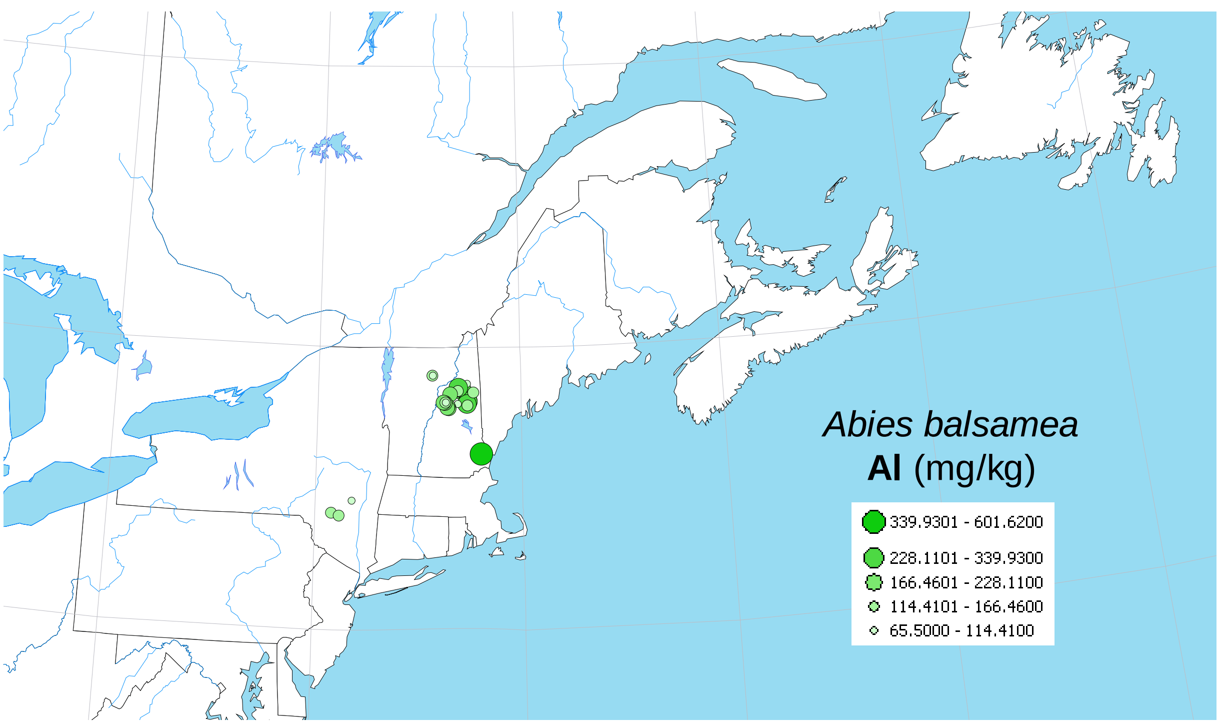
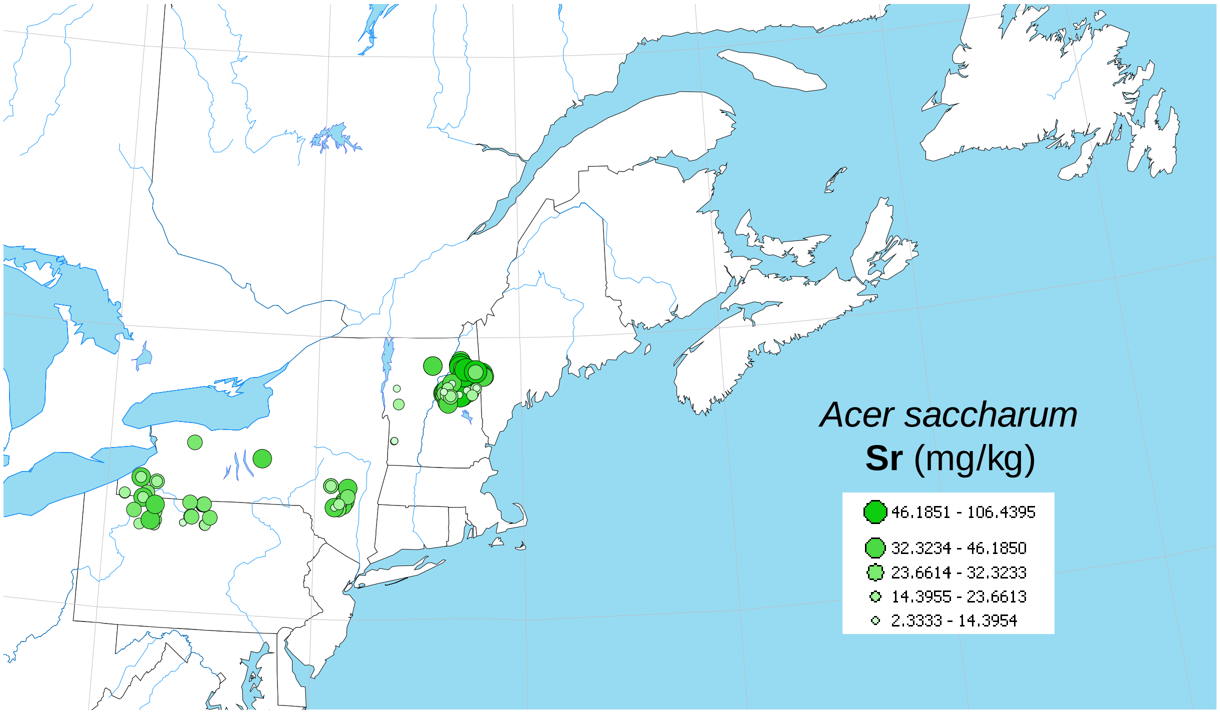
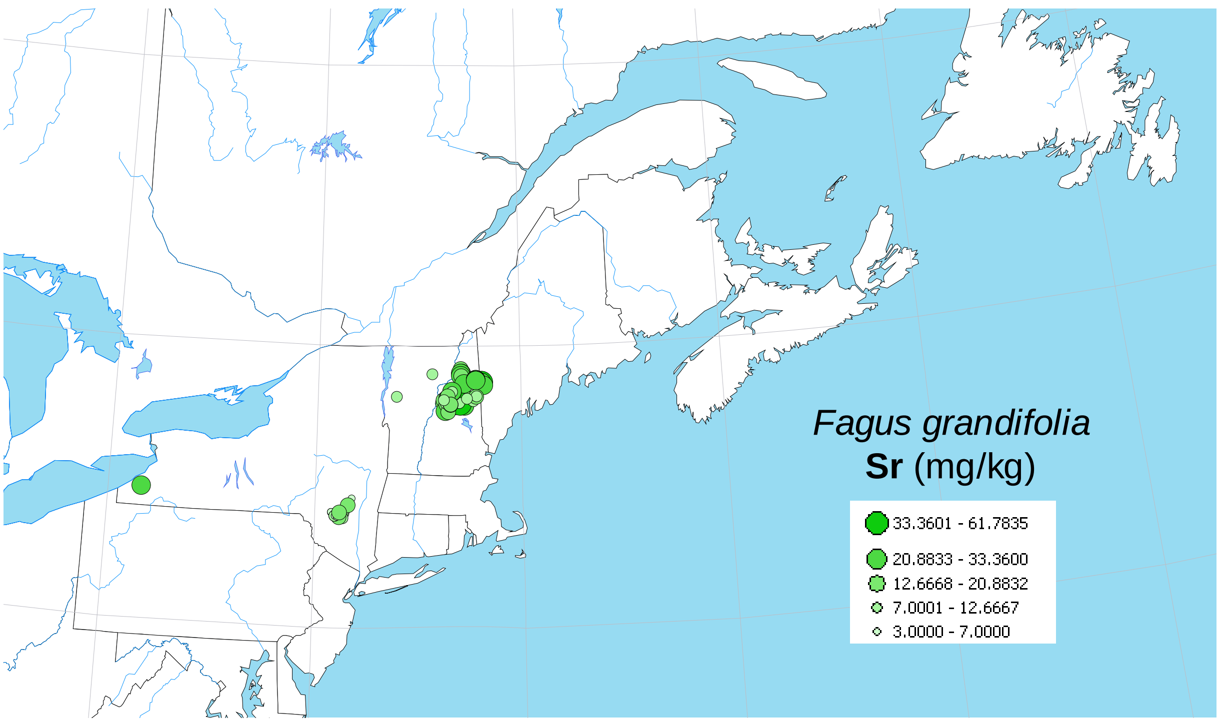
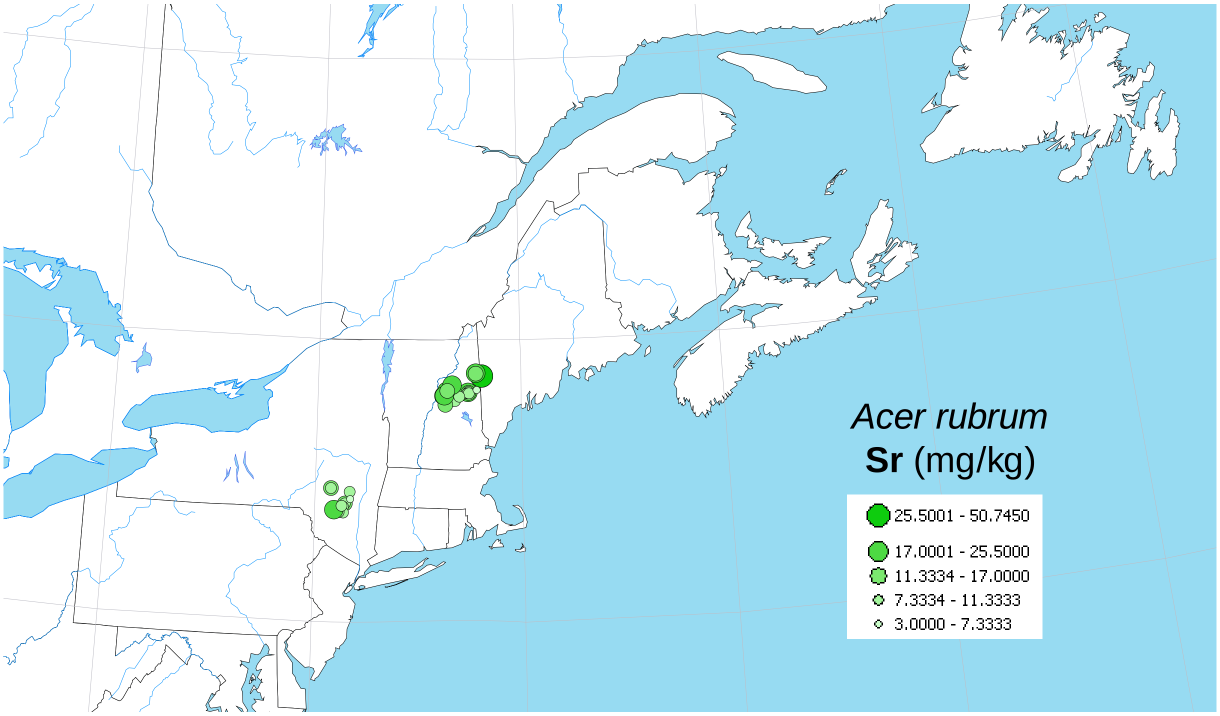
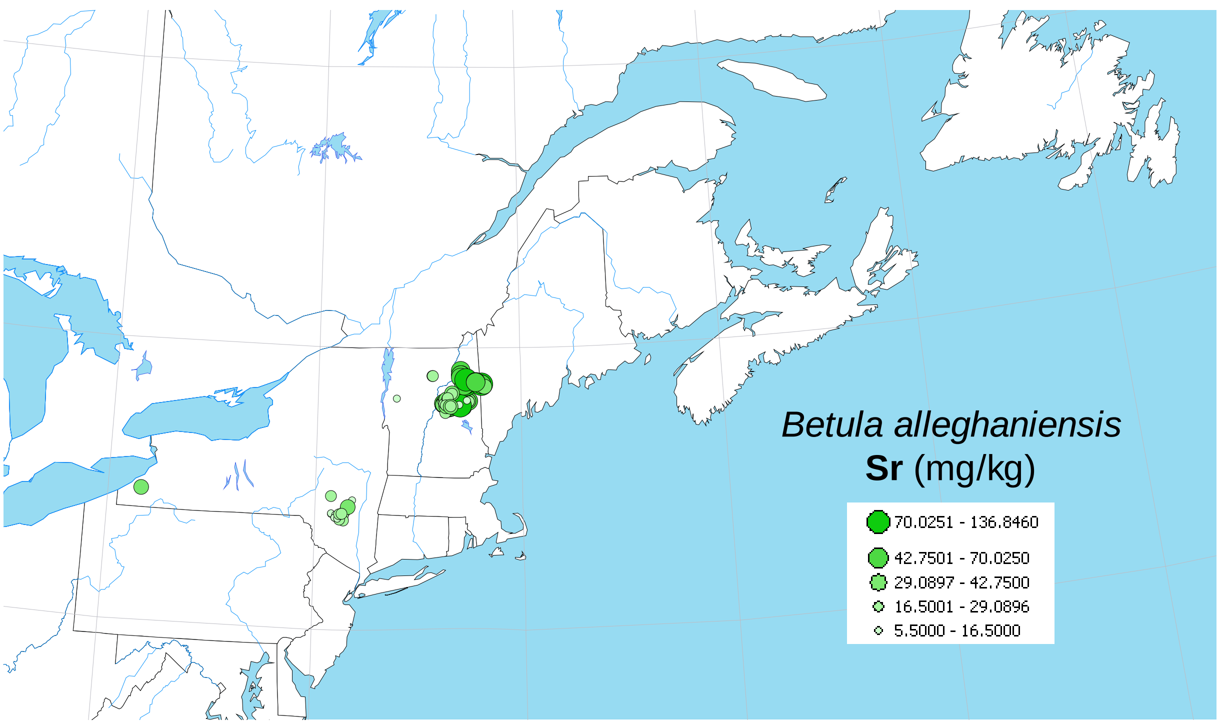


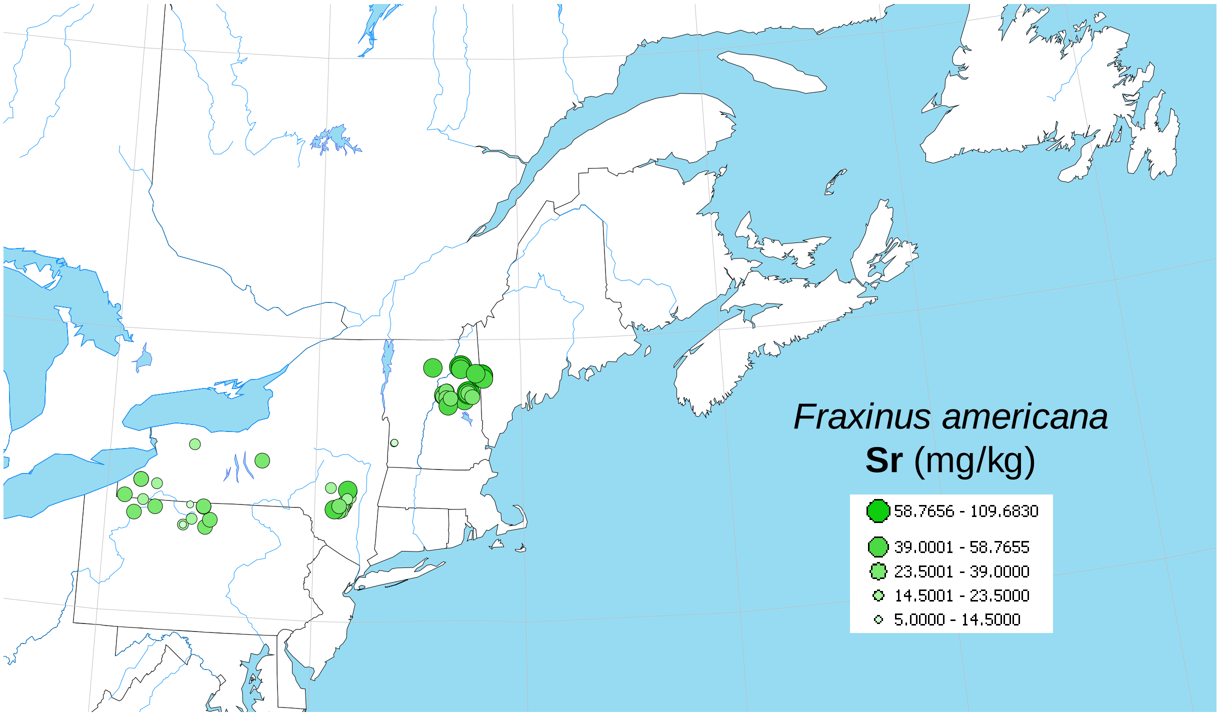
Figure 51. Maps for foliar strontium in hardwood species. (figure spans multiple pages)






Acer rubrum
Sr (mg/kg)
25.5001 - 50.7450
17.0001 - 25.5000
11.3334 - 17.0000
7.3334 - 11.3333
3.0000 - 7.3333


Betula alleghaniensis
Sr (mg/kg)
70.0251 - 136.8460
42.7501 - 70.0250
29.0897 - 42.7500
16.5001 - 29.0896
5.5000 - 16.5000


Fraxinus americana
Sr (mg/kg)
58.7656 - 109.6830
39.0001 - 58.7655
23.5001 - 39.0000
14.5001 - 23.5000
5.0000 - 14.5000

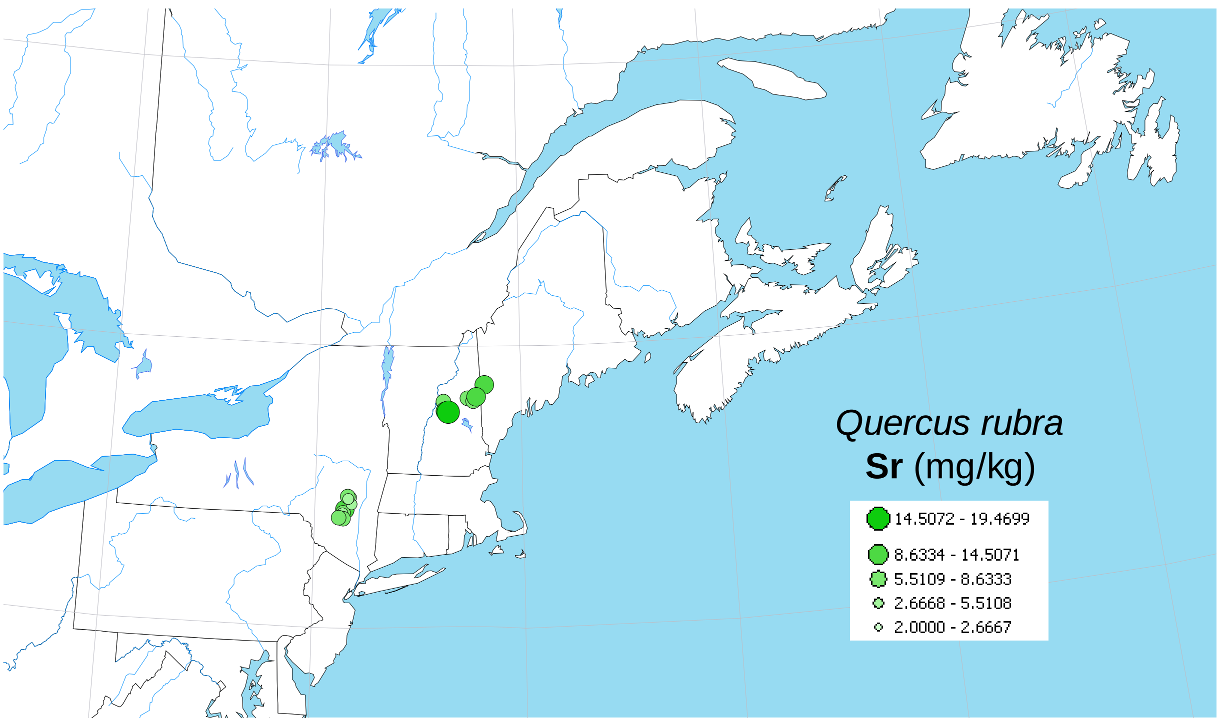
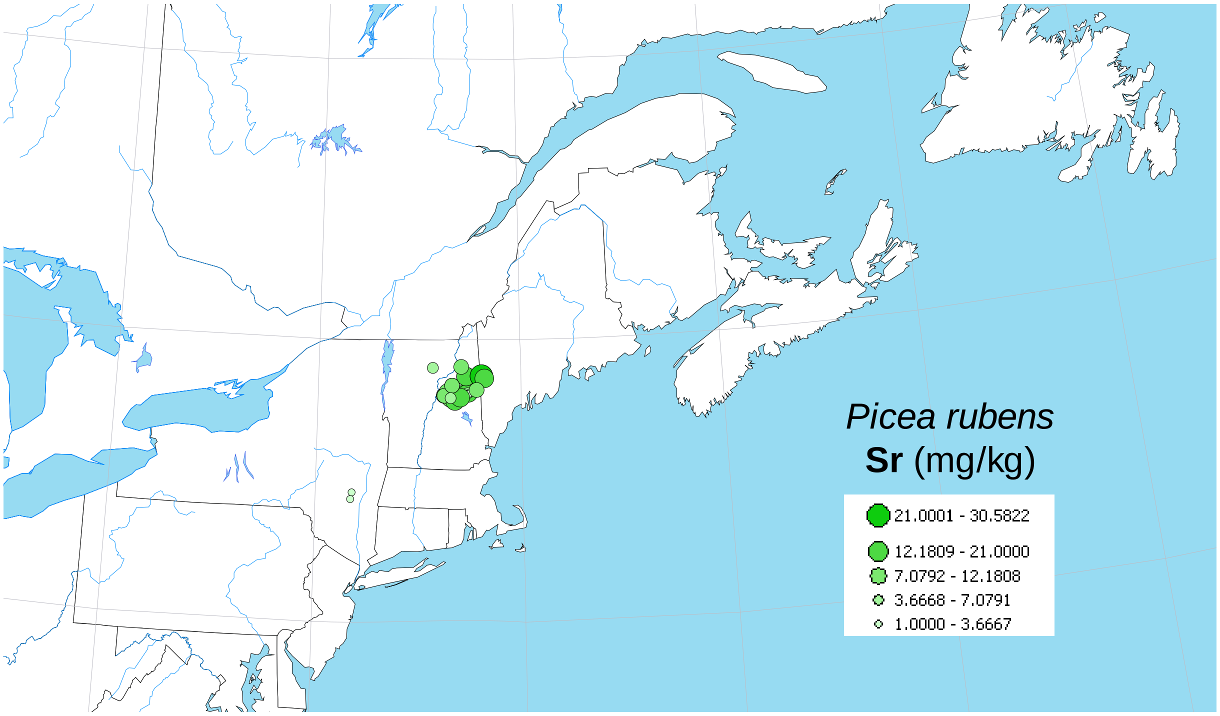

Quercus rubra
Sr (mg/kg)
14.5072 - 19.4699
8.6334 - 14.5071
5.5109 - 8.6333
2.6668 - 5.5108
2.0000 - 2.6667

Figure 52. Maps for foliar strontium in softwood species.



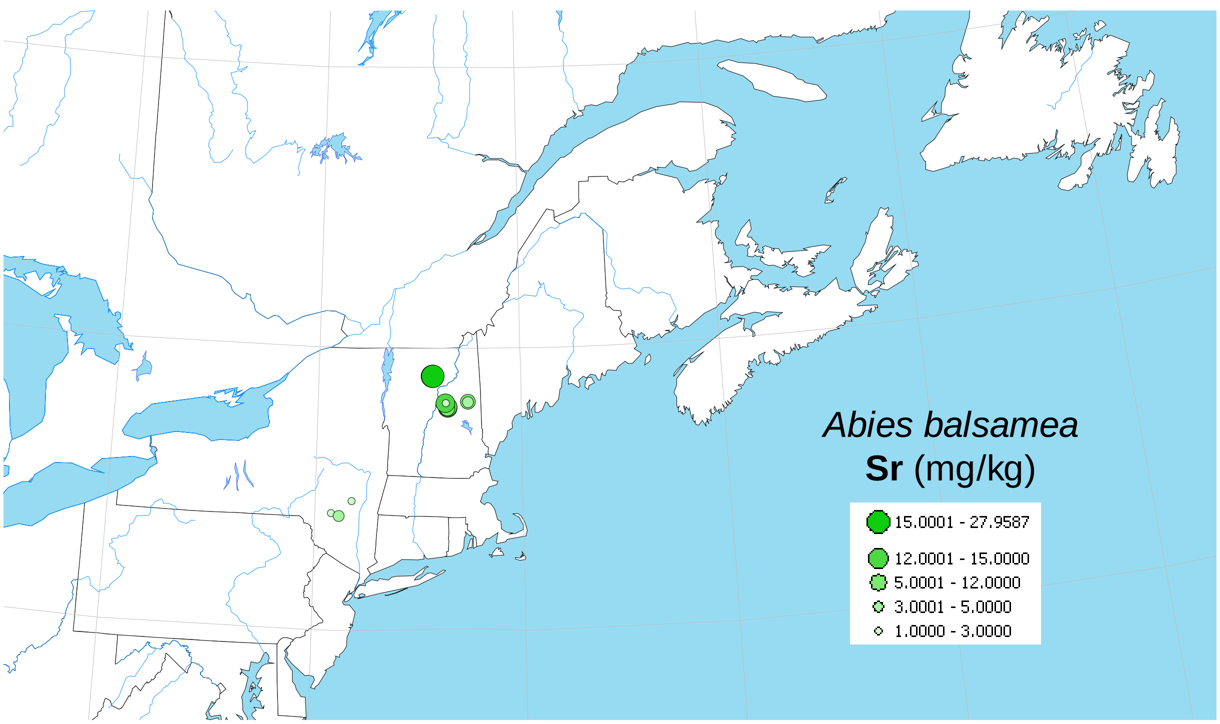
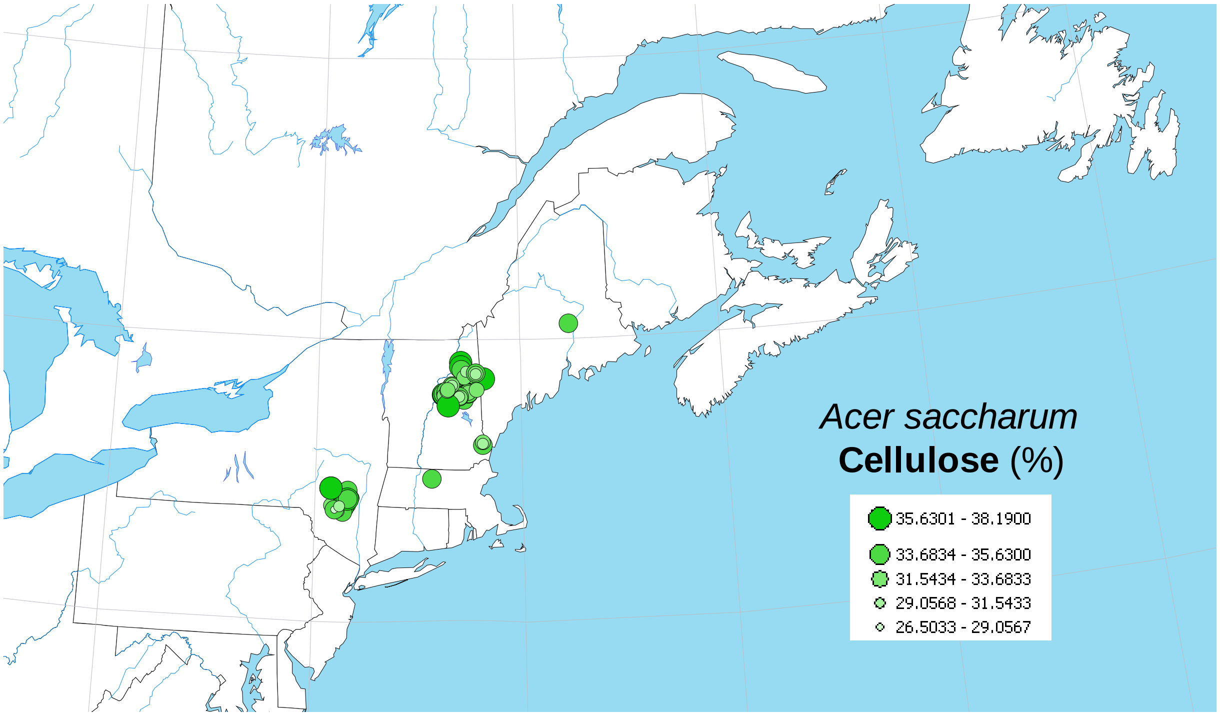
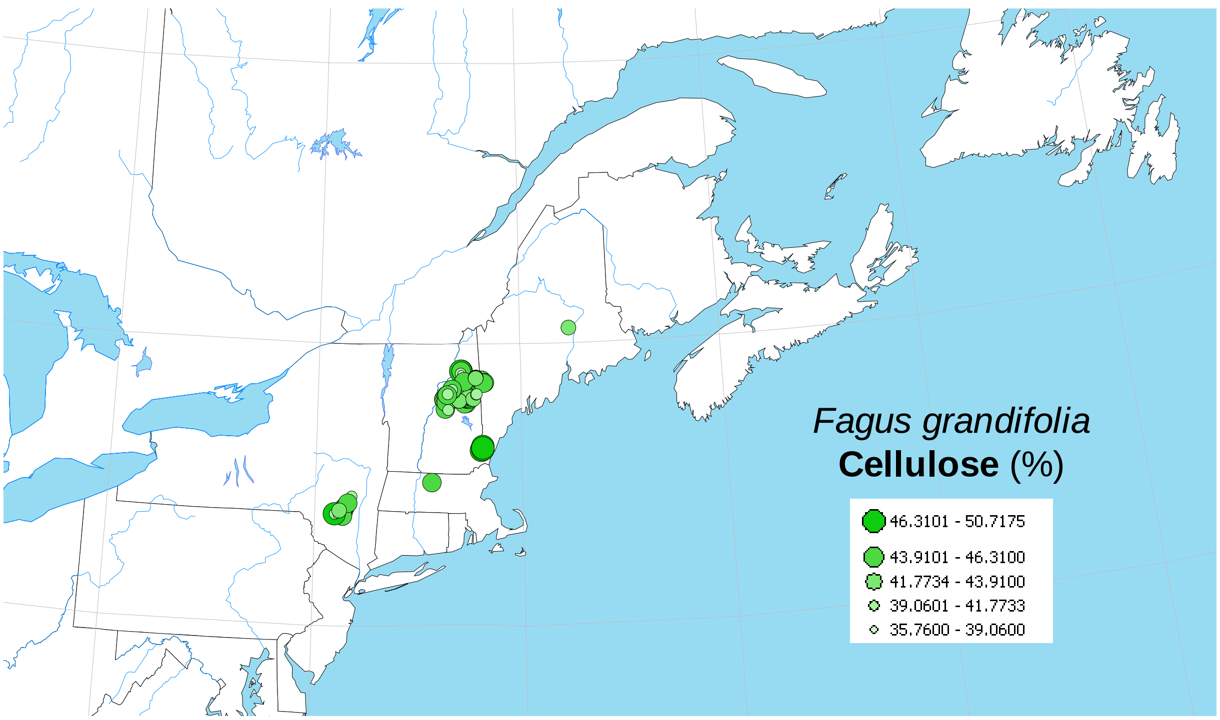
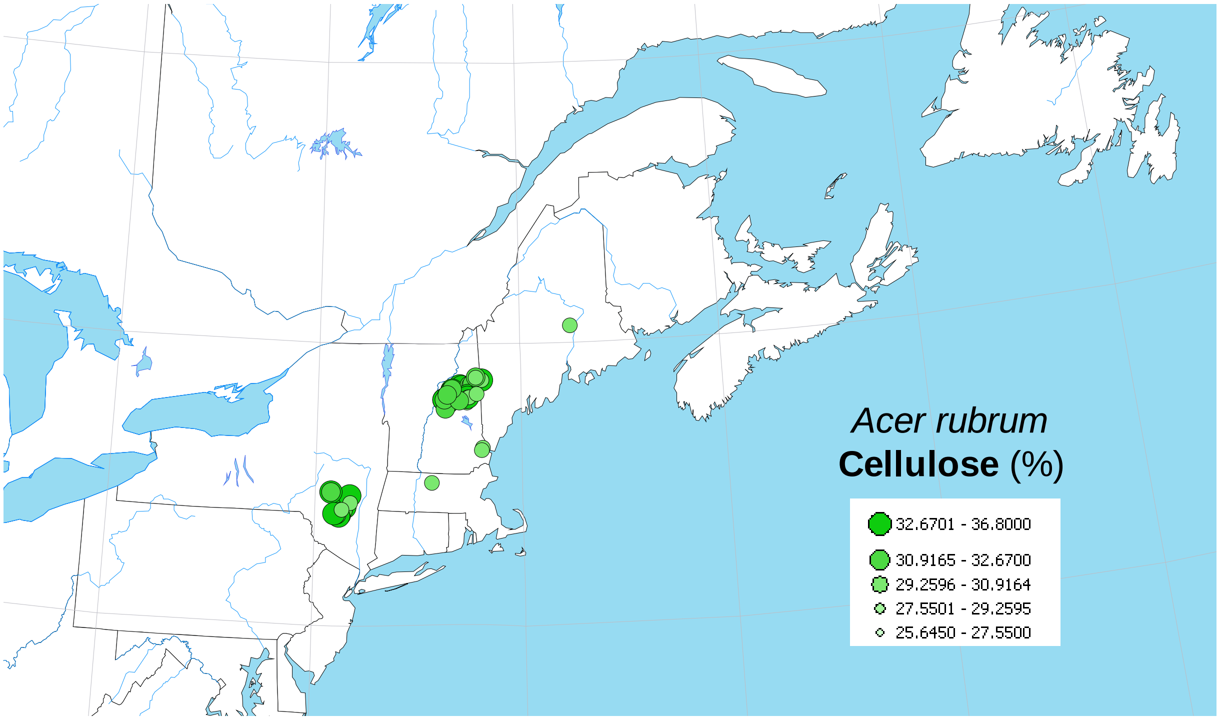
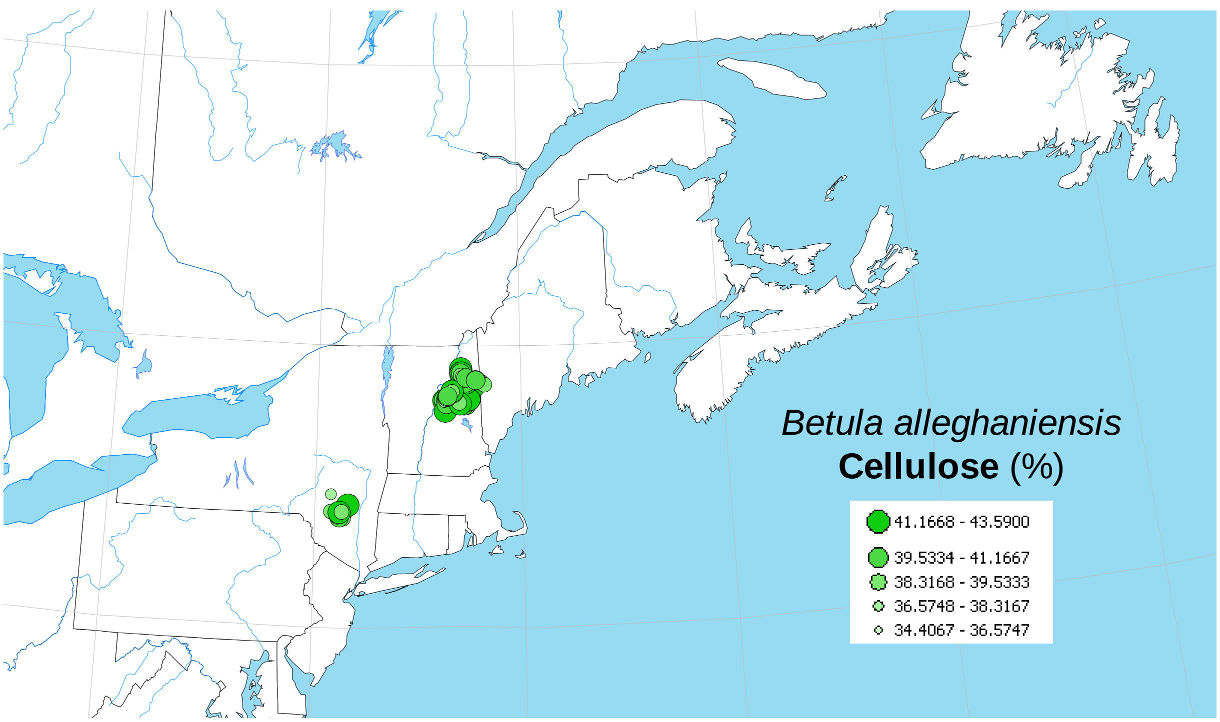


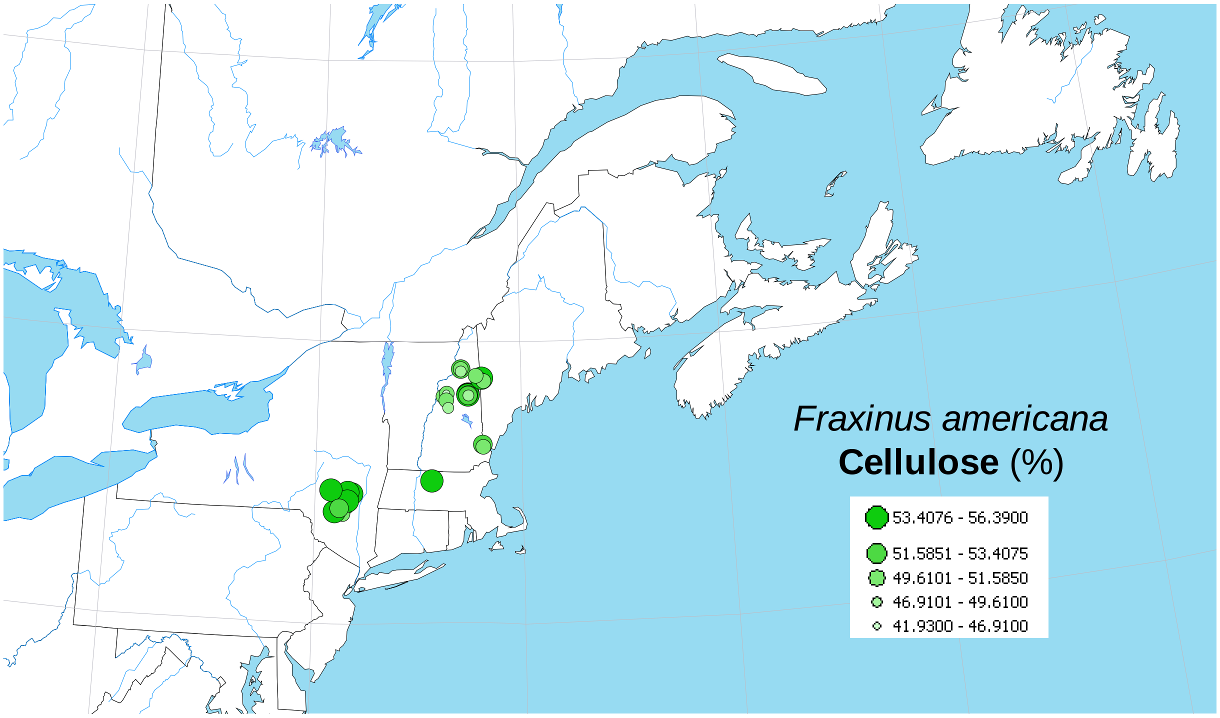
Figure 53. Maps for foliar cellulose in hardwood species. (figure spans multiple pages)






Acer rubrum
Cellulose (%)
32.6701 - 36.8000
30.9165 - 32.6700
29.2596 - 30.9164
27.5501 - 29.2595
25.6450 - 27.5500


Betula alleghaniensis
Cellulose (%)
41.1668 - 43.5900
39.5334 - 41.1667
38.3168 - 39.5333
36.5748 - 38.3167
34.4067 - 36.5747


Fraxinus americana
Cellulose (%)
53.4076 - 56.3900
51.5851 - 53.4075
49.6101 - 51.5850
46.9101 - 49.6100
41.9300 - 46.9100

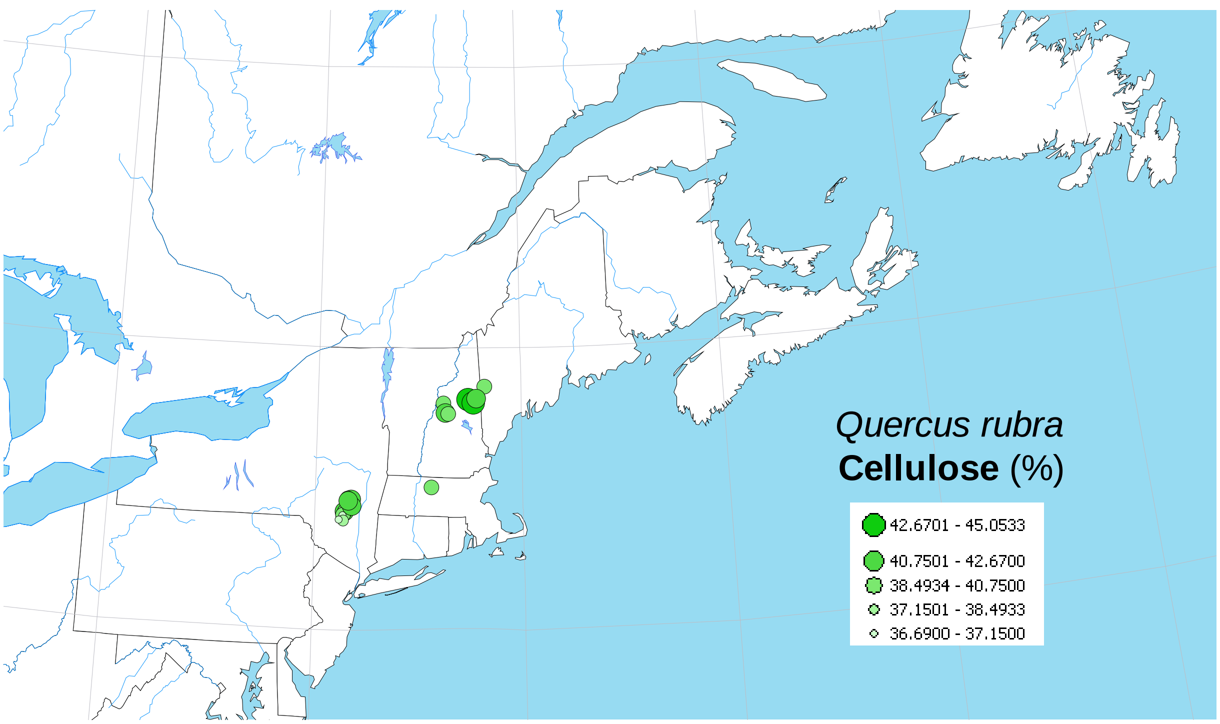
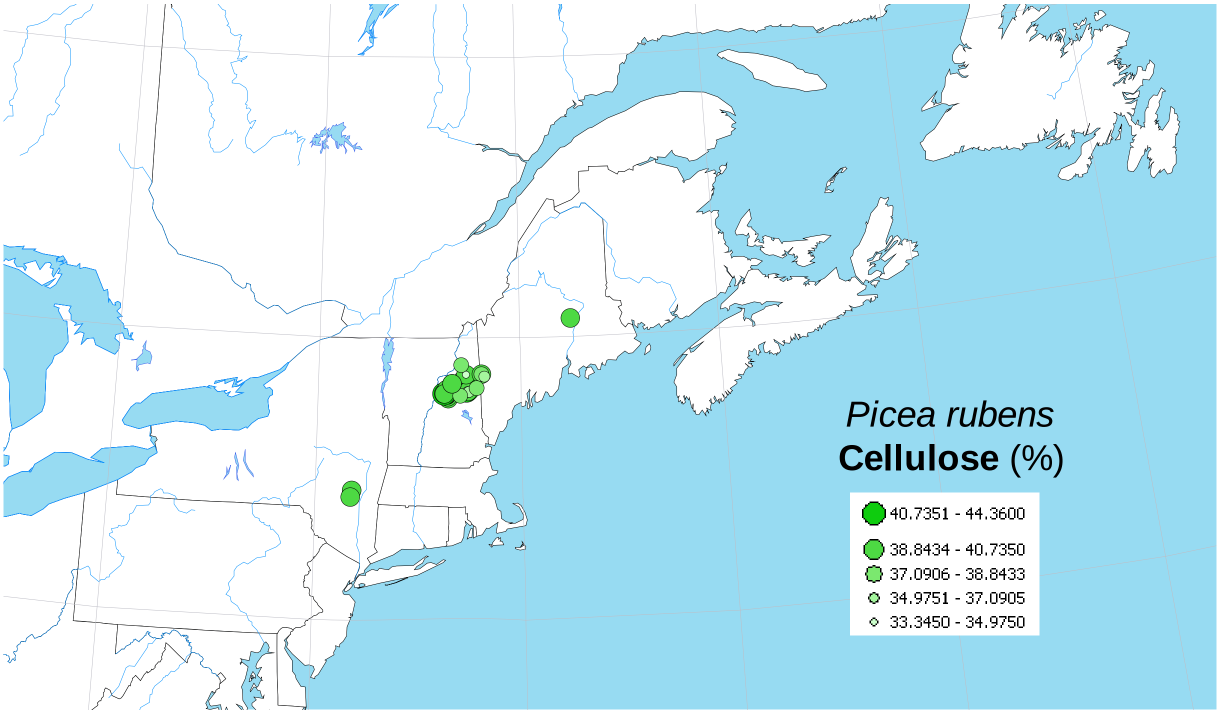

Quercus rubra
Cellulose (%)
42.6701 - 45.0533
40.7501 - 42.6700
38.4934 - 40.7500
37.1501 - 38.4933
36.6900 - 37.1500

Figure 54. Maps for foliar cellulose in softwood species.



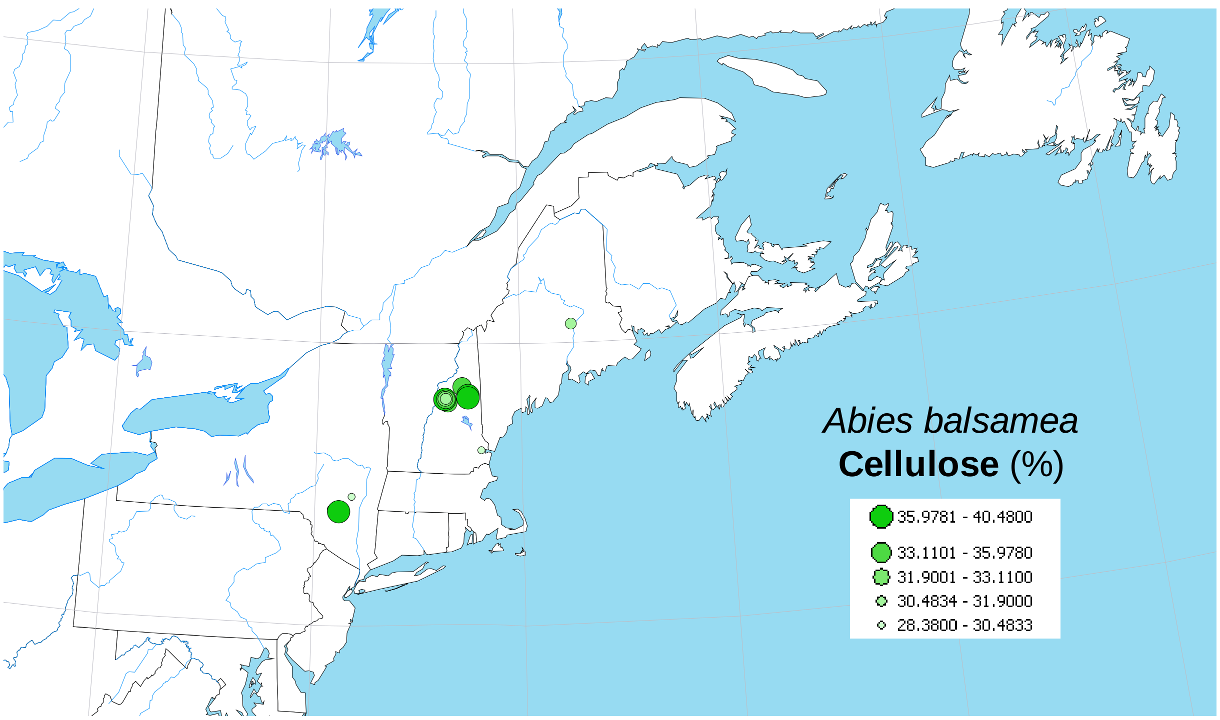
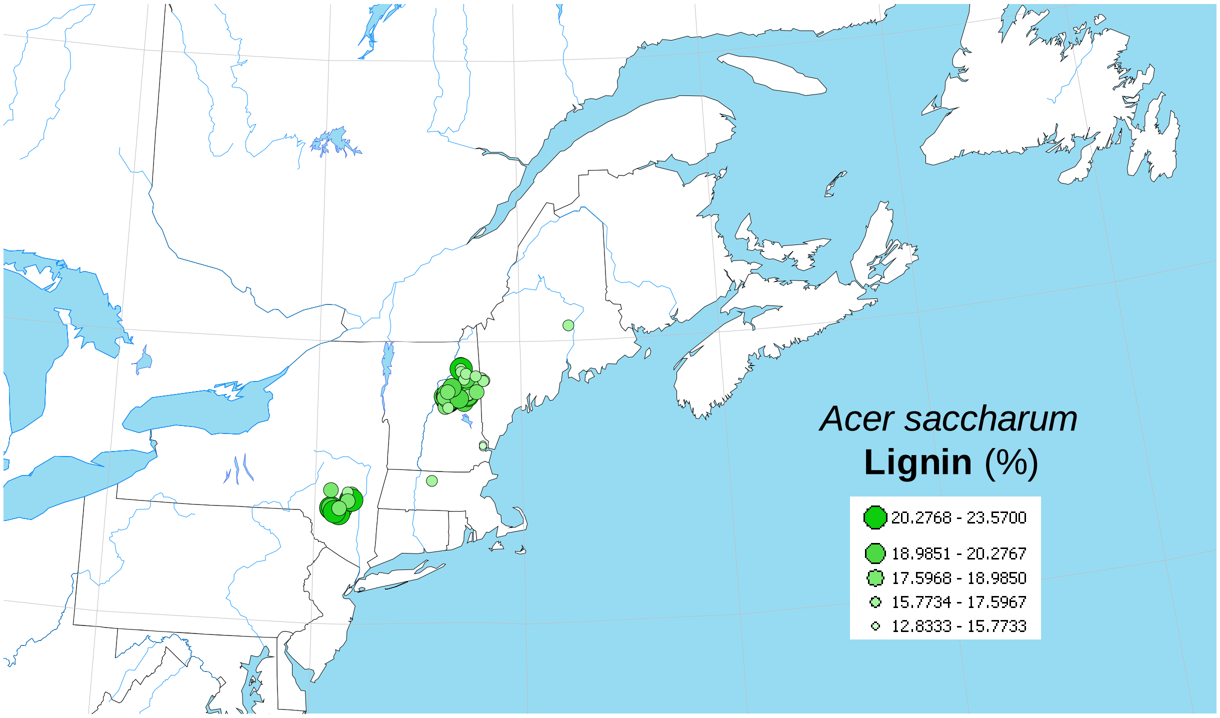
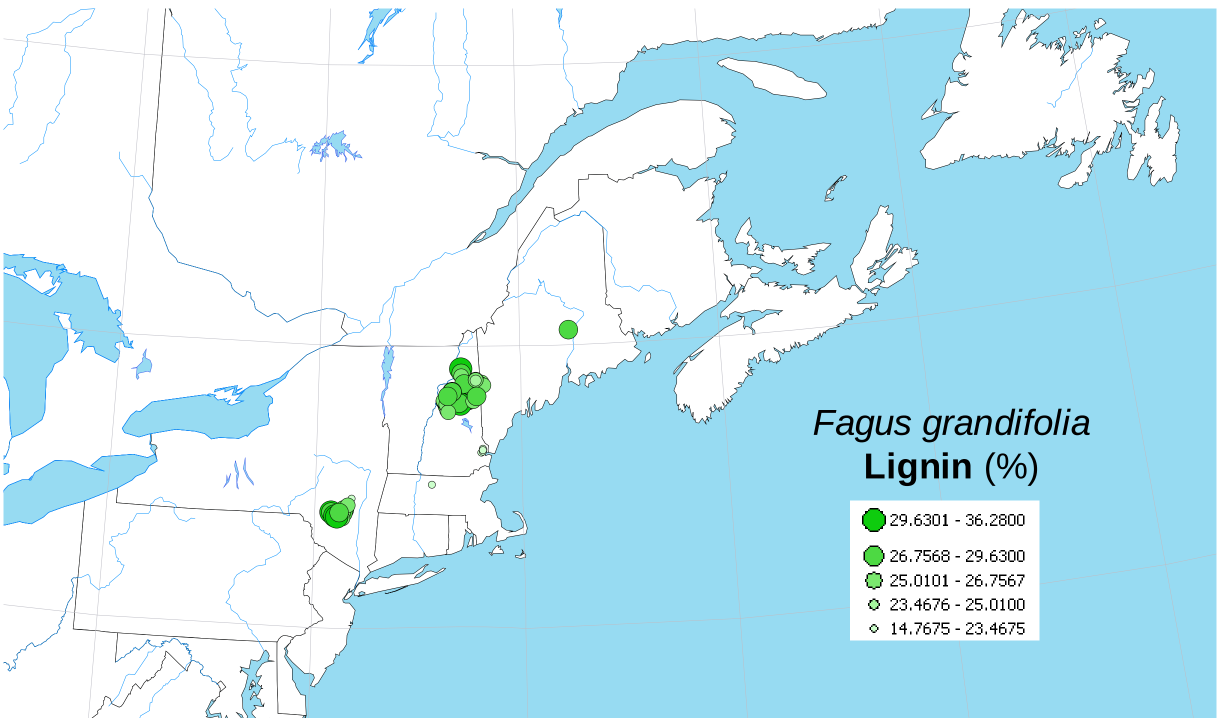
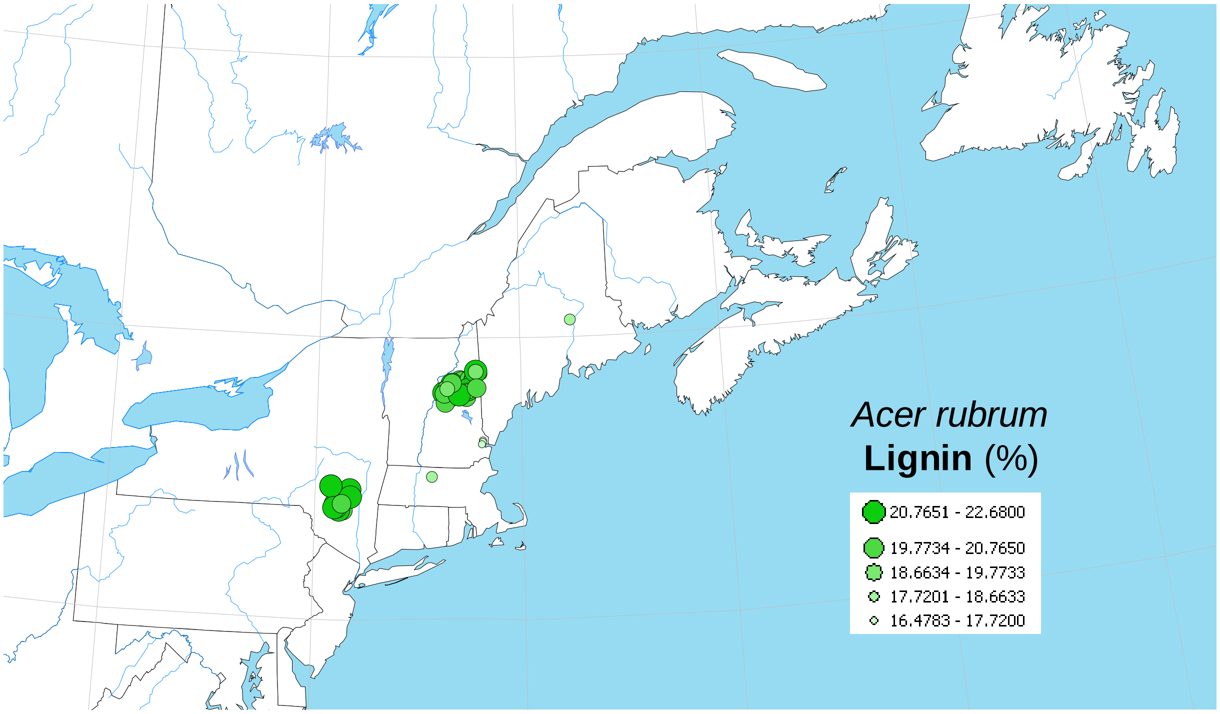
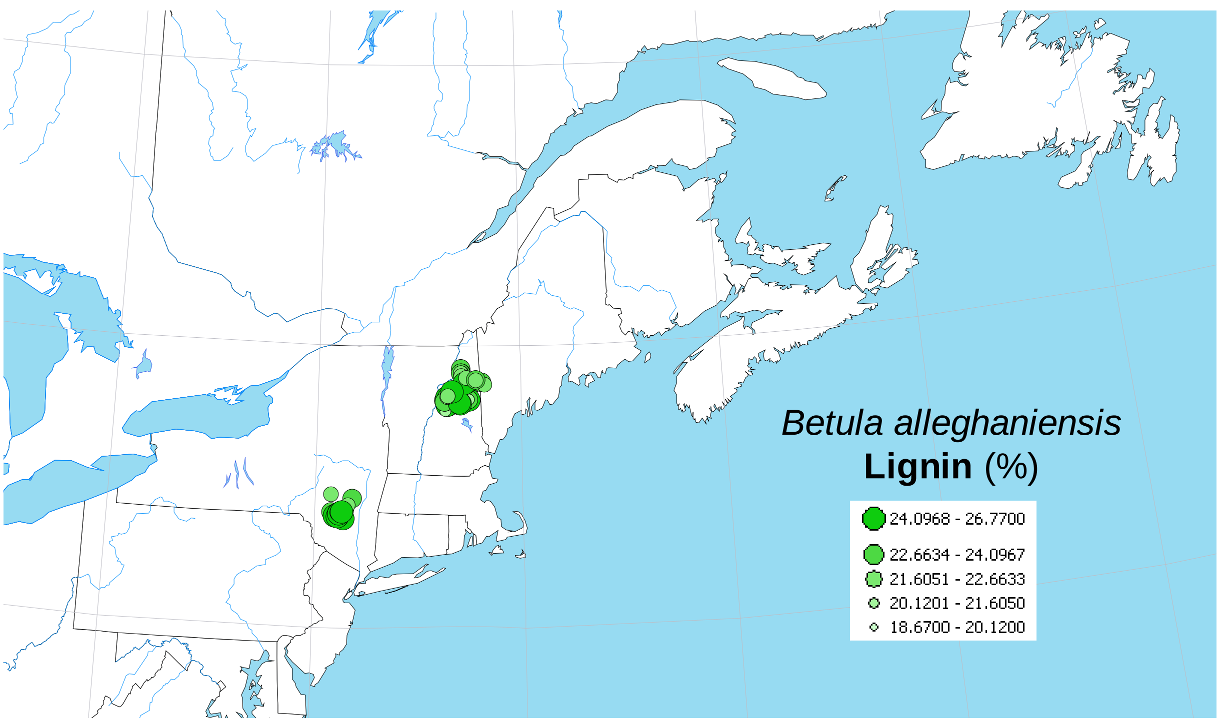


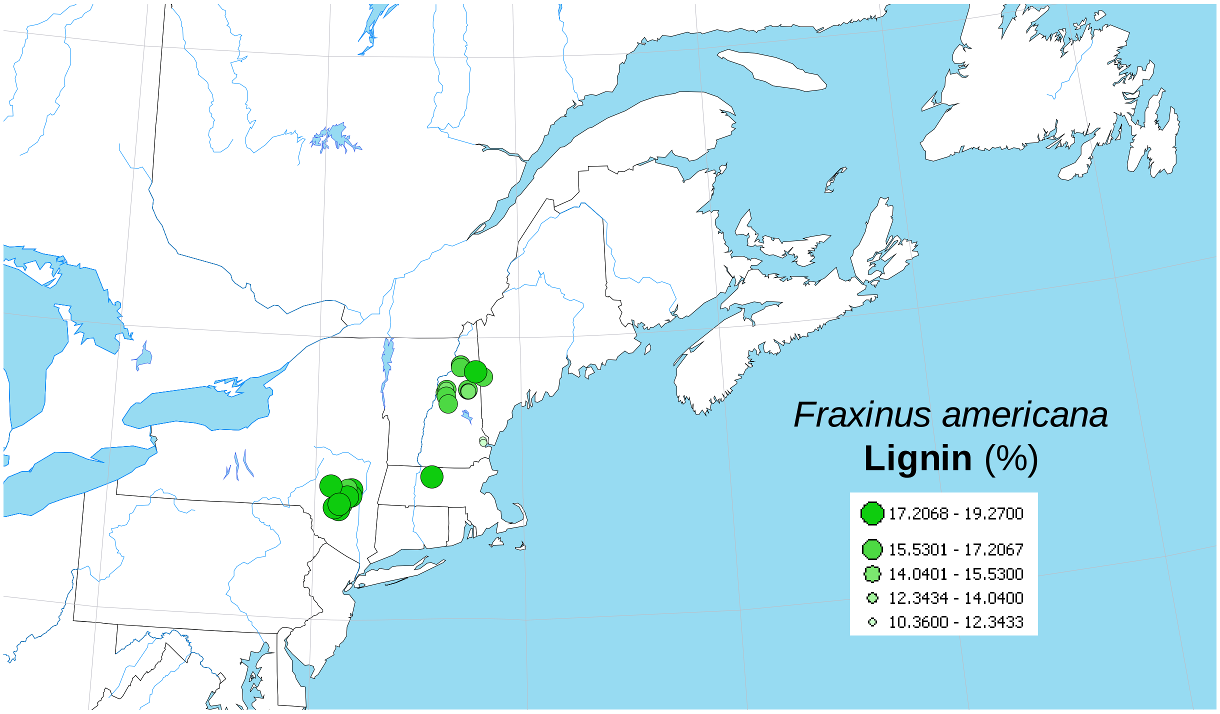
Figure 55. Maps for foliar lignin in hardwood species. (figure spans multiple pages)



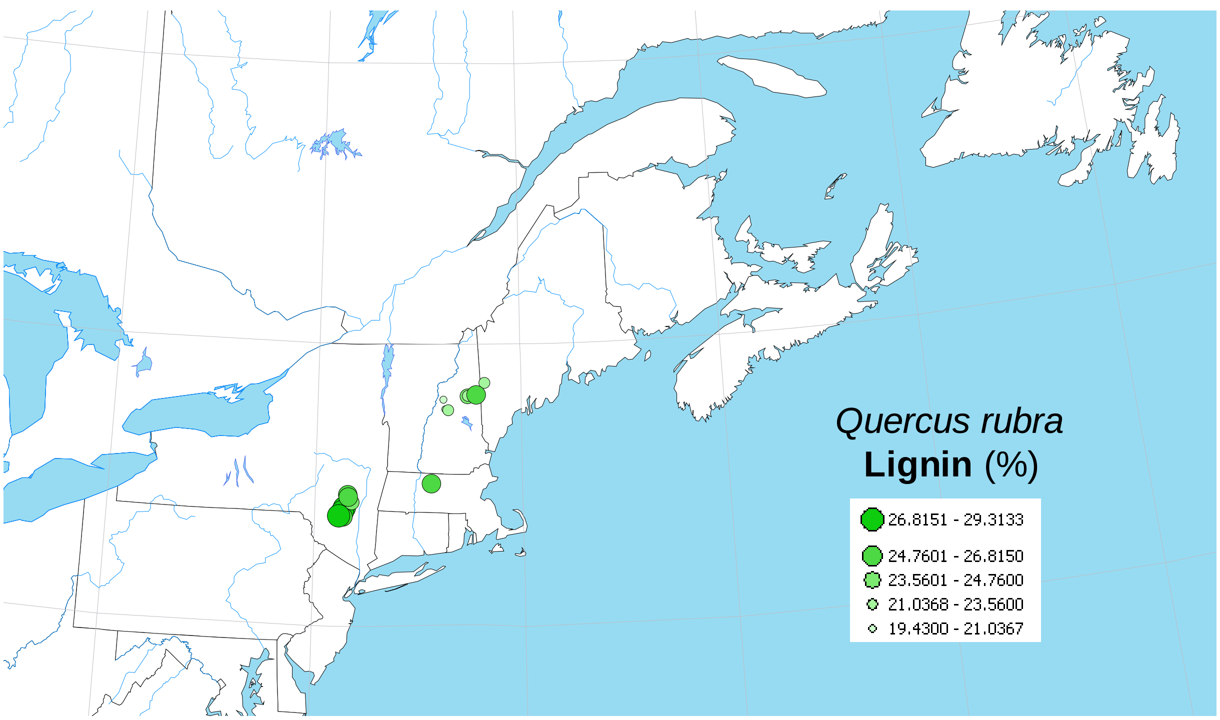



Acer rubrum
Lignin (%)
20.7651 - 22.6800
19.7734 - 20.7650
18.6634 - 19.7733
17.7201 - 18.6633
16.4783 - 17.7200


Betula alleghaniensis
Lignin (%)
24.0968 - 26.7700
22.6634 - 24.0967
21.6051 - 22.6633
20.1201 - 21.6050
18.6700 - 20.1200

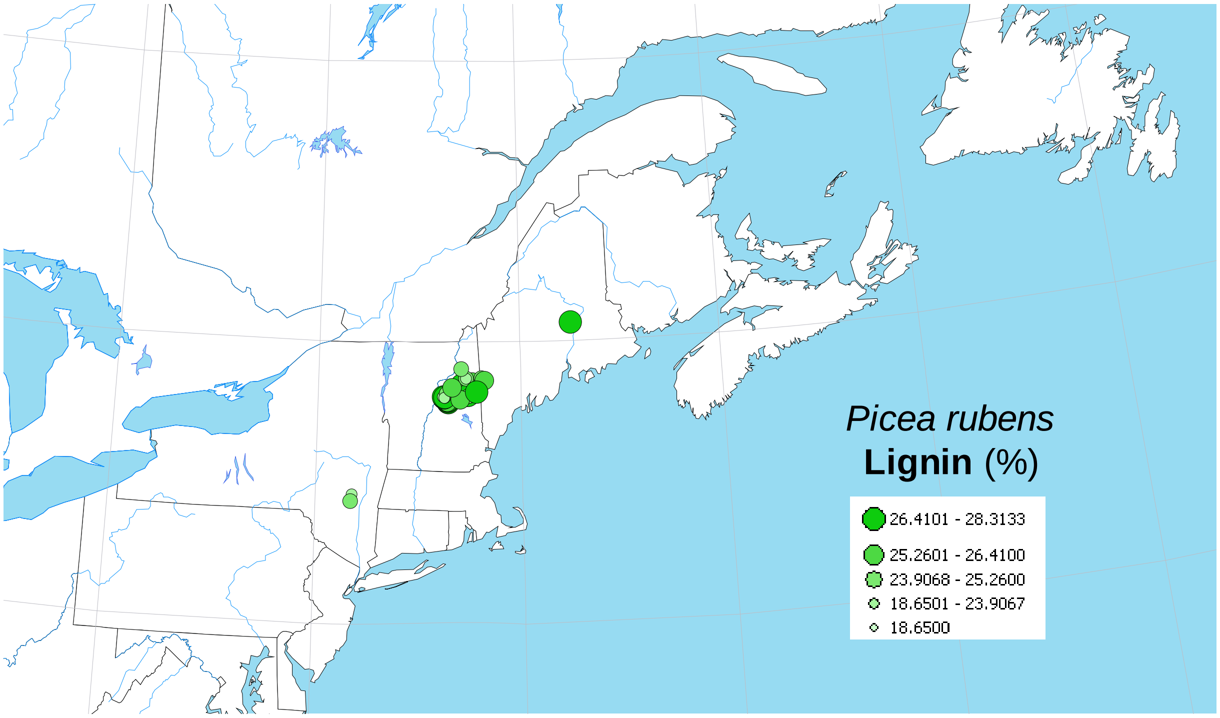


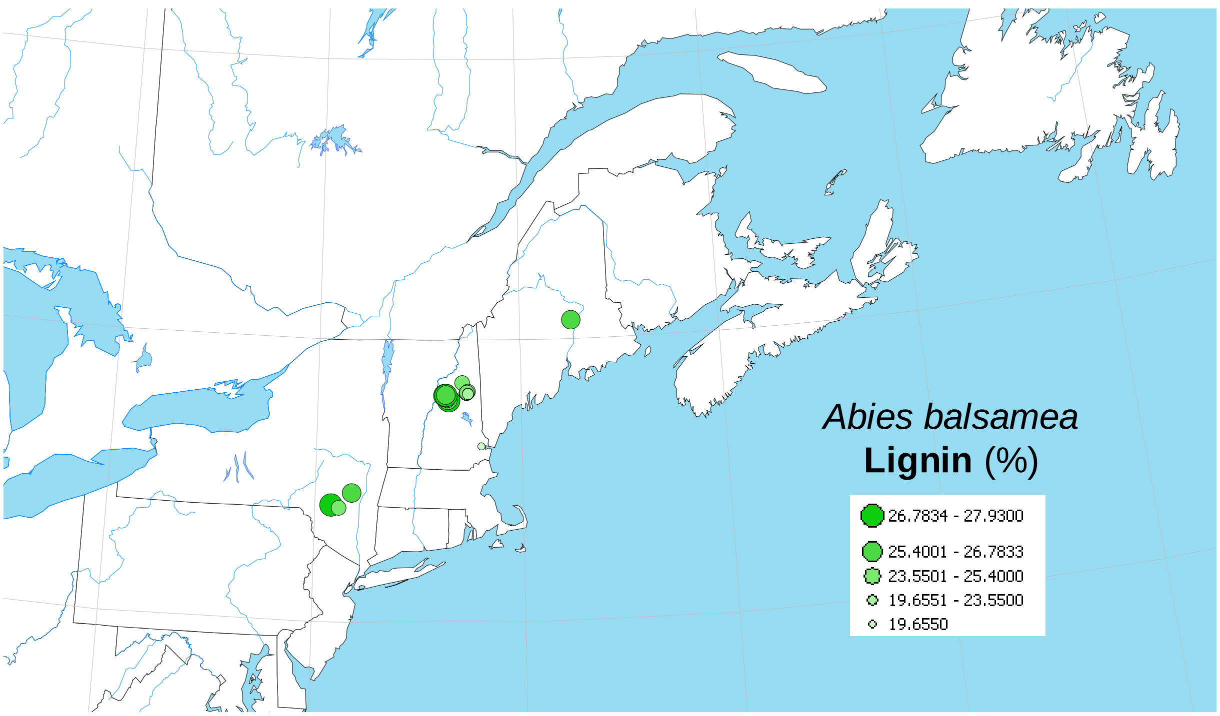
Fraxinus americana
Lignin (%)
17.2068 - 19.2700
15.5301 - 17.2067
14.0401 - 15.5300
12.3434 - 14.0400
10.3600 - 12.3433



Quercus rubra
Lignin (%)
26.8151 - 29.3133
24.7601 - 26.8150
23.5601 - 24.7600
21.0368 - 23.5600
19.4300 - 21.0367

Figure 56. Maps for foliar lignin in softwood species.





Appendix B-5: Foliar Chemistry Linear Regressions with Latitude, Longitude and Elevation

Table 2. Results of linear regression of each parameter against latitude, longitude and elevation. Trend indicates positive or negative correlation and R^2 coefficients for the relationship are given below. (table spans multiple pages)

Latitude

		Acer s.	Fagus g.	Acer r.	Betula a.	Fraxinus a.	Quercus r.	Picea r.	Abies b.
Trend	N	0	0	0	0	0	---	0	0
	Ca	0	0	0	0	0	0	0	+++
	Mg	0	0	0	0	---	0	0	+++
	K	0	0	0	0	0	0	0	0
	P	---	0	0	0	---	0	0	0
	Al	---	0	0	0	0	+++	0	0
	Sr	0	0	0	+++	+++	+++	+++	+++
	Cellulose	0	0	0	0	0	+++	0	0
	Lignin	0	0	---	0	0	---	0	0
R^2	N	0.0123	0.0241	0.0123	0.0139	0.0889	0.2814	0.0023	0.0068
	Ca	0.0498	0.0060	0.0044	0.0104	0.0070	0.0011	0.0225	0.1907
	Mg	0.0216	0.0011	0.0009	0.0005	0.1410	0.0473	0.0002	0.1006
	K	0.0162	0.0404	0.0179	0.0052	0.0657	0.0001	0.0185	0.0013
	P	0.1119	0.0733	0.0676	0.0529	0.1093	0.0374	0.0166	0.0028
	Al	0.1008	0.0186	0.0221	0.0286	0.0069	0.2011	0.0339	0.0126
	Sr	0.0589	0.0899	0.0494	0.1025	0.2527	0.3212	0.1210	0.2637
	Cellulose	0.0028	0.0005	0.0216	0.0110	0.0008	0.3370	0.0115	0.0140
	Lignin	0.0366	0.0344	0.1375	0.0498	0.0206	0.4365	0.0053	0.0020

Longitude

		Acer s.	Fagus g.	Acer r.	Betula a.	Fraxinus a.	Quercus r.	Picea r.	Abies b.
Trend	N	0	0	0	0	---	---	0	0
	Ca	0	0	0	0	0	0	0	+++
	Mg	0	0	0	0	0	+++	0	+++
	K	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0
	Al	---	0	0	0	0	0	0	0
	Sr	0	0	0	0	+++	+++	+++	0
	Cellulose	0	0	0	0	0	+++	0	0
	Lignin	0	---	---	0	0	---	0	0

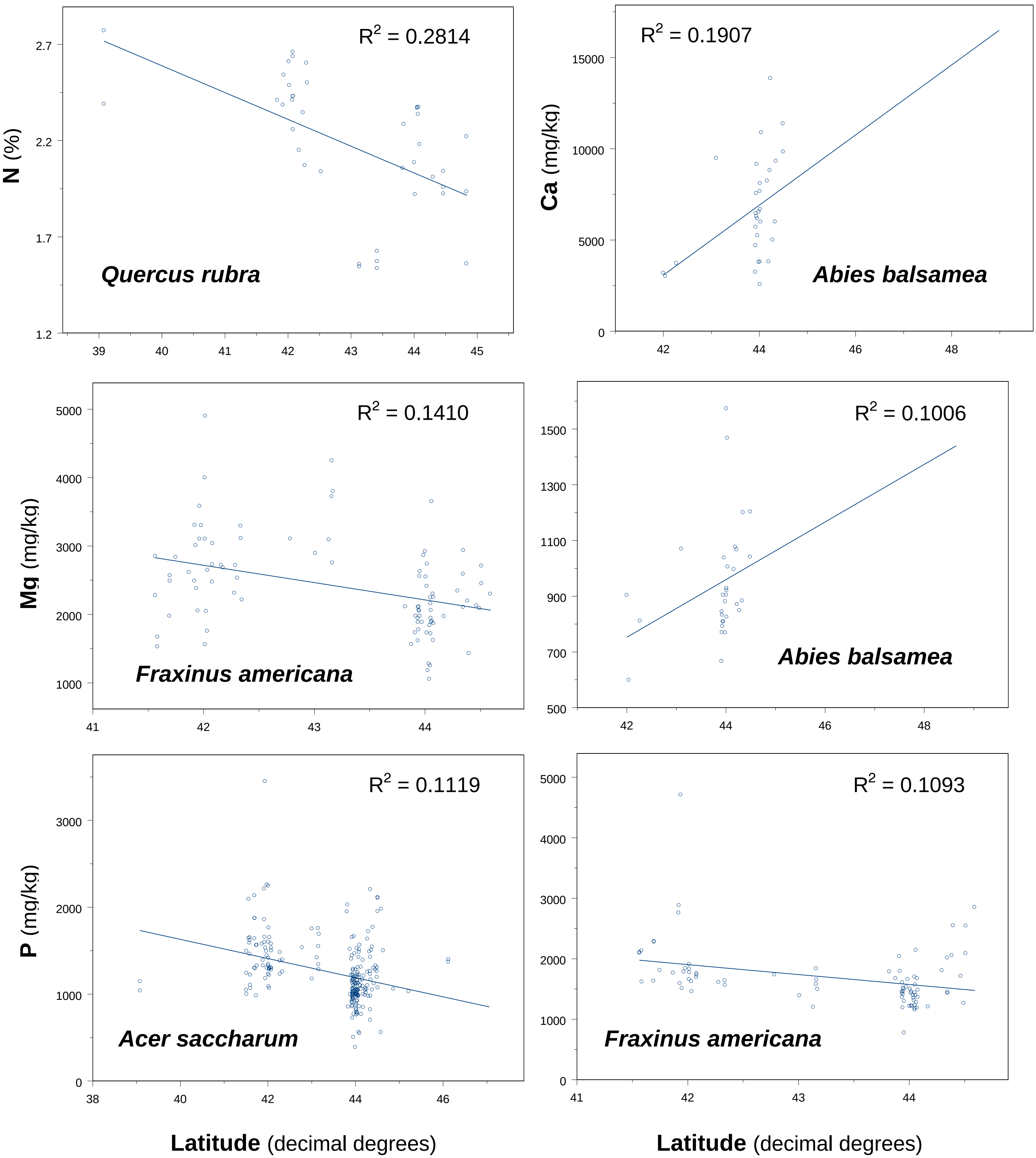
R²								
N	0.0387	0.0306	0.0387	0.0573	0.1808	0.2999	0.0562	0.0244
Ca	0.0685	0.0058	0.0021	0.0047	0.0001	0.0005	0.0140	0.1403
Mg	0.0630	0.0038	0.0002	0.0001	0.0680	0.1173	0.0028	0.1024
K	0.0297	0.0403	0.0278	0.0008	0.0219	0.0743	0.0225	0.0104
P	0.0982	0.0573	0.0208	0.0539	0.0687	0.0715	0.0000	0.0041
Al	0.2020	0.0211	0.0086	0.0056	0.0097	0.0623	0.0200	0.0861
Sr	0.0194	0.0394	0.0351	0.0568	0.2013	0.3195	0.1618	0.0621
Cellulose	0.0017	0.0273	0.0656	0.0025	0.0004	0.3465	0.0162	0.0001
Lignin	0.0942	0.1061	0.2826	0.0662	0.0683	0.3515	0.0000	0.0620

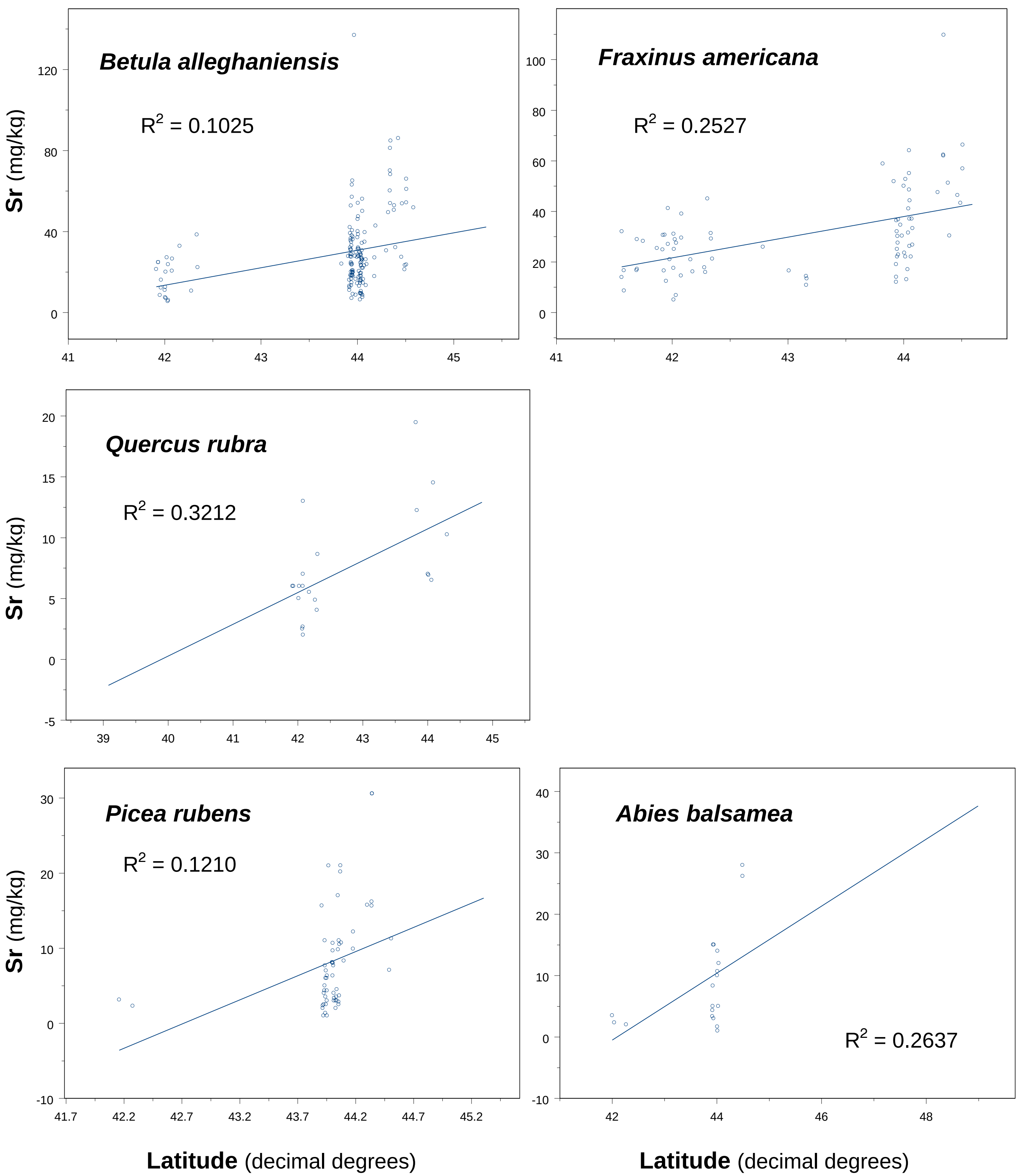
Elevation

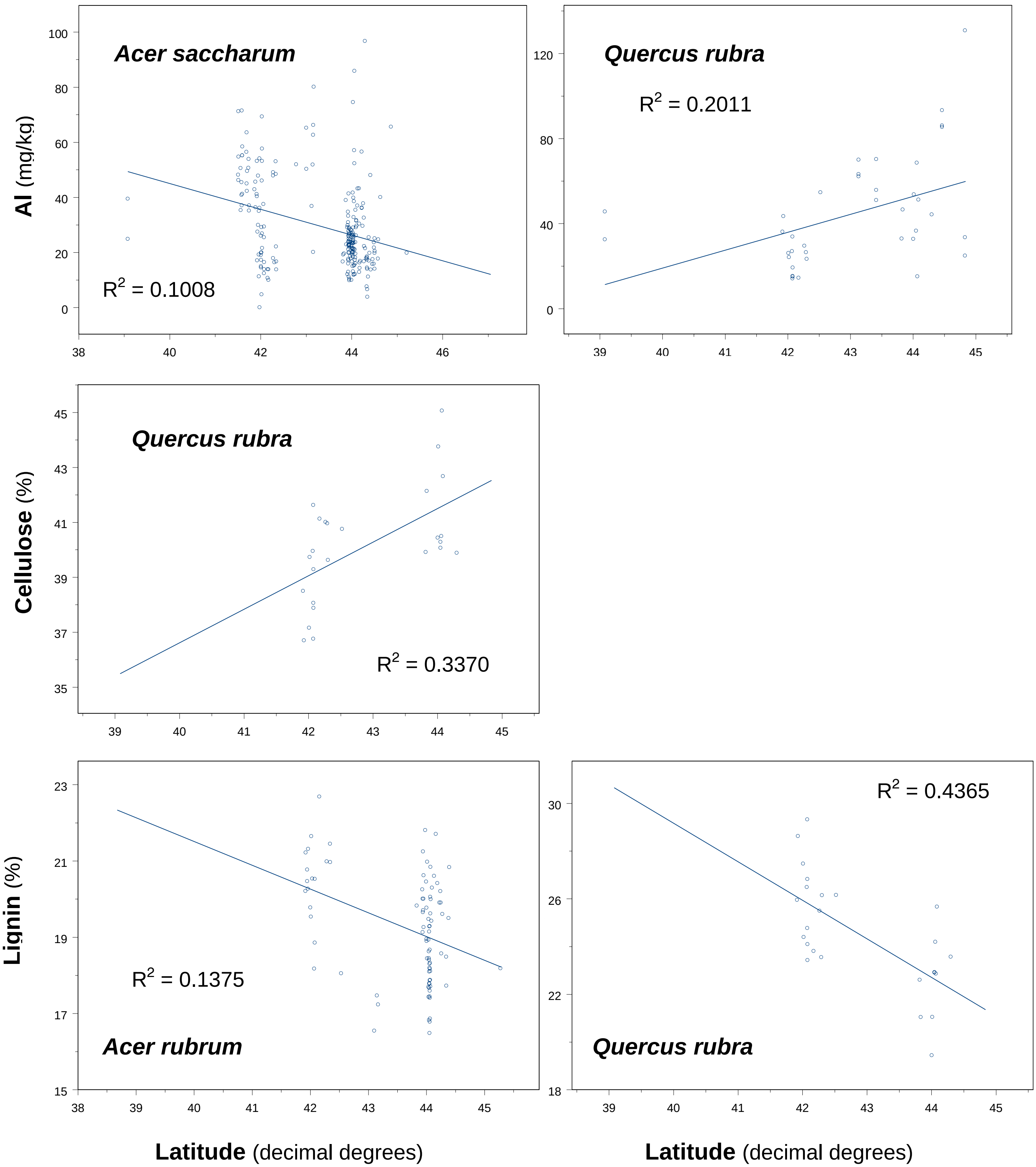
		Acer s.	Fagus g.	Acer r.	Betula a.	Fraxinus a.	Quercus r.	Picea r.	Abies b.
Trend	N	+++	+++	+++	+++	+++	+++	+++	+++
	Ca	0	0	0	---	---	0	---	---
	Mg	0	0	0	0	0	---	0	0
	K	0	0	0	0	0	0	---	---
	P	0	0	0	0	0	+++	0	0
	Al	0	0	0	0	0	---	0	---
	Sr	0	0	0	---	0	---	+++	---
	Cellulose	0	---	+++	0	---	---	0	0
	Lignin	+++	0	+++	0	+++	0	0	+++
R²	N	0.3683	0.2849	0.3683	0.2086	0.4209	0.6124	0.2780	0.1043
	Ca	0.0988	0.0585	0.0043	0.1273	0.3413	0.0471	0.1430	0.2385
	Mg	0.0690	0.0678	0.0065	0.0961	0.0779	0.1302	0.0218	0.0541
	K	0.0258	0.0189	0.0302	0.0145	0.0071	0.0007	0.2152	0.1560
	P	0.0164	0.0067	0.0282	0.0322	0.0942	0.1051	0.0005	0.0114
	Al	0.0424	0.0002	0.0006	0.0026	0.0062	0.3273	0.0062	0.5345
	Sr	0.0478	0.0760	0.0056	0.1532	0.0817	0.1325	0.5517	0.4748
	Cellulose	0.0230	0.2141	0.2011	0.0080	0.2800	0.4083	0.0437	0.0043
	Lignin	0.2869	0.0855	0.4103	0.0050	0.1135	0.0781	0.0669	0.3627

‘**---**’ indicates a significant negative relationship with an r2 >0.10.
‘**+++**’ indicates a significant positive relationship with r2 >0.10.
‘0’ indicates either no significant relationship or significant with an r2 < 0.10.

Figure 57. Graphs of parameters with strongest trends with latitude. (figure spans multiple pages)

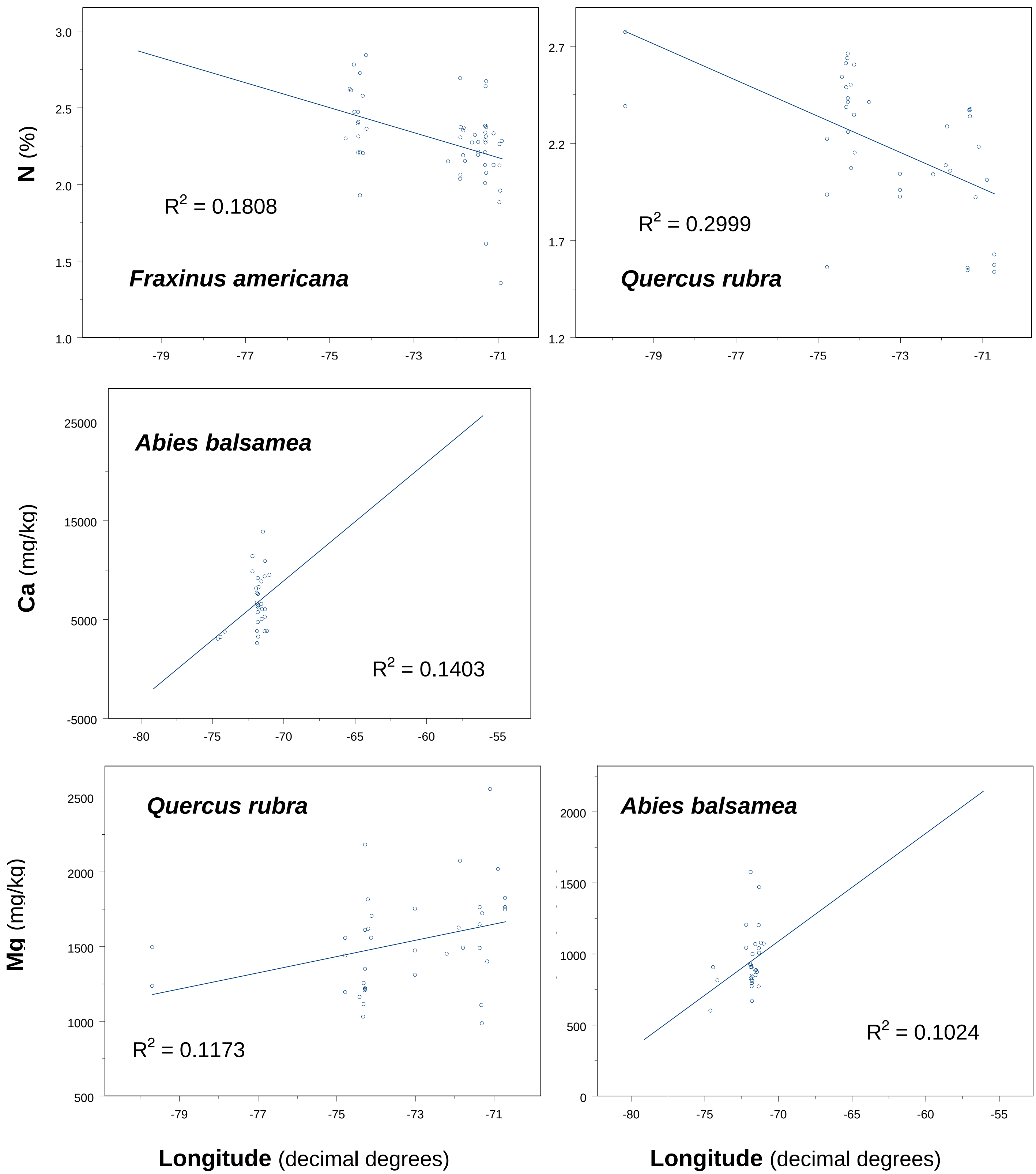


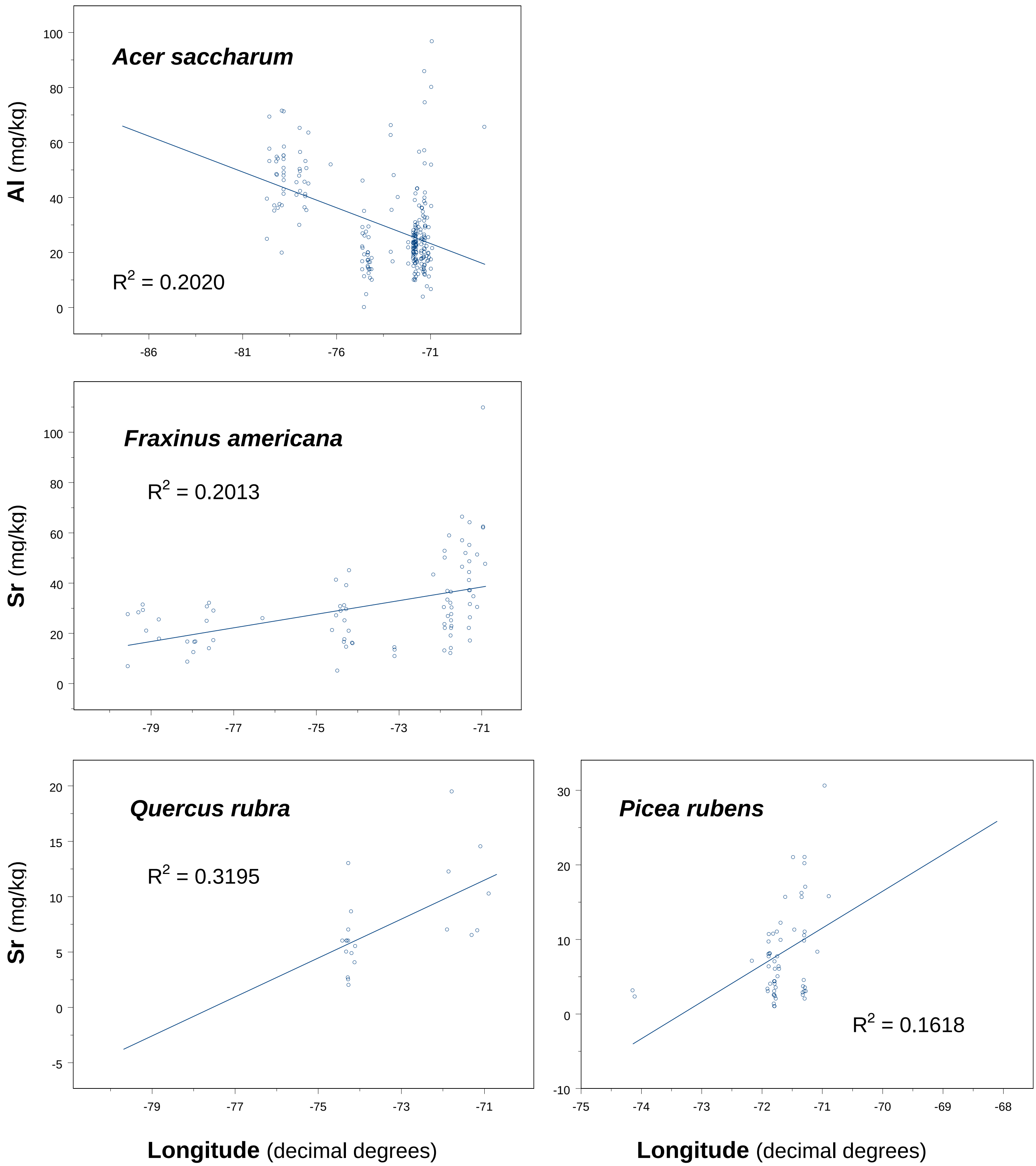

Betula alleghaniensis
R2 = 0.1025
Fraxinus americana
R2 = 0.2527
Quercus rubra
R2 = 0.3212
Picea rubens
R2 = 0.1210
Abies balsamea
R2 = 0.2637
Sr (mg/kg)
Sr (mg/kg)
Sr (mg/kg)
Latitude (decimal degrees)
Latitude (decimal degrees)



Acer saccharum
R2 = 0.1008
Al (mg/kg)
100
80
60
40
20
0
38
40
42
44
46
Quercus rubra
R2 = 0.2011
120
80
40
0
39
40
41
42
43
44
45
Quercus rubra
R2 = 0.3370
Cellulose (%)
45
43
41
39
37
35
39
40
41
42
43
44
45
Acer rubrum
R2 = 0.1375
Lignin (%)
23
21
19
17
15
38
39
40
41
42
43
44
45
Quercus rubra
R2 = 0.4365
30
26
22
18
39
40
41
42
43
44
45
Latitude (decimal degrees)
Latitude (decimal degrees)

Figure 58. Graphs of parameters with strongest trends with longitude. (figure spans multiple pages)




Acer saccharum
R^2 = 0.2020
Al (mg/kg)
Fraxinus americana
R^2 = 0.2013
Sr (mg/kg)
Quercus rubra
R^2 = 0.3195
Sr (mg/kg)
Picea rubens
R^2 = 0.1618
Longitude (decimal degrees)
Longitude (decimal degrees)

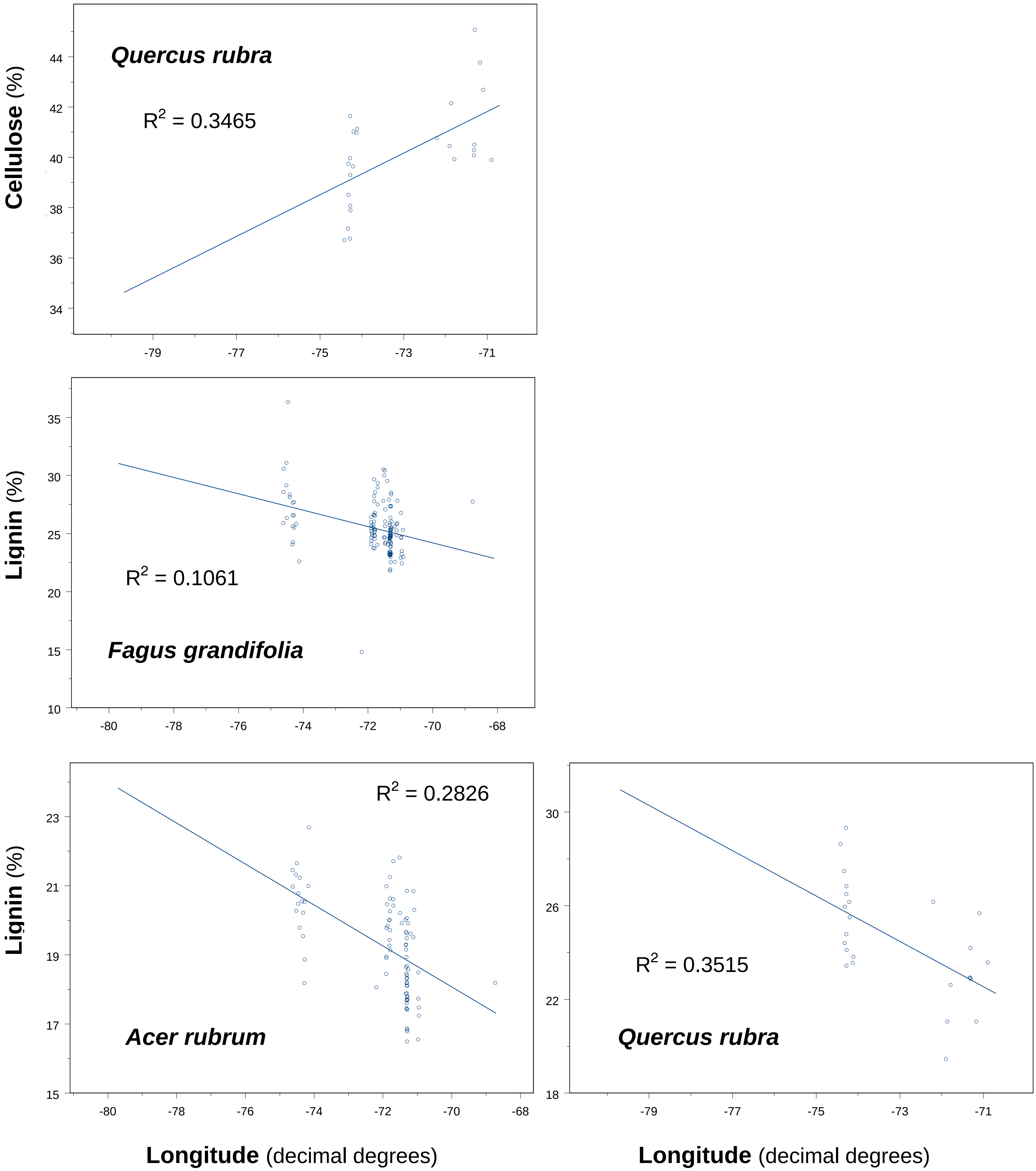
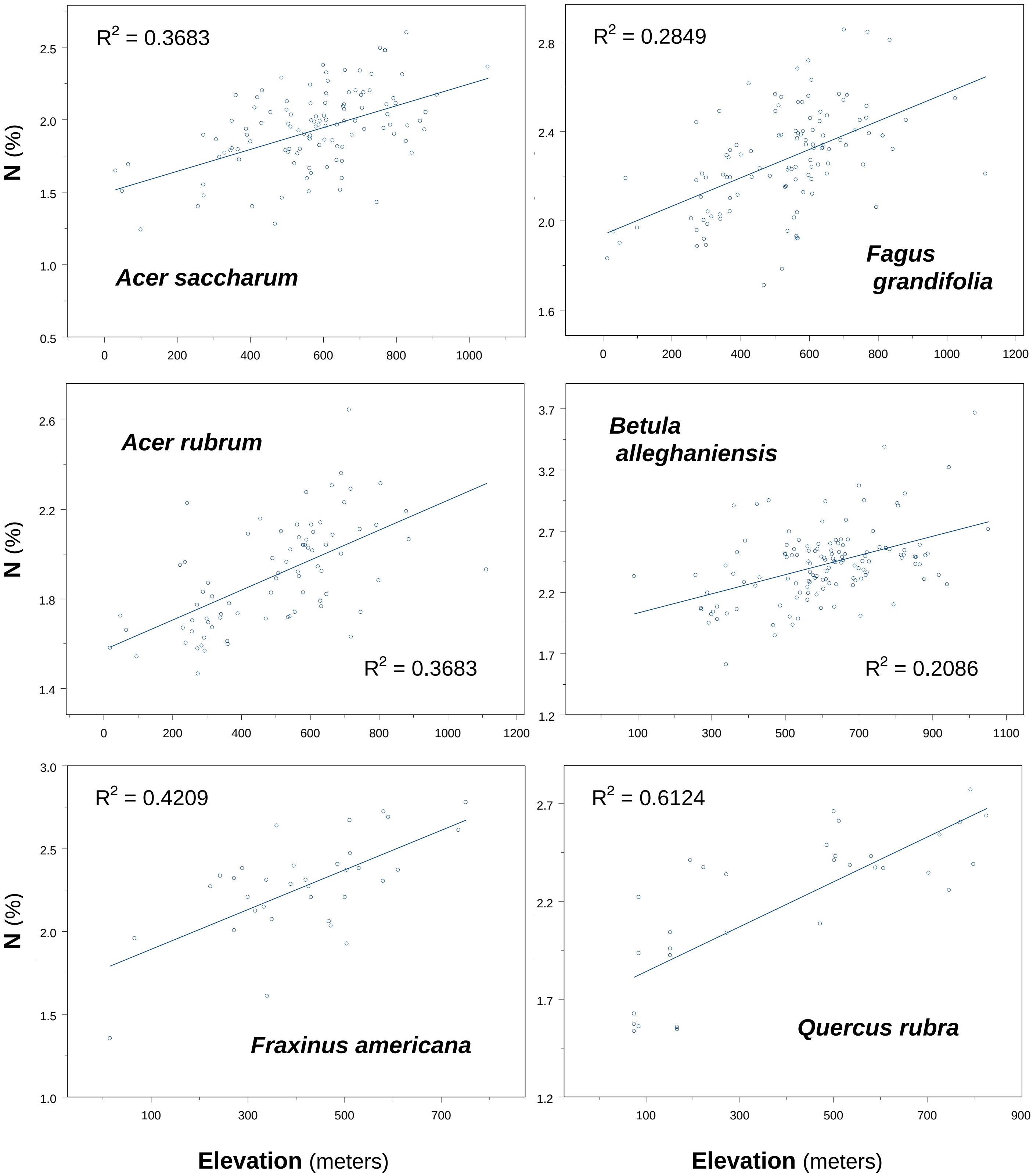
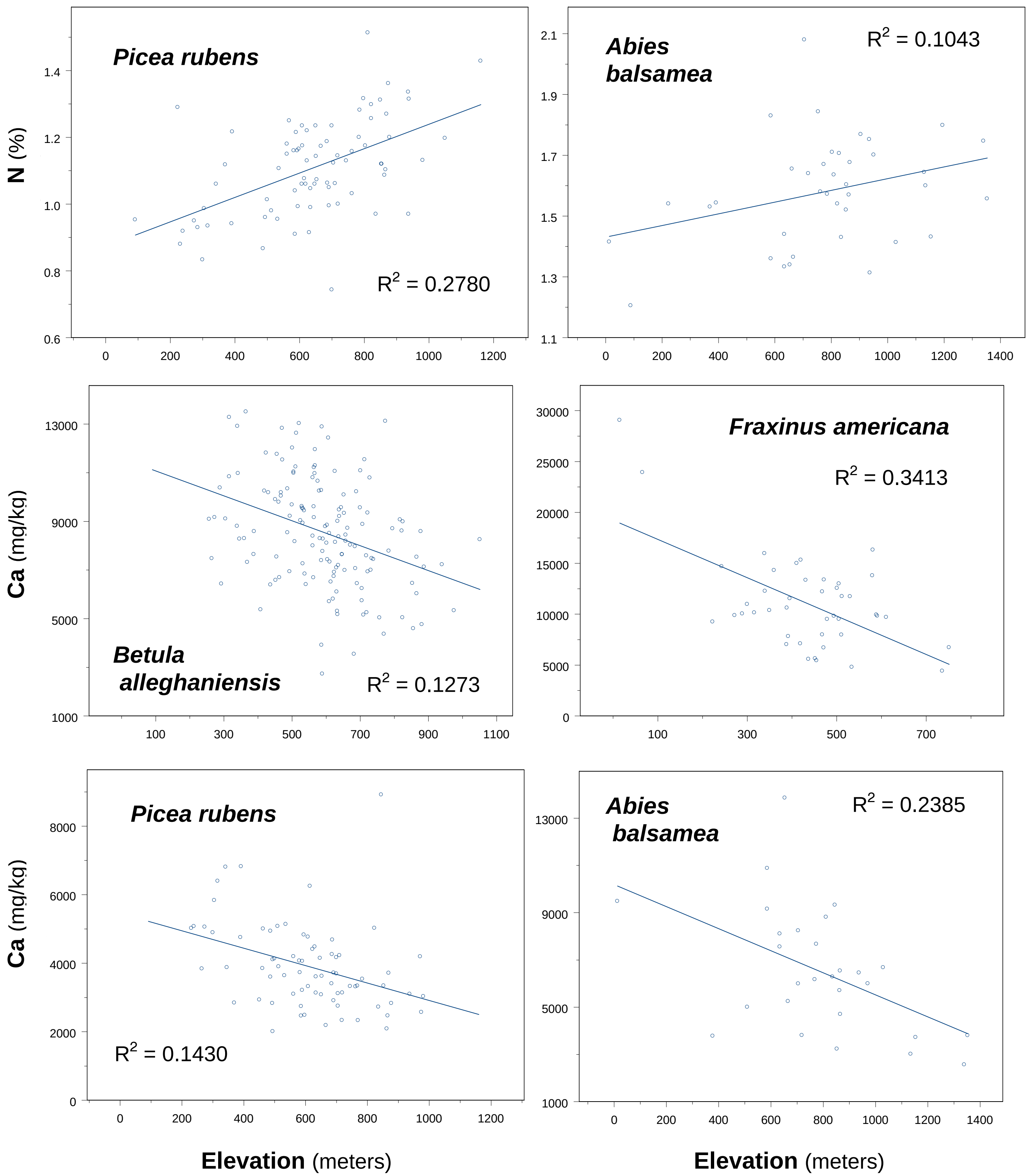
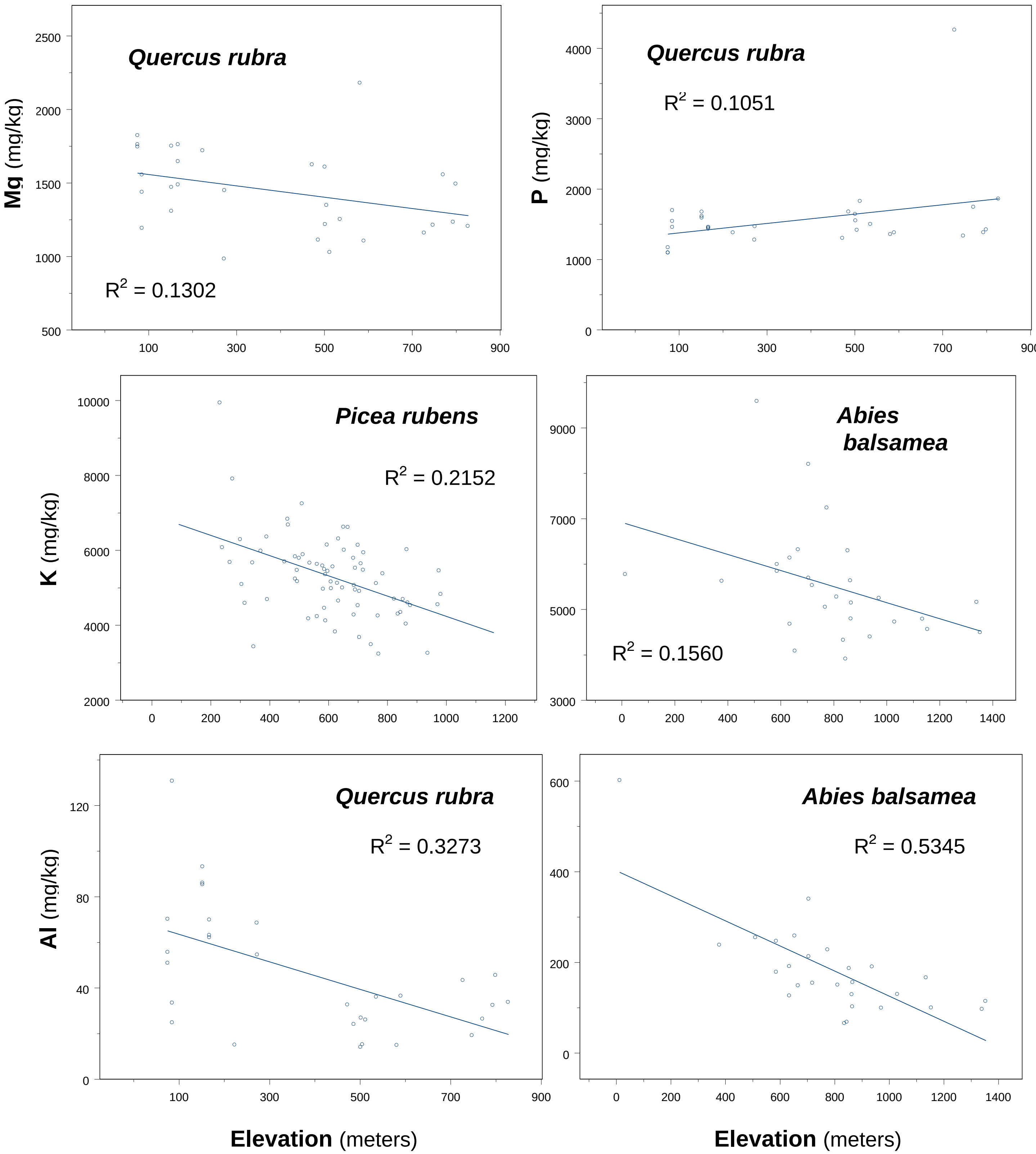
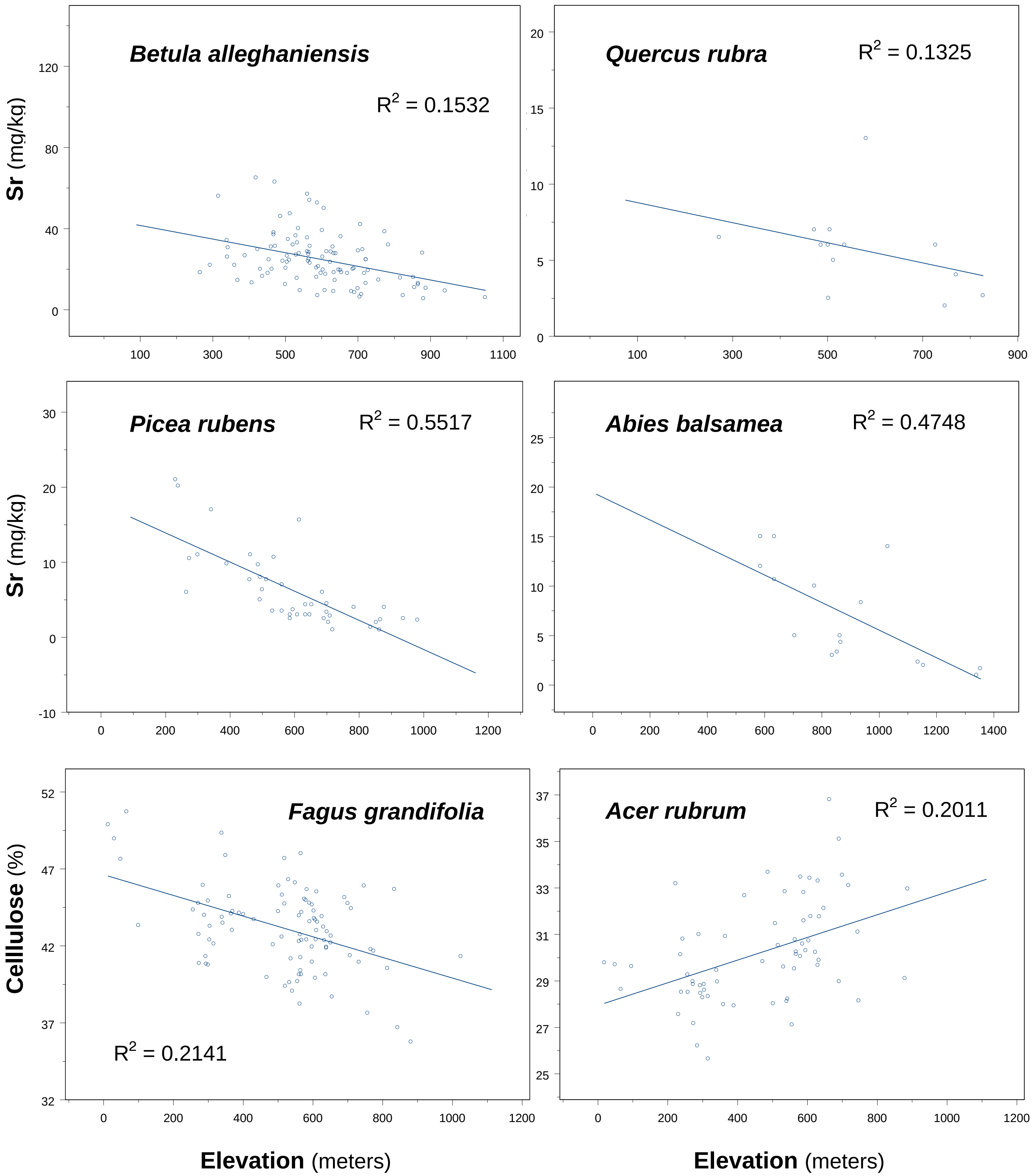

Quercus rubra
R^2 = 0.3465
Cellulose (%)
44
42
40
38
36
34
-79
-77
-75
-73
-71
Lignin (%)
35
30
25
20
15
10
R^2 = 0.1061
Fagus grandifolia
-80
-78
-76
-74
-72
-70
-68
Lignin (%)
23
21
19
17
15
R^2 = 0.2826
Acer rubrum
-80
-78
-76
-74
-72
-70
-68
30
26
22
18
R^2 = 0.3515
Quercus rubra
-79
-77
-75
-73
-71
Longitude (decimal degrees)
Longitude (decimal degrees)

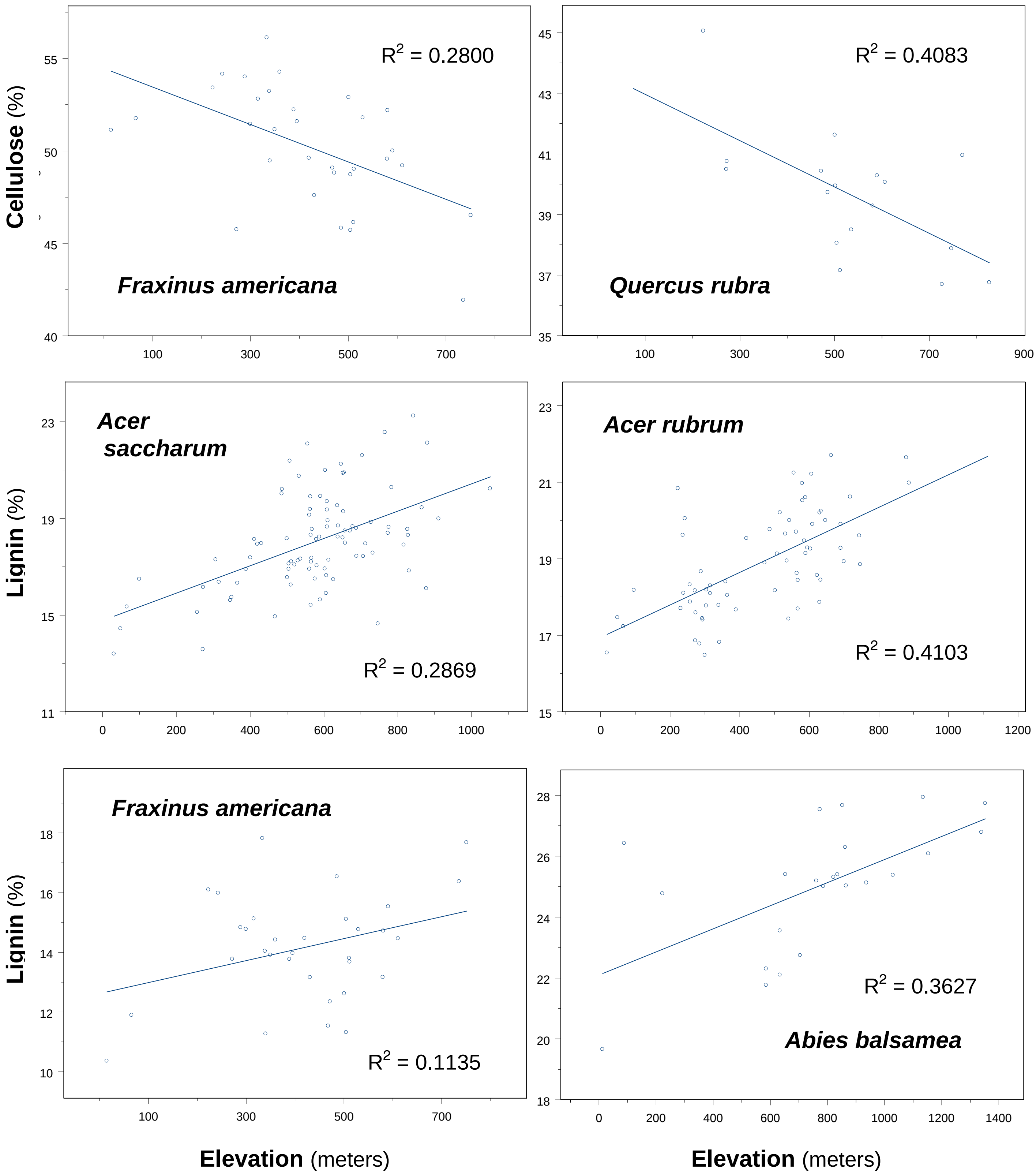
Figure 59. Graphs of parameters with strongest trends with elevation. (figure spans multiple pages)




Picea rubens
R2 = 0.2780
N (%)
1.4
1.2
1.0
0.8
0.6
0
200
400
600
800
1000
1200
Abies balsamea
R2 = 0.1043
2.1
1.9
1.7
1.5
1.3
1.1
0
200
400
600
800
1000
1200
1400
Betula alleghaniensis
R2 = 0.1273
Ca (mg/kg)
13000
9000
5000
1000
100
300
500
700
900
1100
Fraxinus americana
R2 = 0.3413
30000
25000
20000
15000
10000
5000
0
100
300
500
700
Picea rubens
R2 = 0.1430
Ca (mg/kg)
8000
6000
4000
2000
0
0
200
400
600
800
1000
1200
Abies balsamea
R2 = 0.2385
13000
9000
5000
1000
0
200
400
600
800
1000
1200
1400
Elevation (meters)
Elevation (meters)


Quercus rubra
R² = 0.1302
Mg (mg/kg)
Quercus rubra
R² = 0.1051
P (mg/kg)
Picea rubens
R² = 0.2152
K (mg/kg)
Abies balsamea
R² = 0.1560
Quercus rubra
R² = 0.3273
Al (mg/kg)
Abies balsamea
R² = 0.5345
Elevation (meters)
Elevation (meters)


Betula alleghaniensis
R2 = 0.1532
Quercus rubra
R2 = 0.1325
Picea rubens
R2 = 0.5517
Abies balsamea
R2 = 0.4748
Fagus grandifolia
R2 = 0.2141
Acer rubrum
R2 = 0.2011
Sr (mg/kg)
Sr (mg/kg)
Cellulose (%)
Elevation (meters)
Elevation (meters)

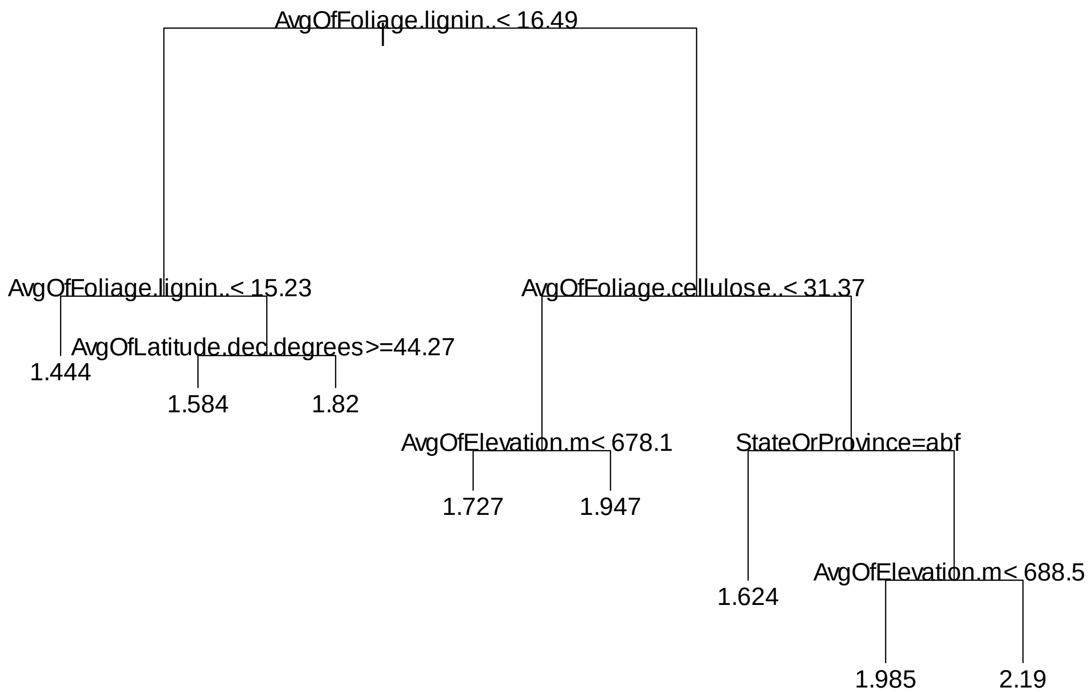


R2 = 0.2800
Fraxinus americana
Cellulose (%)
55
50
45
40
100
300
500
700
R2 = 0.4083
Quercus rubra
45
43
41
39
37
35
100
300
500
700
900
Acer saccharum
R2 = 0.2869
Lignin (%)
23
19
15
11
0
200
400
600
800
1000
Acer rubrum
R2 = 0.4103
23
21
19
17
15
0
200
400
600
800
1000
1200
Fraxinus americana
R2 = 0.1135
Lignin (%)
18
16
14
12
10
100
300
500
700
R2 = 0.3627
Abies balsamea
28
26
24
22
20
18
0
200
400
600
800
1000
1200
1400
Elevation (meters)
Elevation (meters)

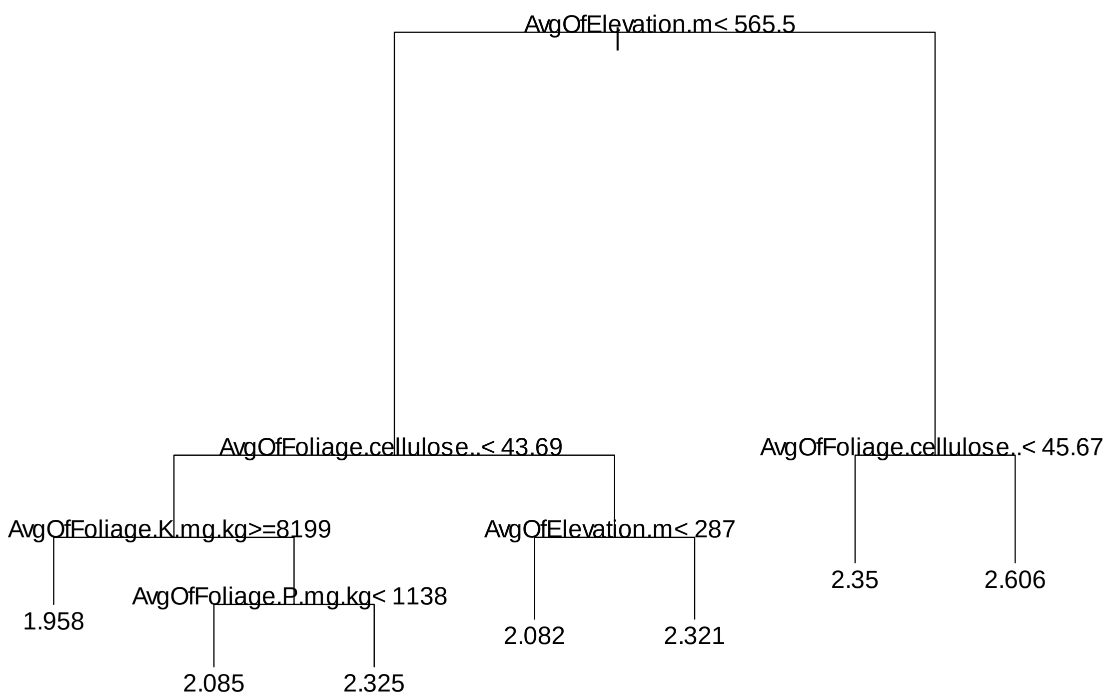
Appendix B-6: Foliar Chemistry Classification and Regression Trees (CART)

Figure 60. Classification and regression trees (CART) for foliar nitrogen in hardwood species. (figure spans multiple pages)

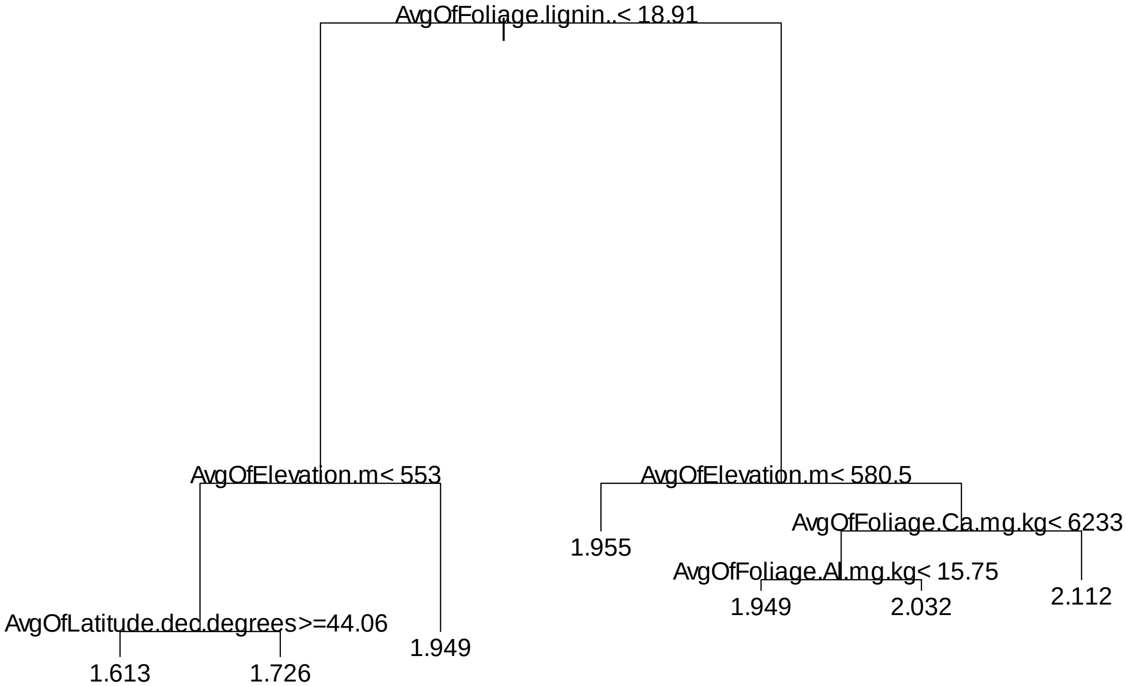
N : *Acer saccharum*



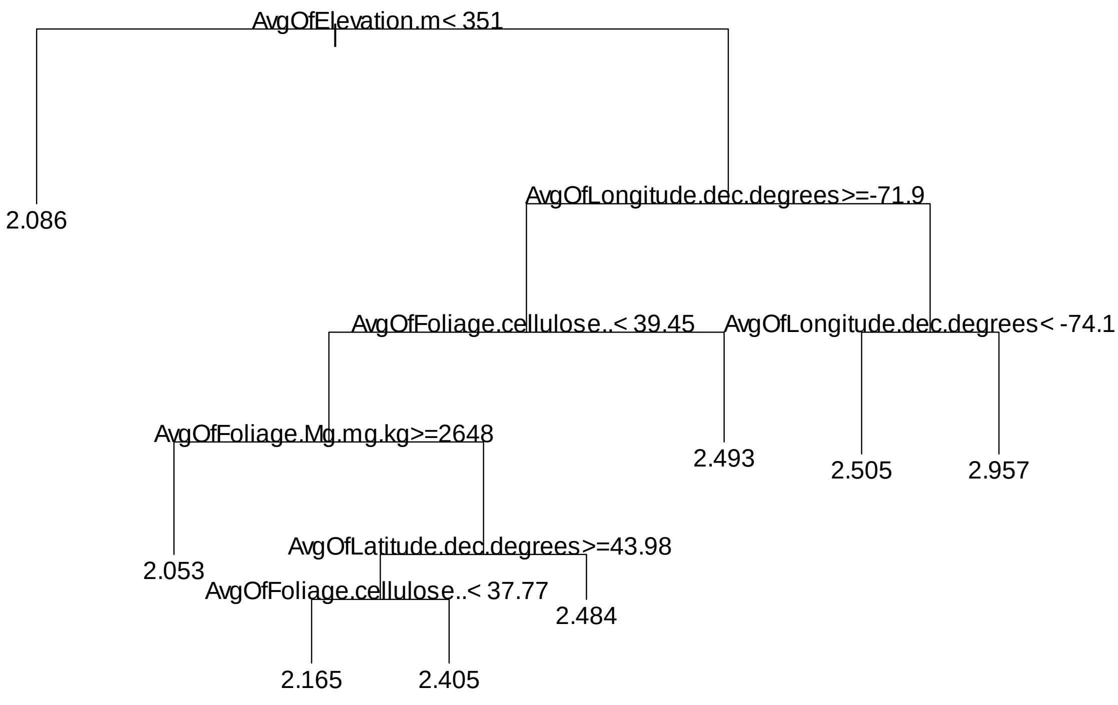
N : *Fagus grandifolia*



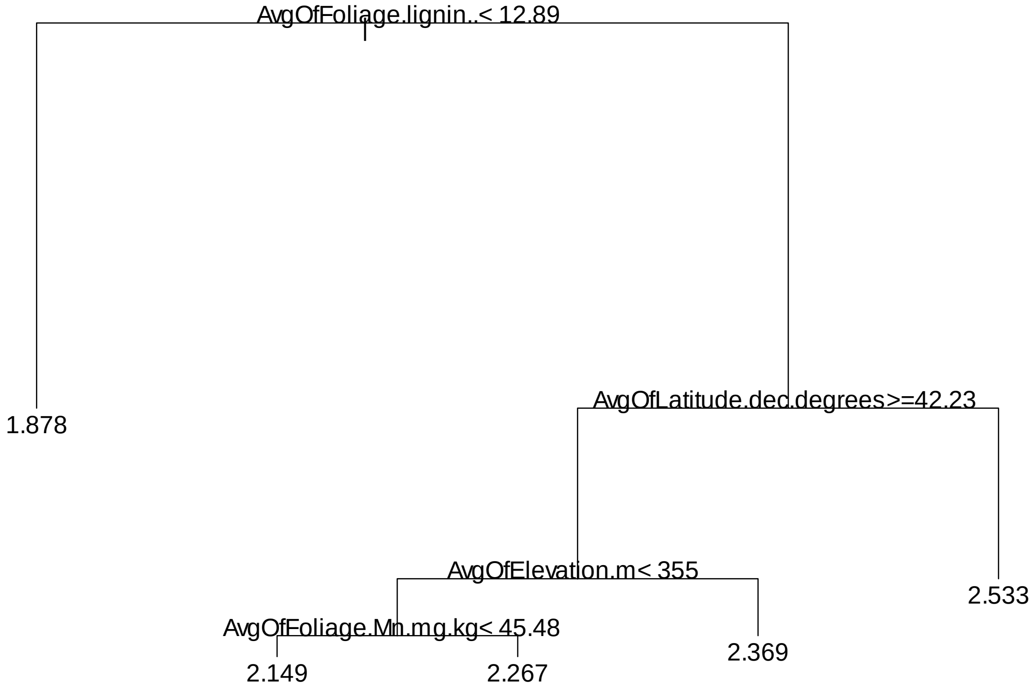
N : *Acer rubrum*



N : *Betula alleghaniensis*



N : *Fraxinus americana*



N : *Quercus rubra*

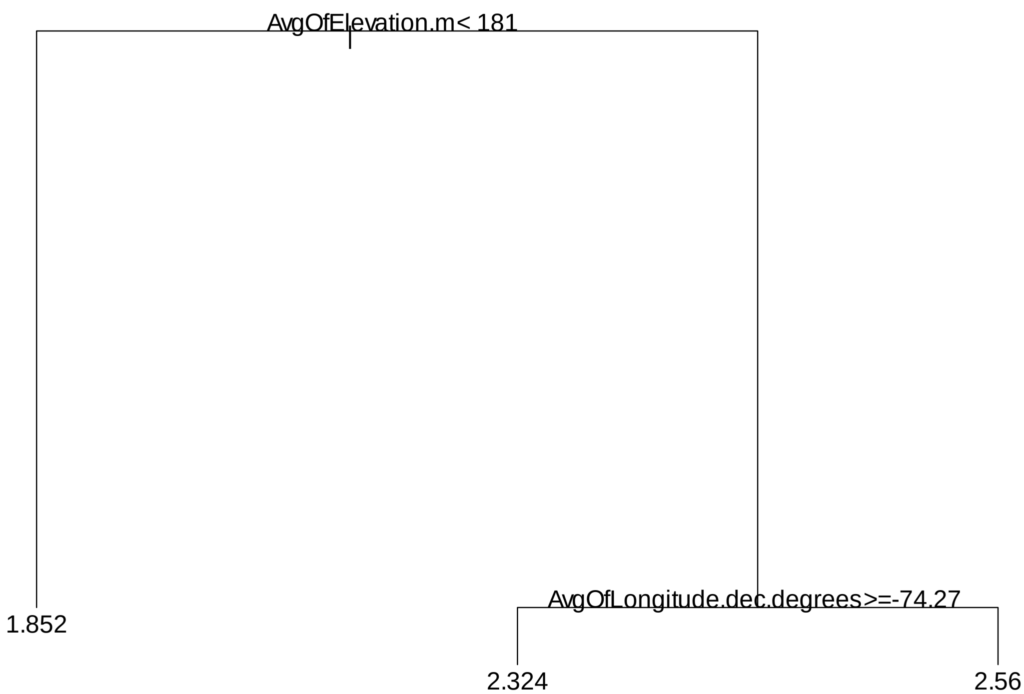


Figure 61. Classification and regression trees (CART) for foliar nitrogen in softwood species.

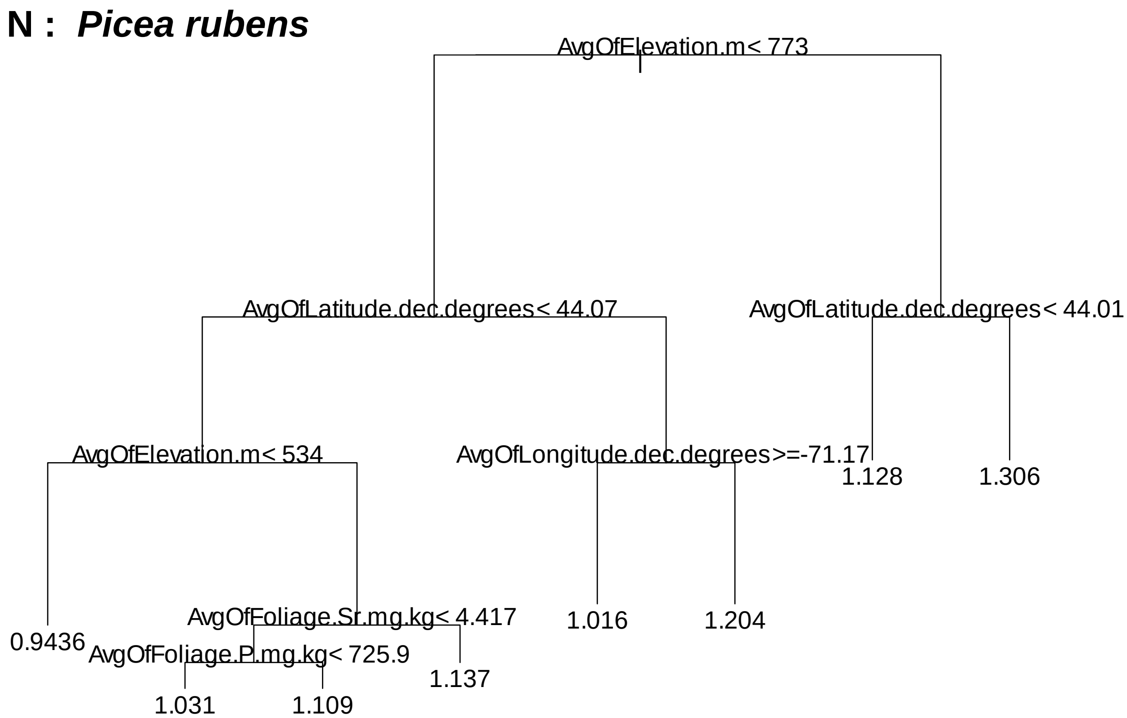
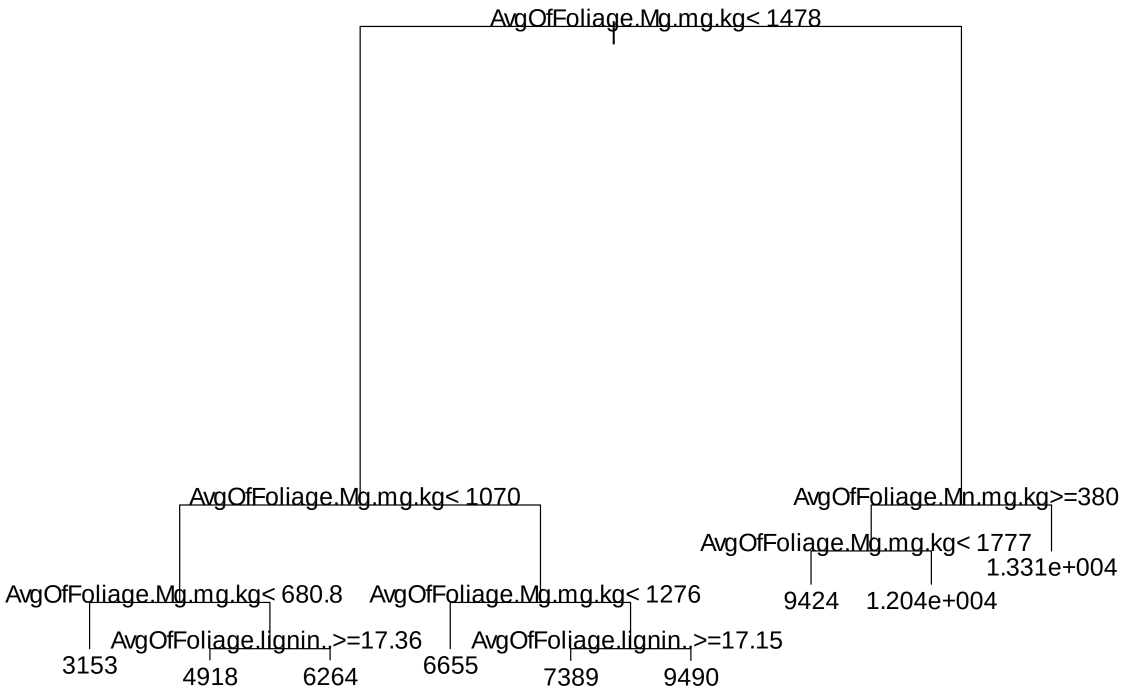
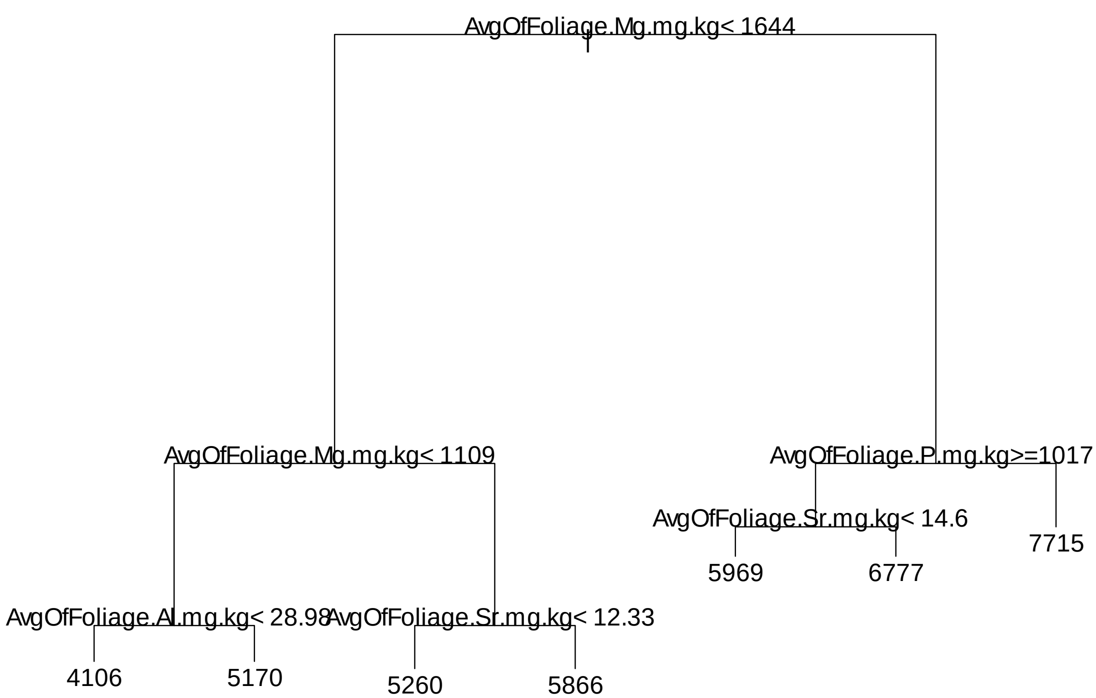


Figure 62. Classification and regression trees (CART) for foliar calcium in hardwood species. (figure spans multiple pages)

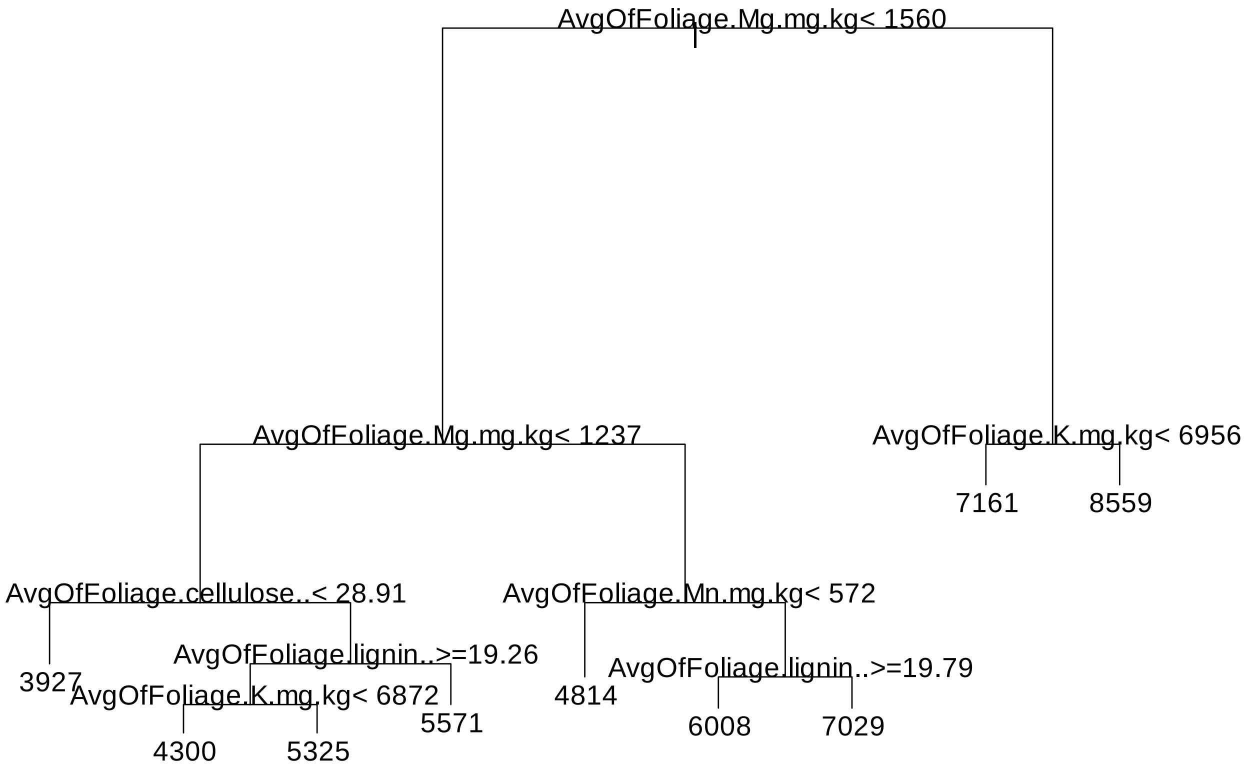
Ca : *Acer saccharum*



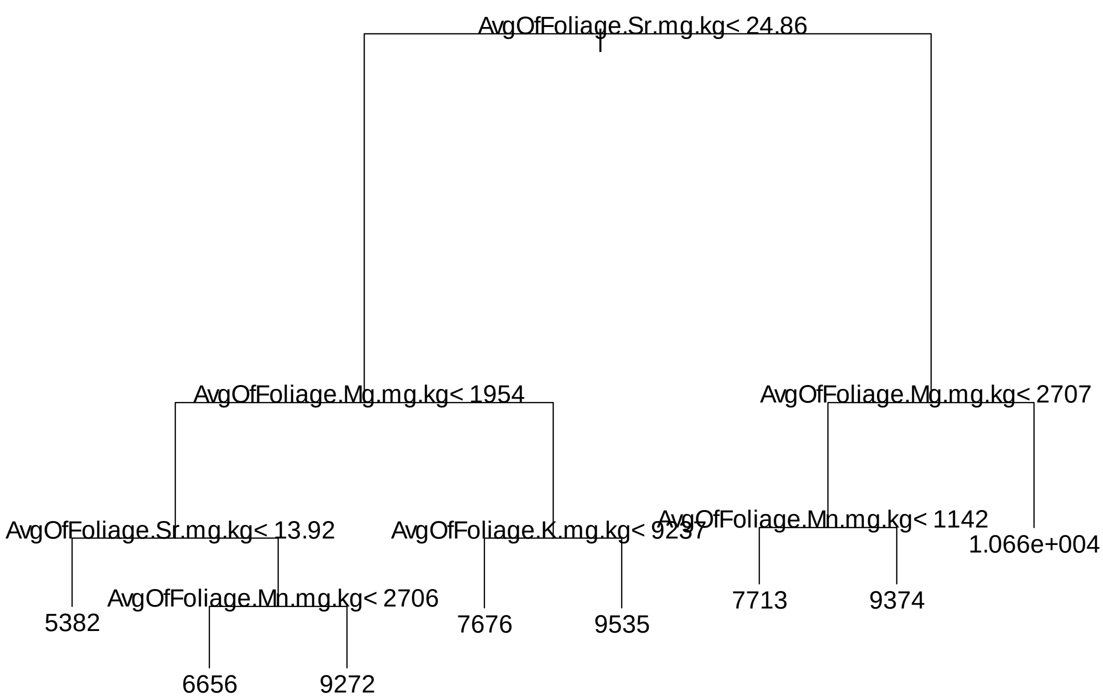
Ca : *Fagus grandifolia*



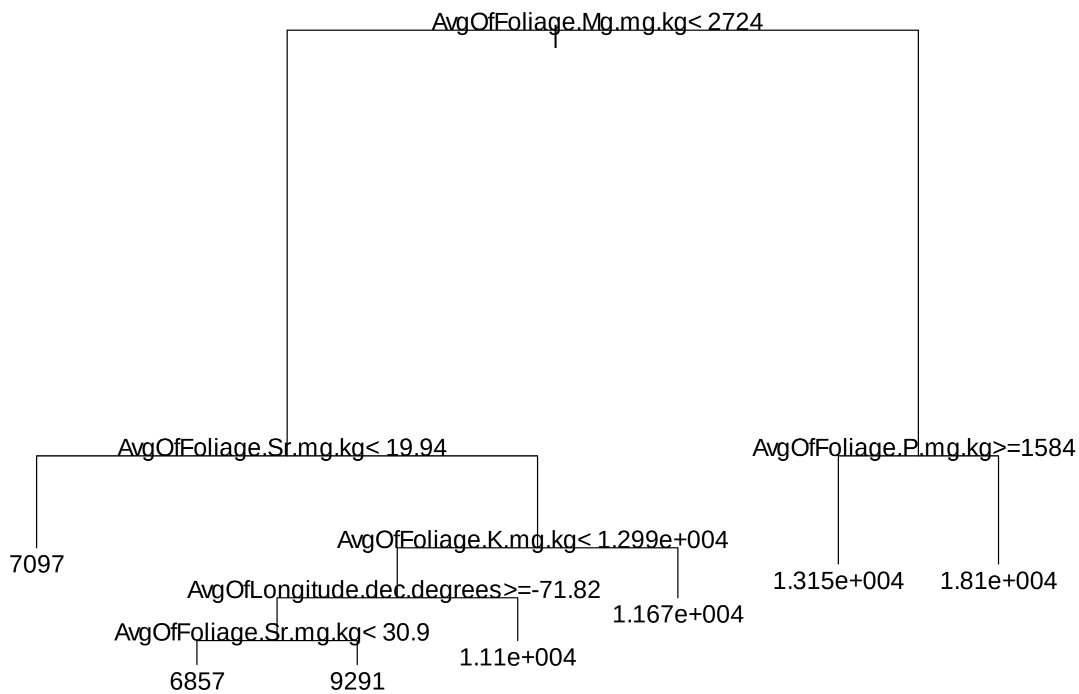
Ca : *Acer rubrum*



Ca : *Betula alleghaniensis*



Ca : *Fraxinus americana*



Ca : *Quercus rubra*

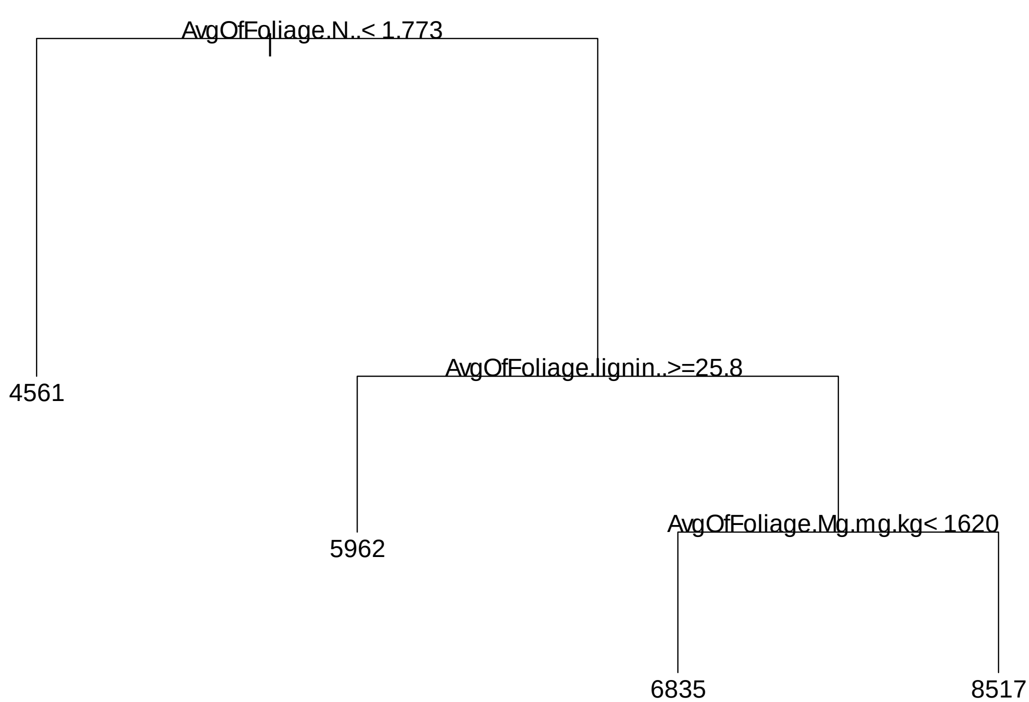
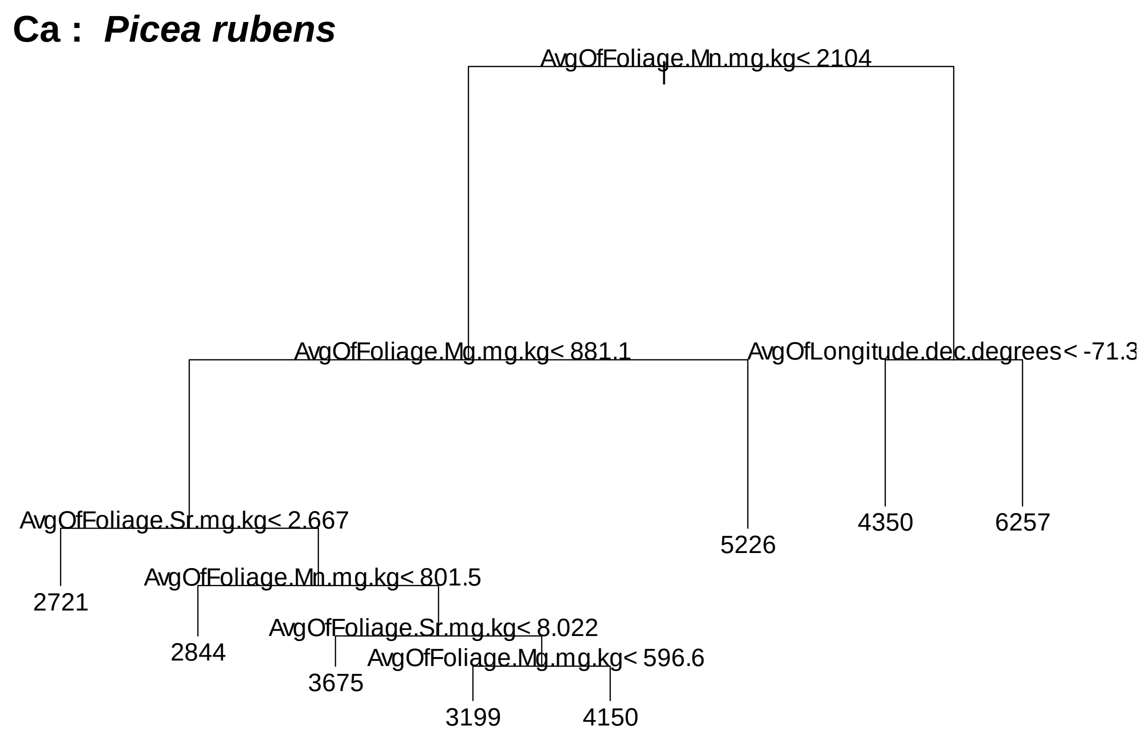


Figure 63. Classification and regression trees (CART) for foliar calcium in softwood species.



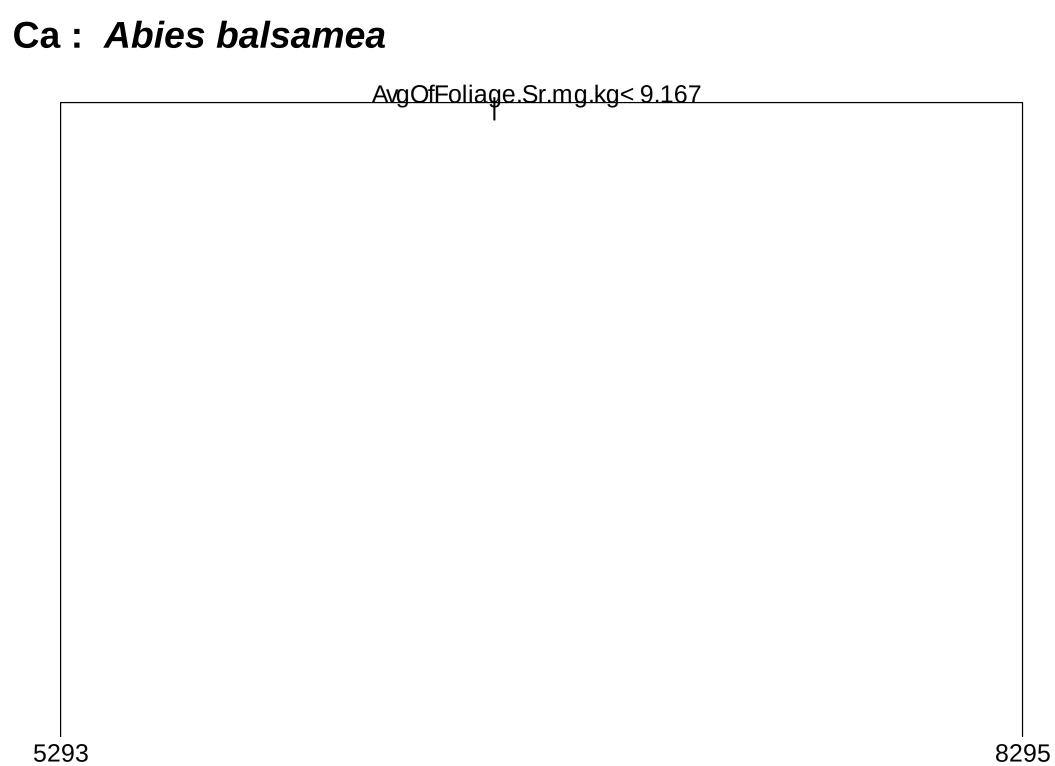
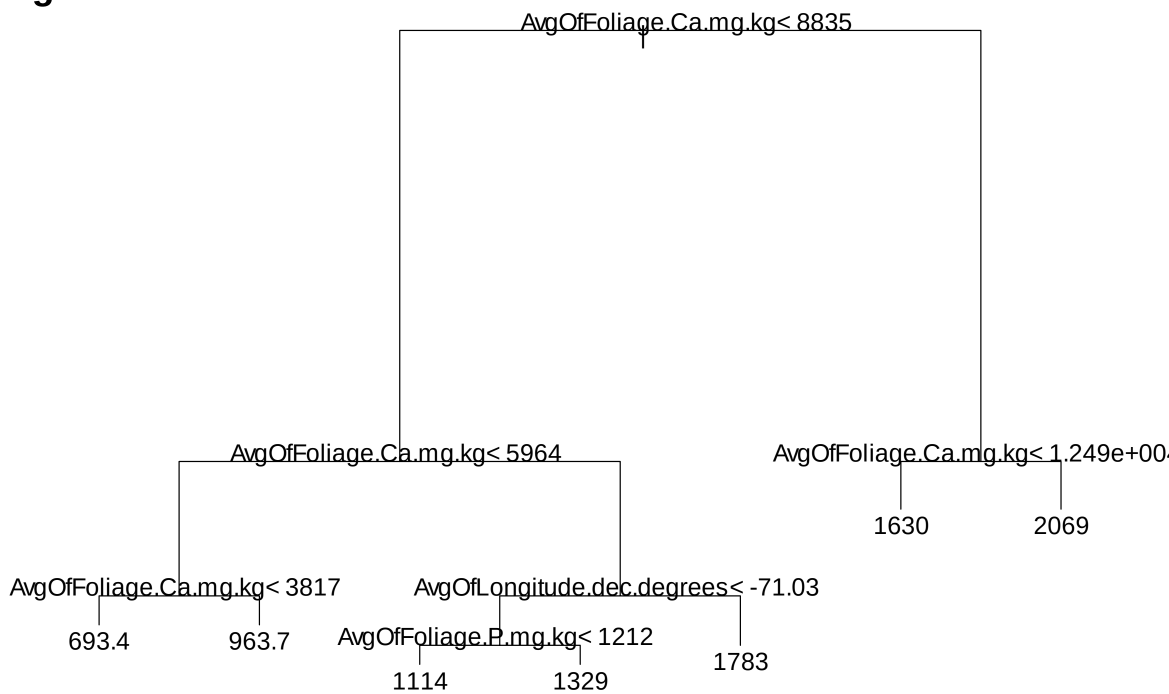
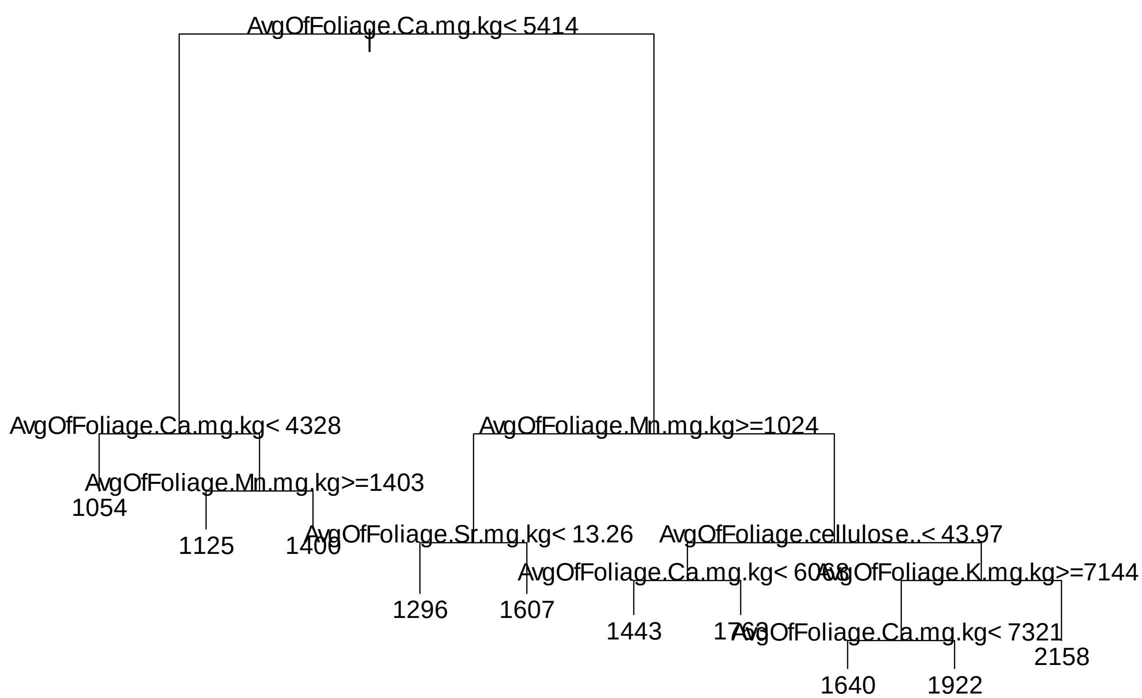


Figure 64. Classification and regression trees (CART) for foliar magnesium in hardwood species. (figure spans multiple pages)

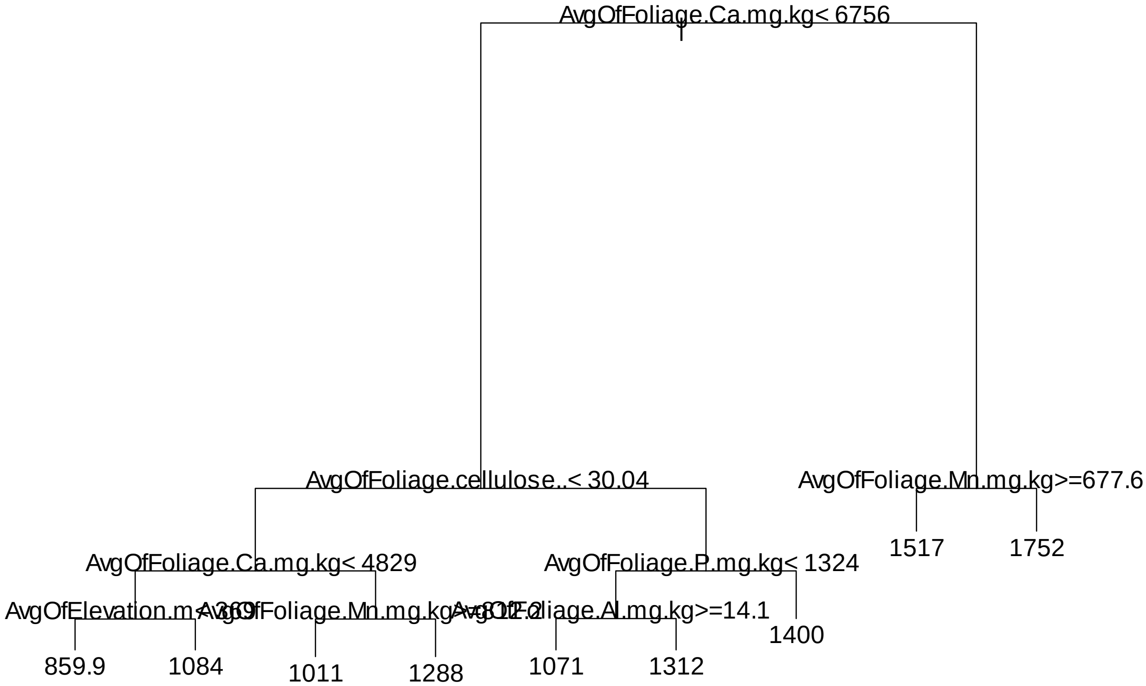
Mg : *Acer saccharum*



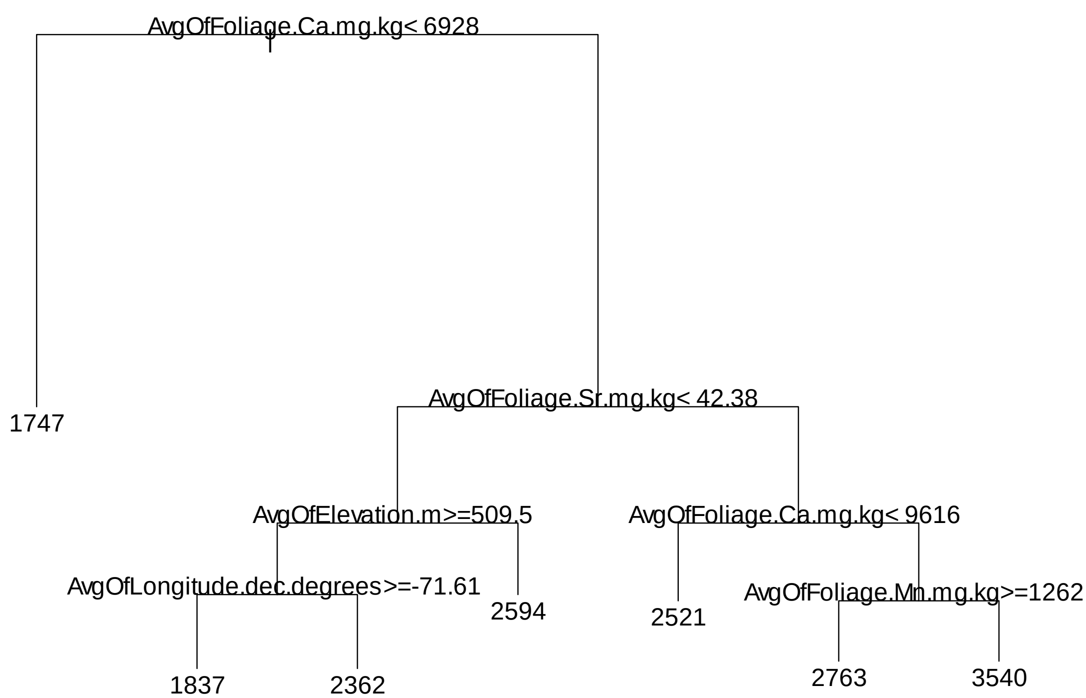
Mg : *Fagus grandifolia*



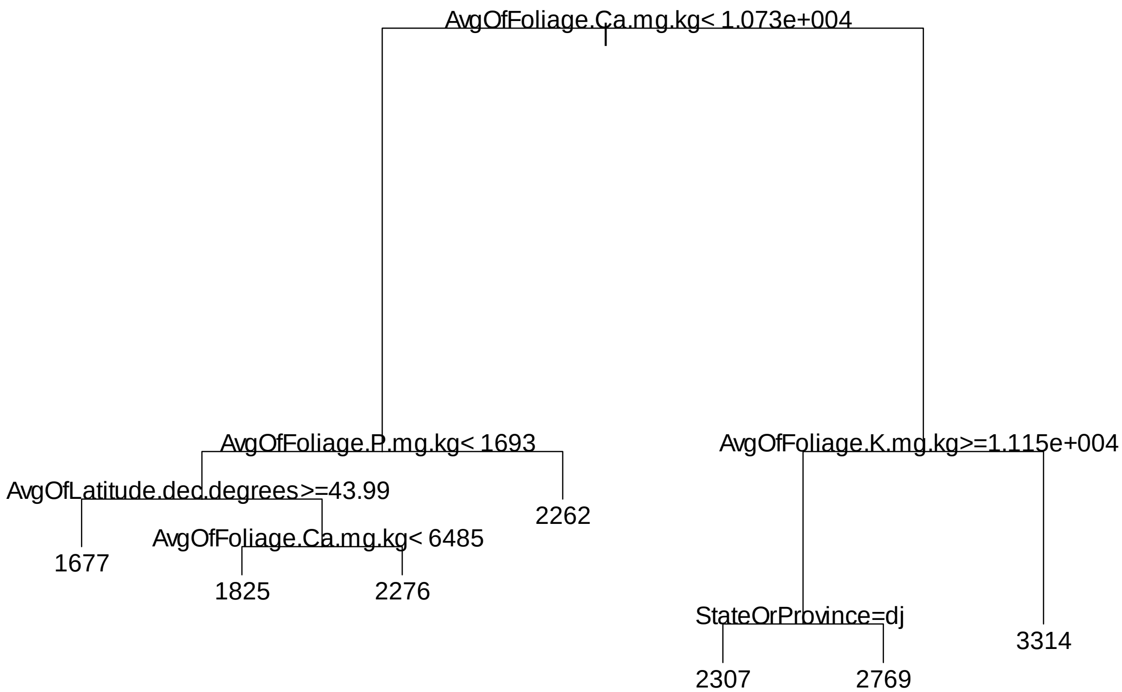
Mg : *Acer rubrum*



Mg : *Betula alleghaniensis*



Mg : *Fraxinus americana*



Mg : *Quercus rubra*

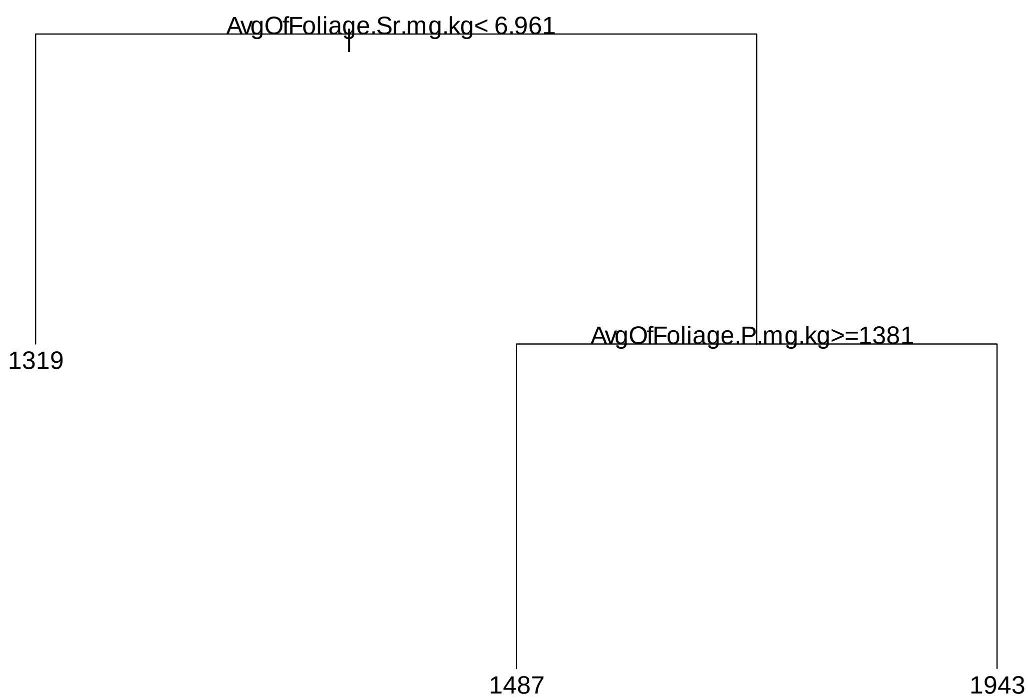


Figure 65. Classification and regression trees (CART) for foliar magnesium in softwood species.

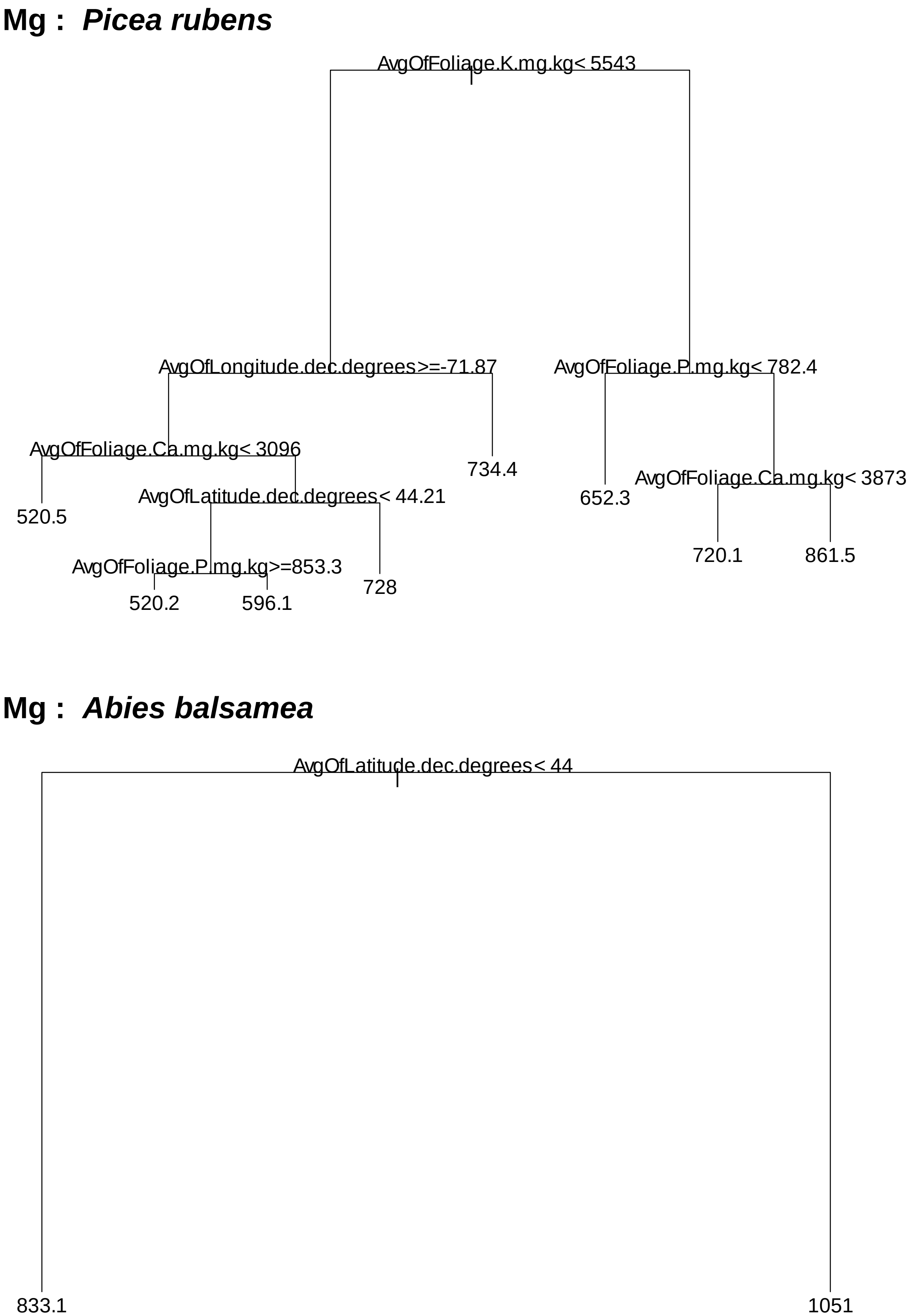
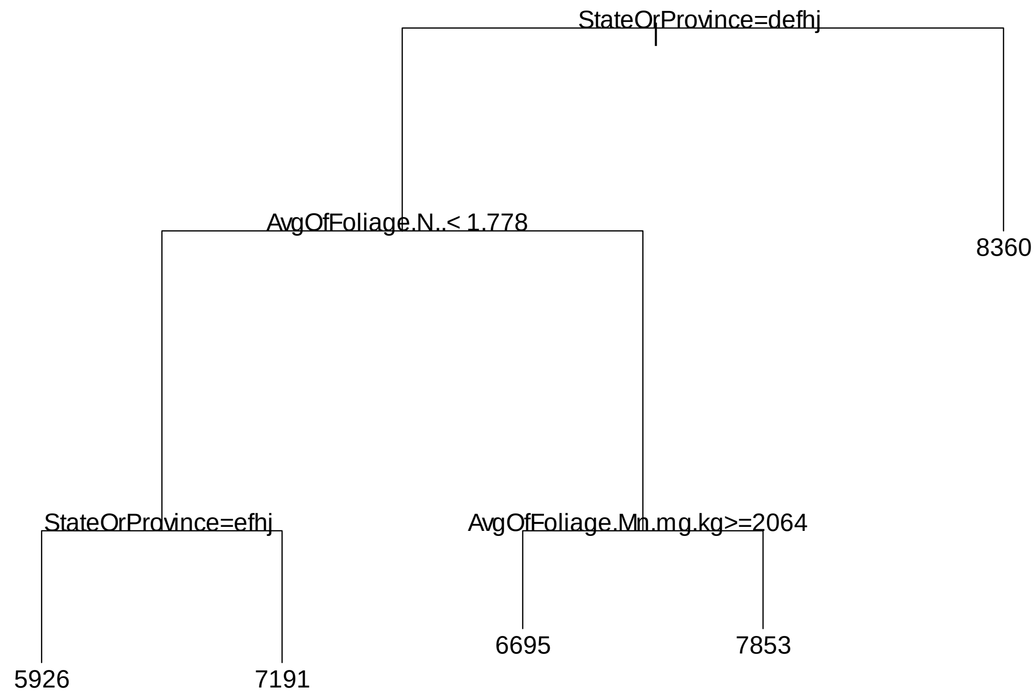
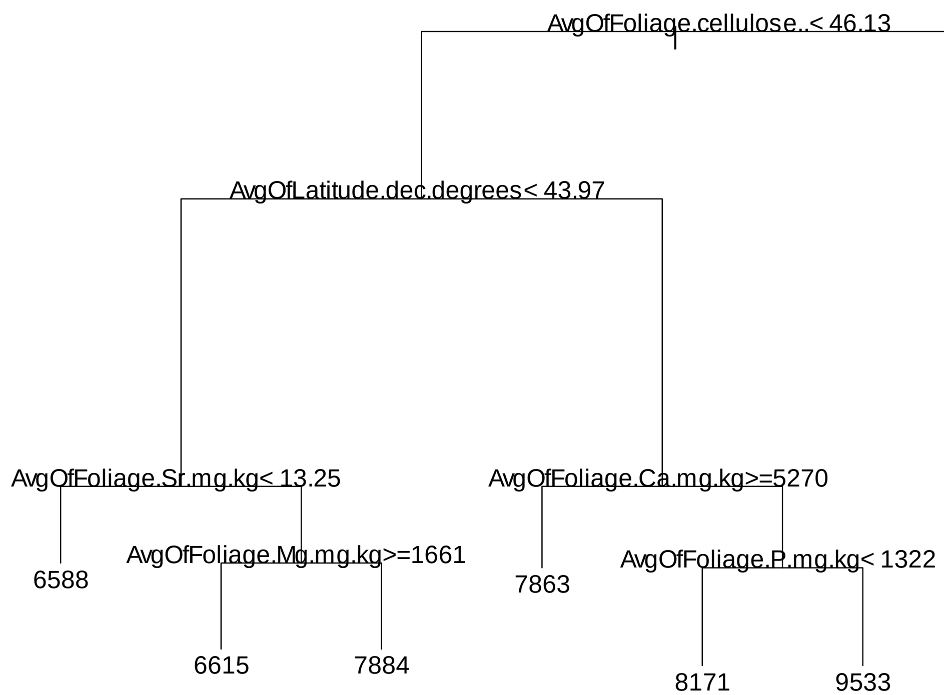


Figure 66. Classification and regression trees (CART) for foliar potassium in hardwood species. (figure spans multiple pages)

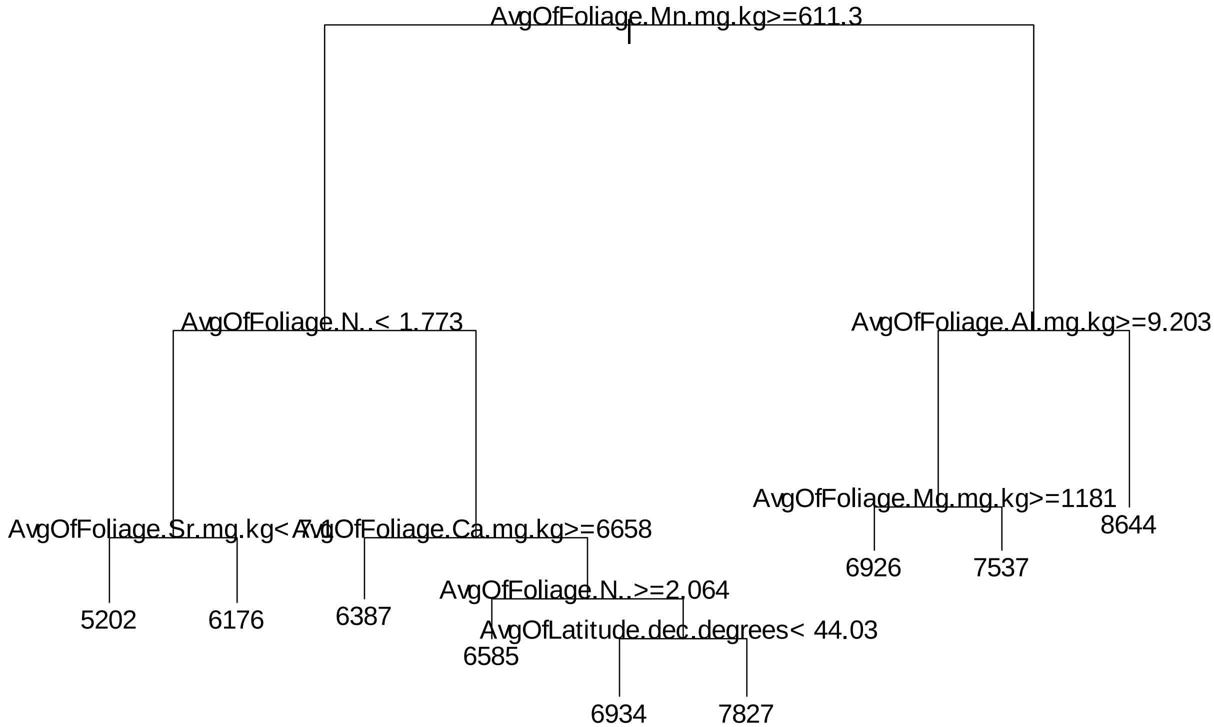
K : *Acer saccharum*



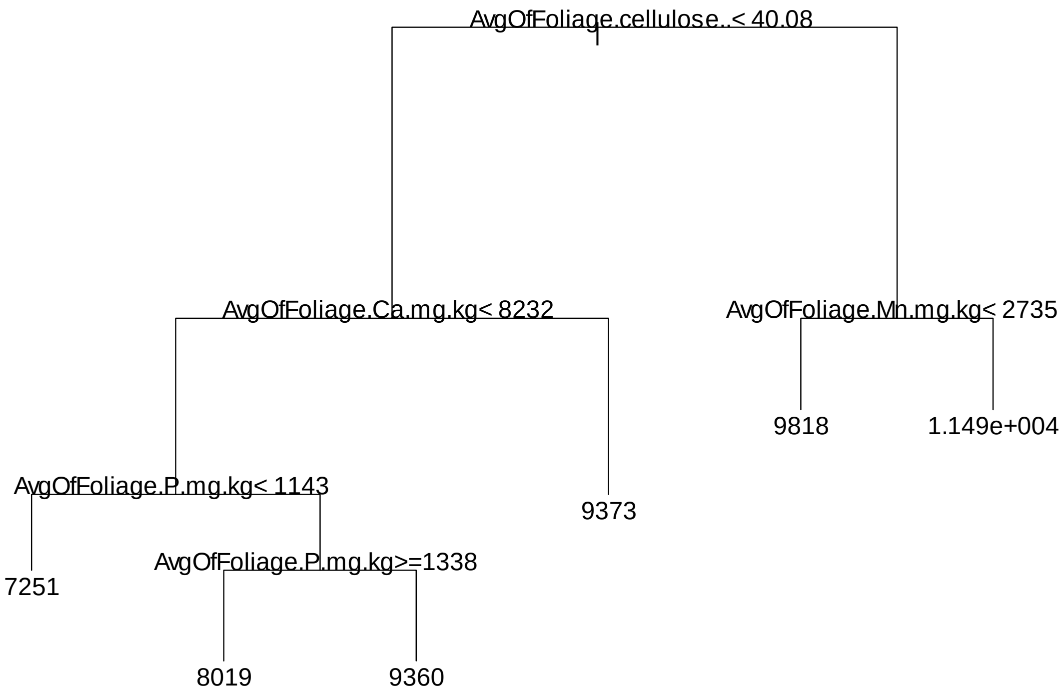
K : *Fagus grandifolia*



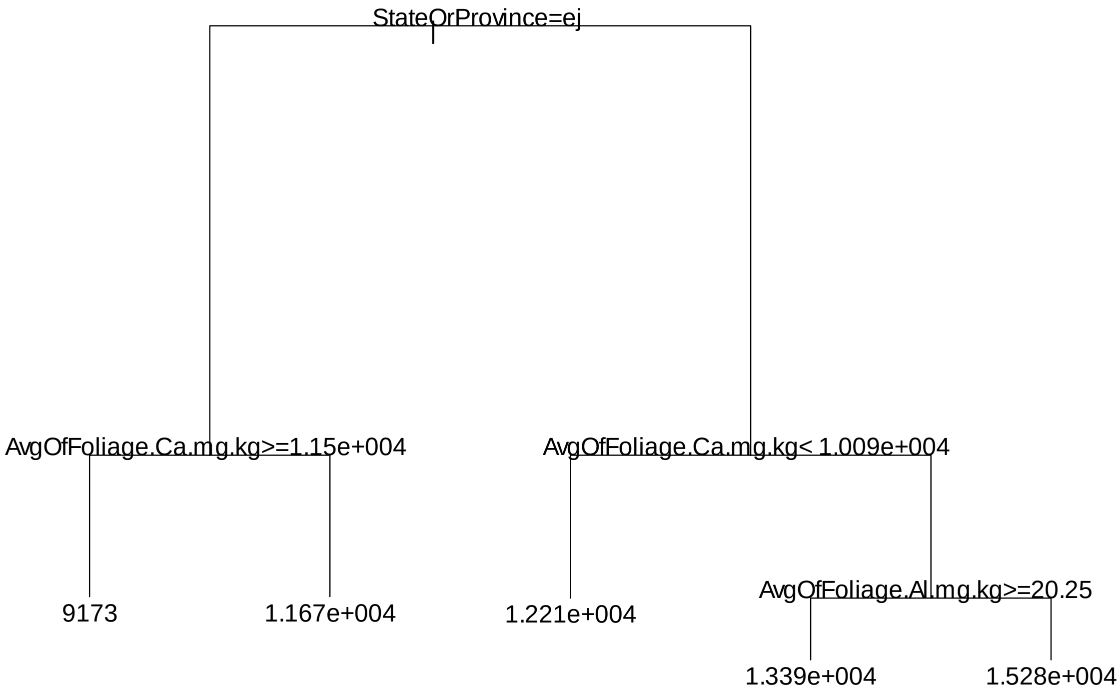
K : *Acer rubrum*



K : *Betula alleghaniensis*



K : *Fraxinus americana*



K : *Quercus rubra*

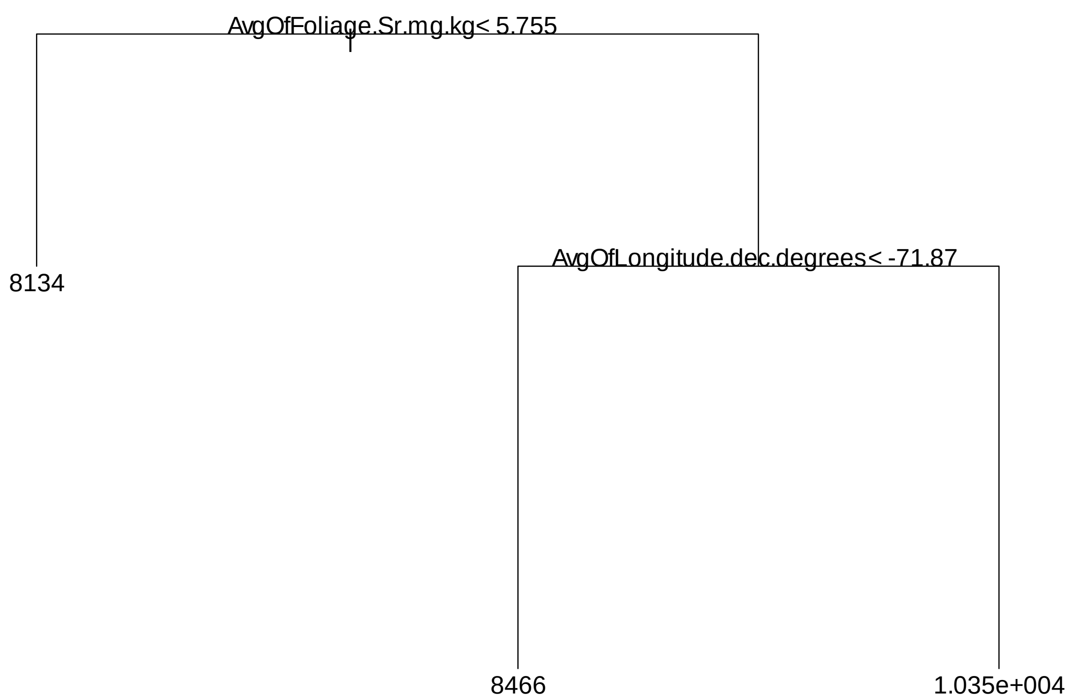
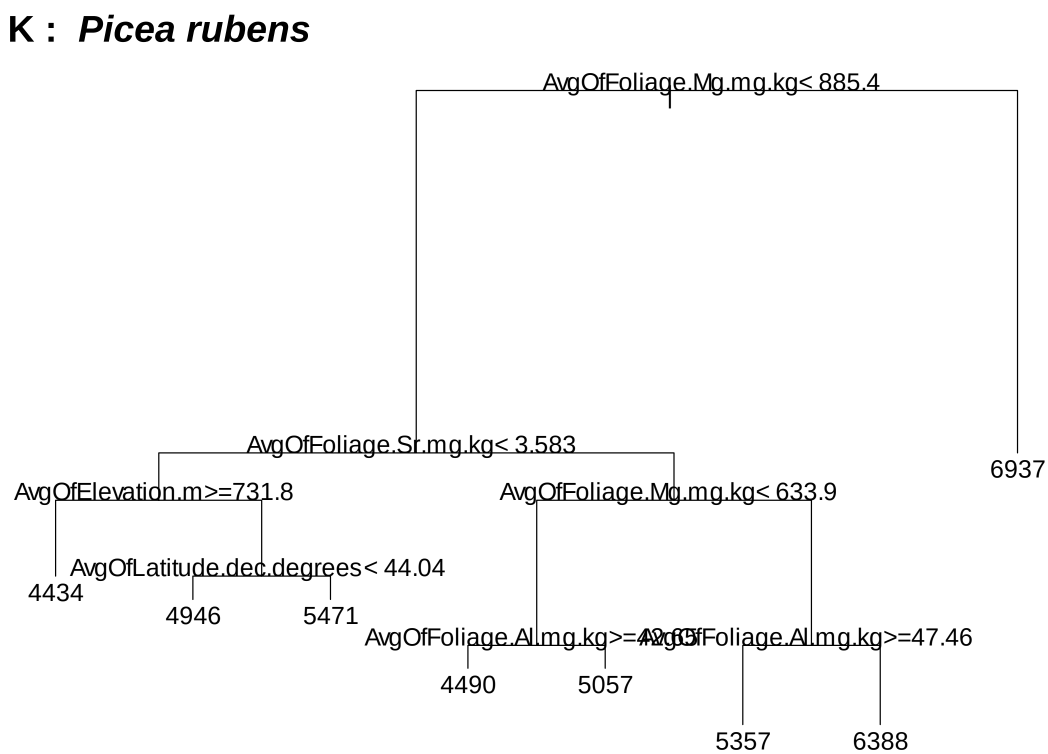


Figure 67. Classification and regression trees (CART) for foliar potassium in softwood species.



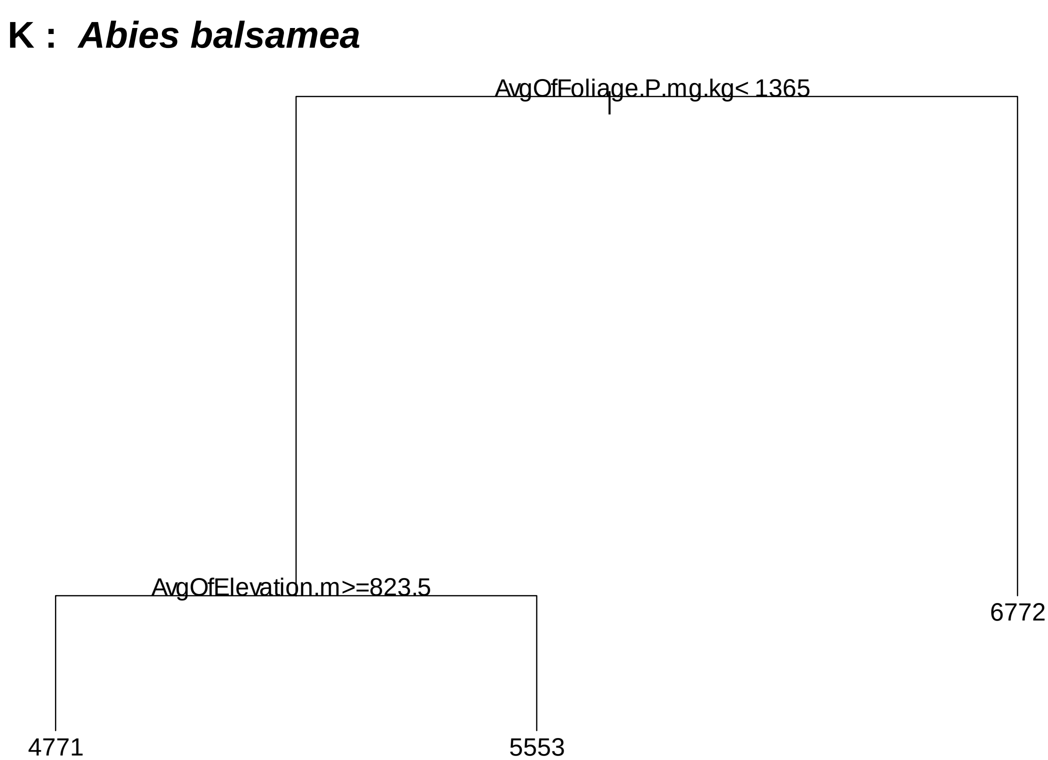
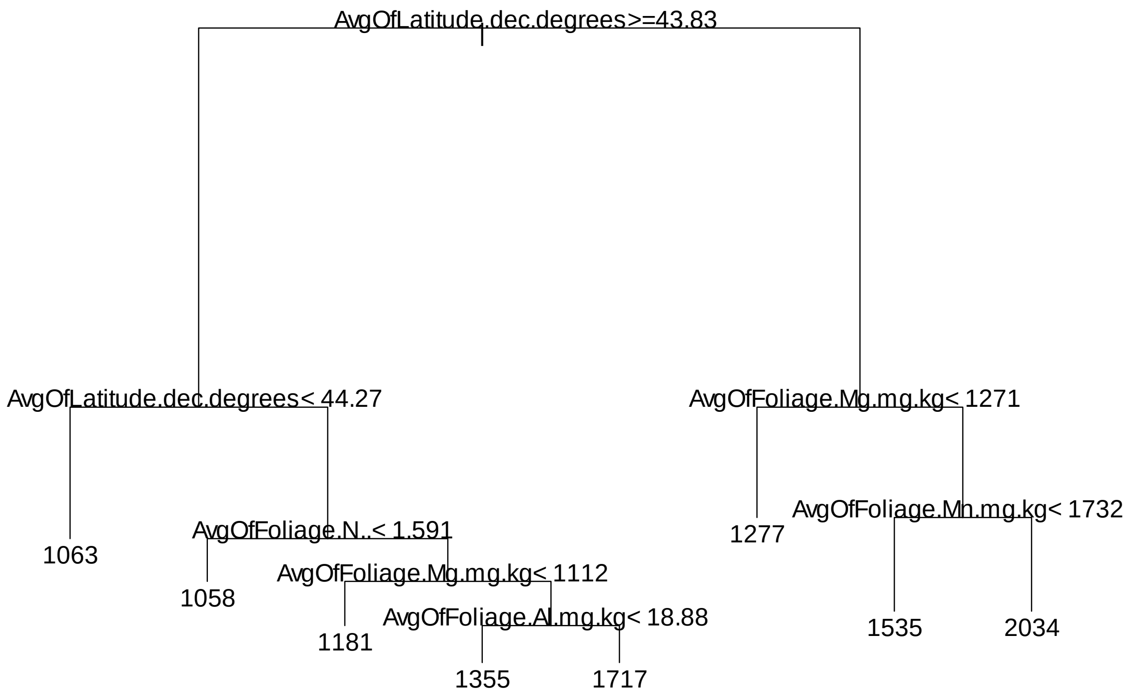
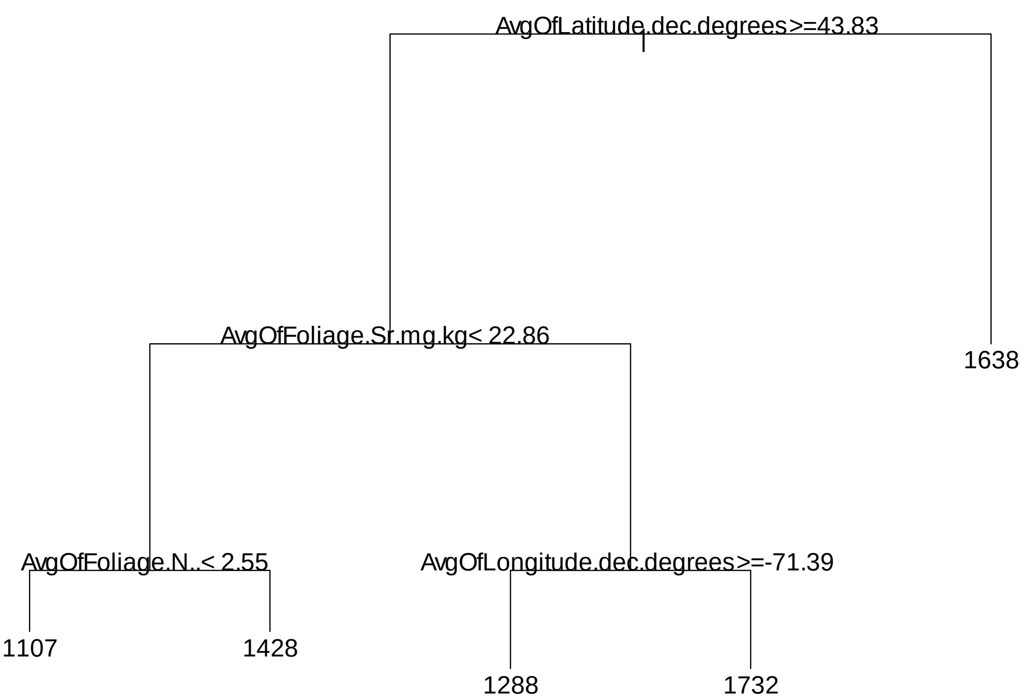


Figure 68. Classification and regression trees (CART) for foliar phosphorus in hardwood species. (figure spans multiple pages)

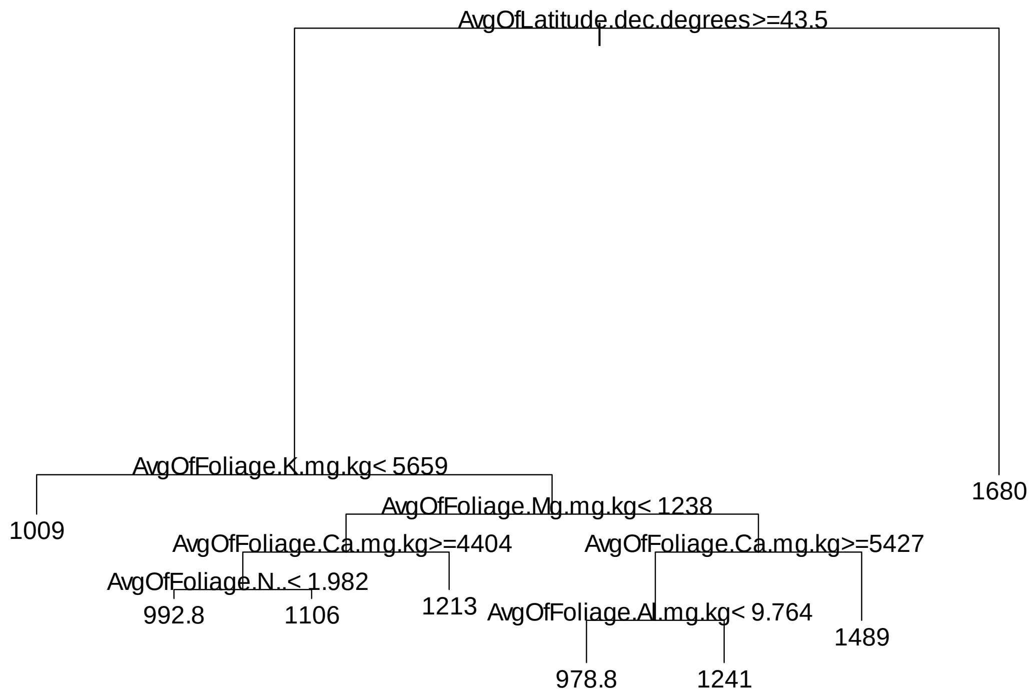
P : ***Acer saccharum***



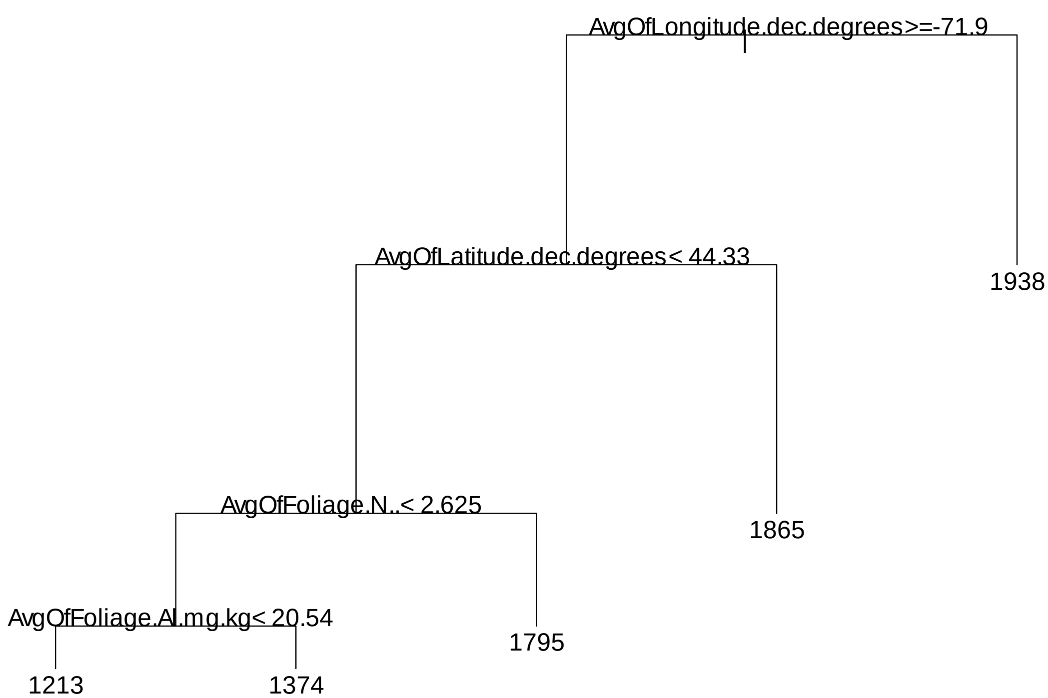
P : ***Fagus grandifolia***



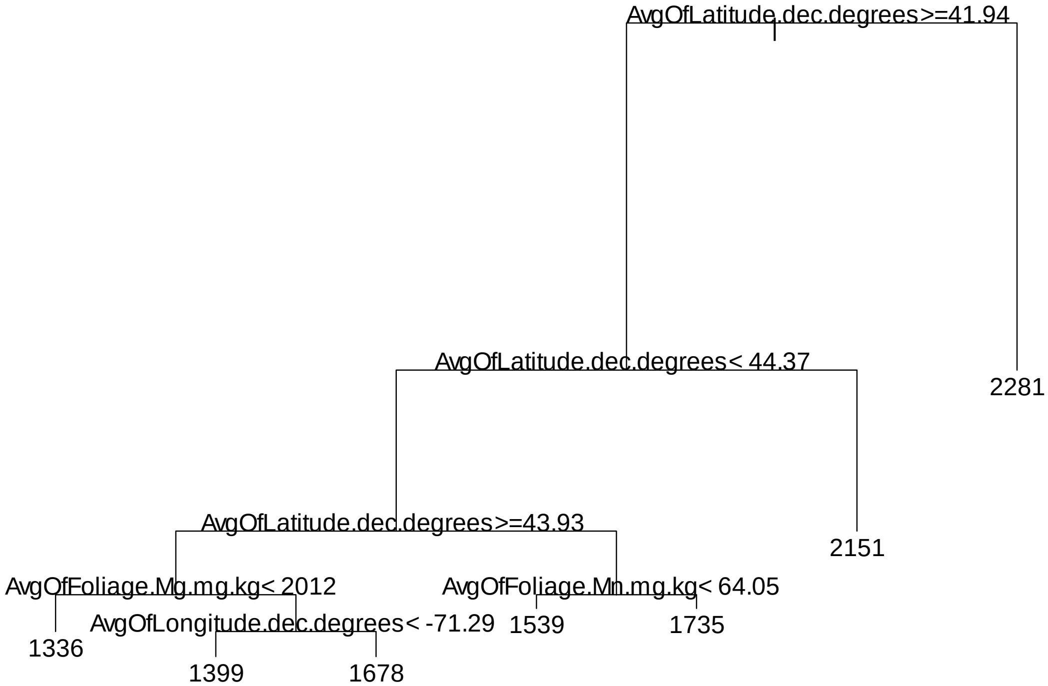
P : ***Acer rubrum***



P : ***Betula alleghaniensis***



P : *Fraxinus americana*



P : *Quercus rubra*

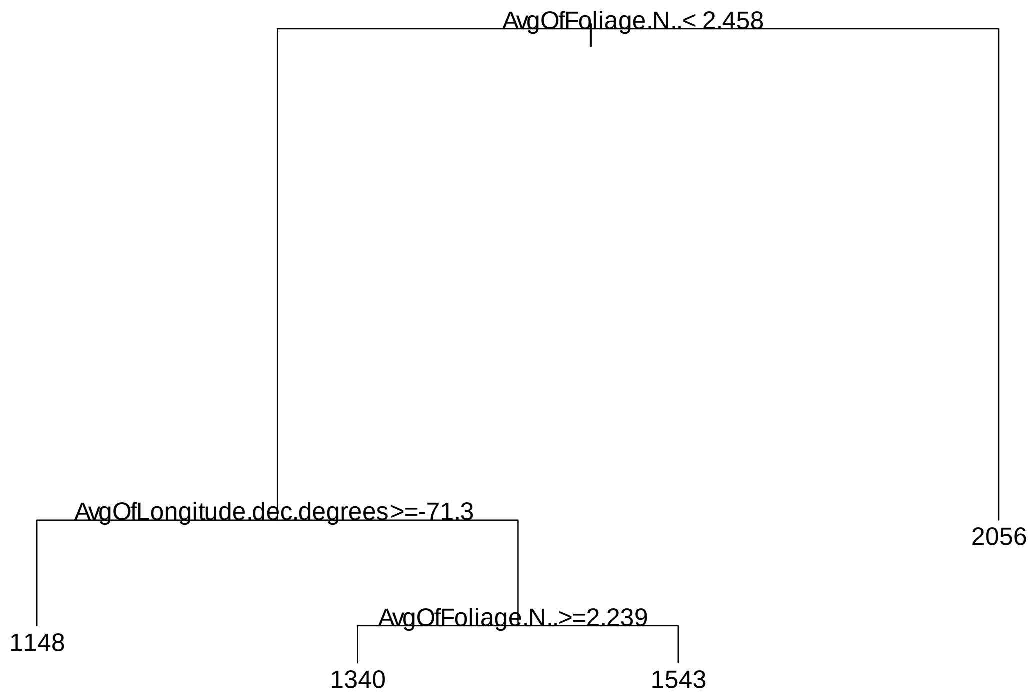
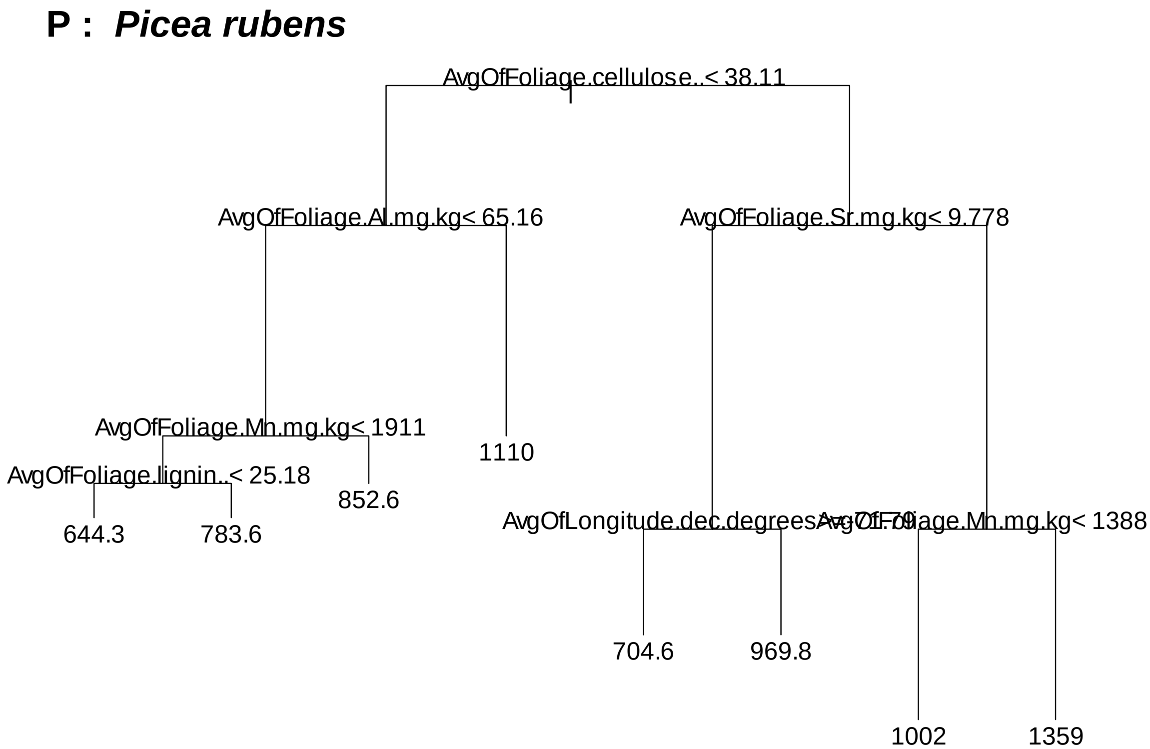


Figure 69. Classification and regression trees (CART) for foliar phosphorus in softwood species.



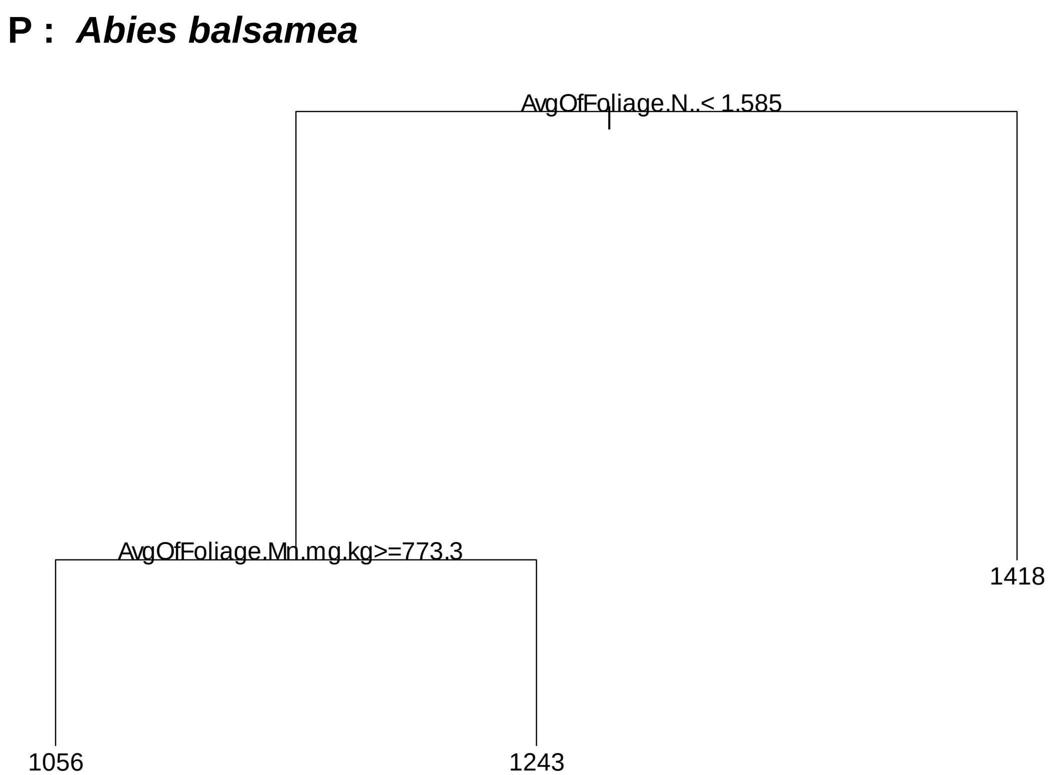
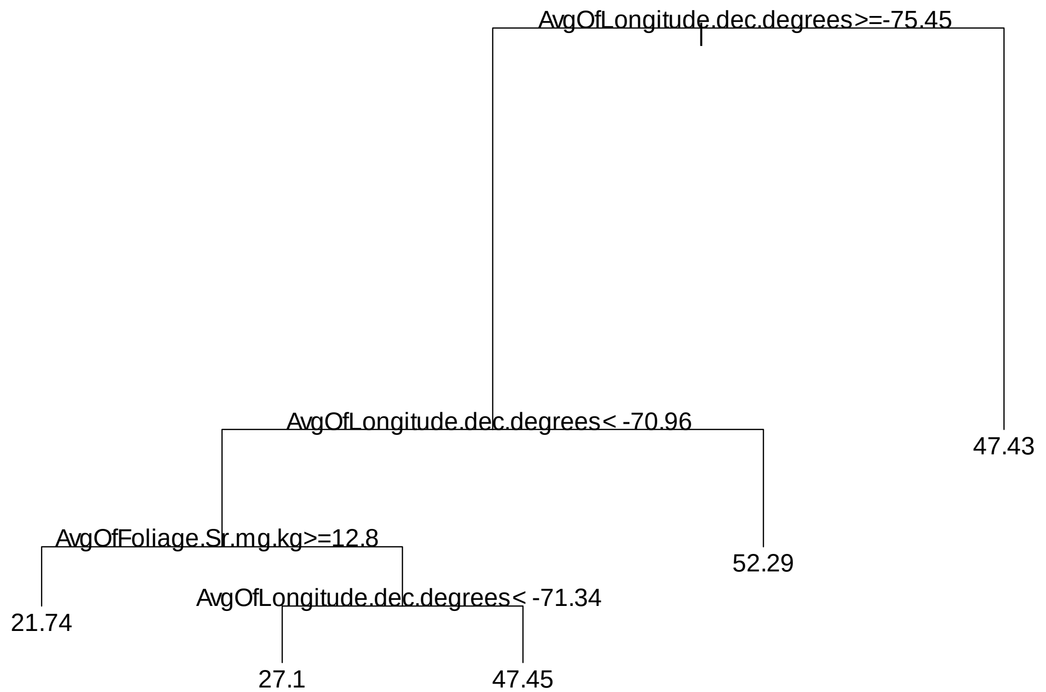
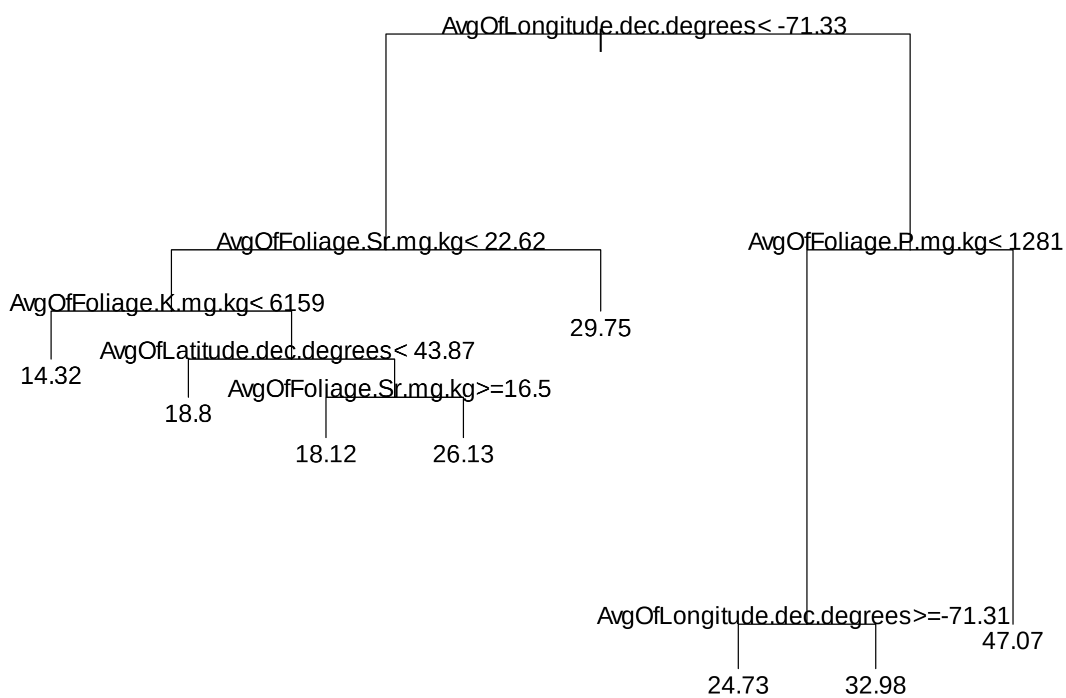


Figure 70. Classification and regression trees (CART) for foliar aluminum in hardwood species. (figure spans multiple pages)

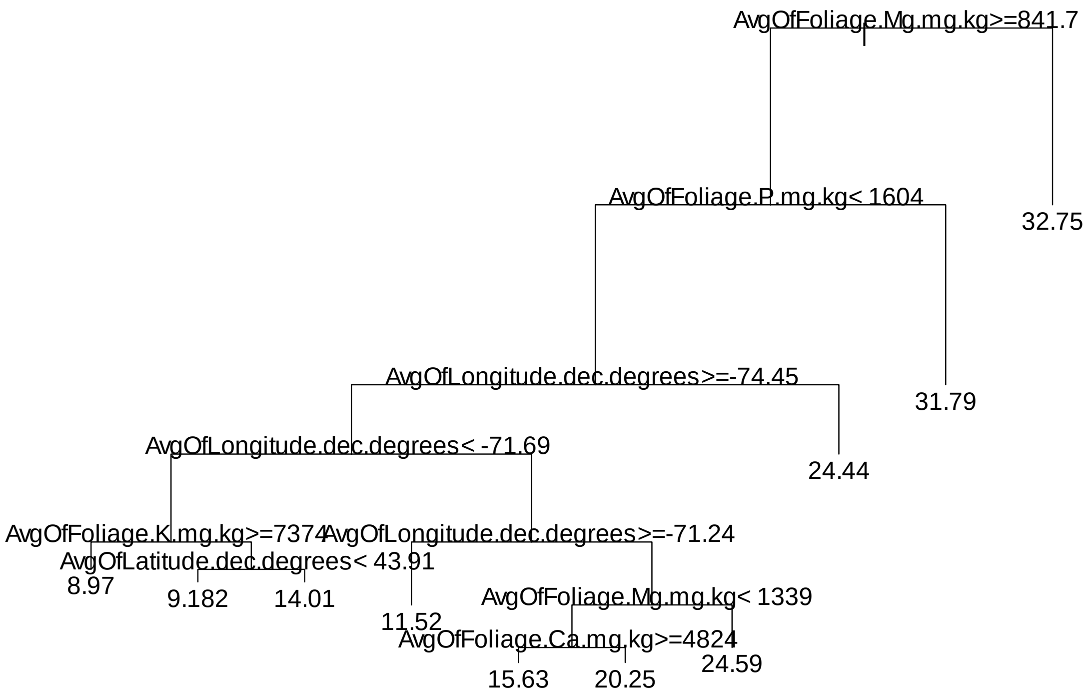
Al : *Acer saccharum*



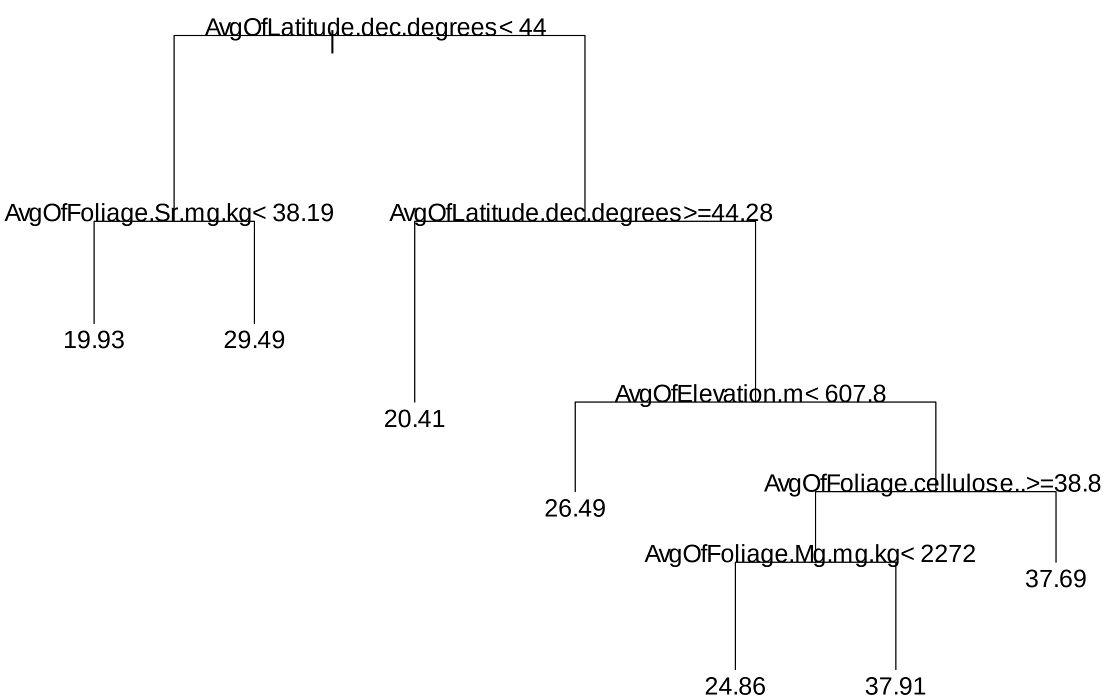
Al : *Fagus grandifolia*



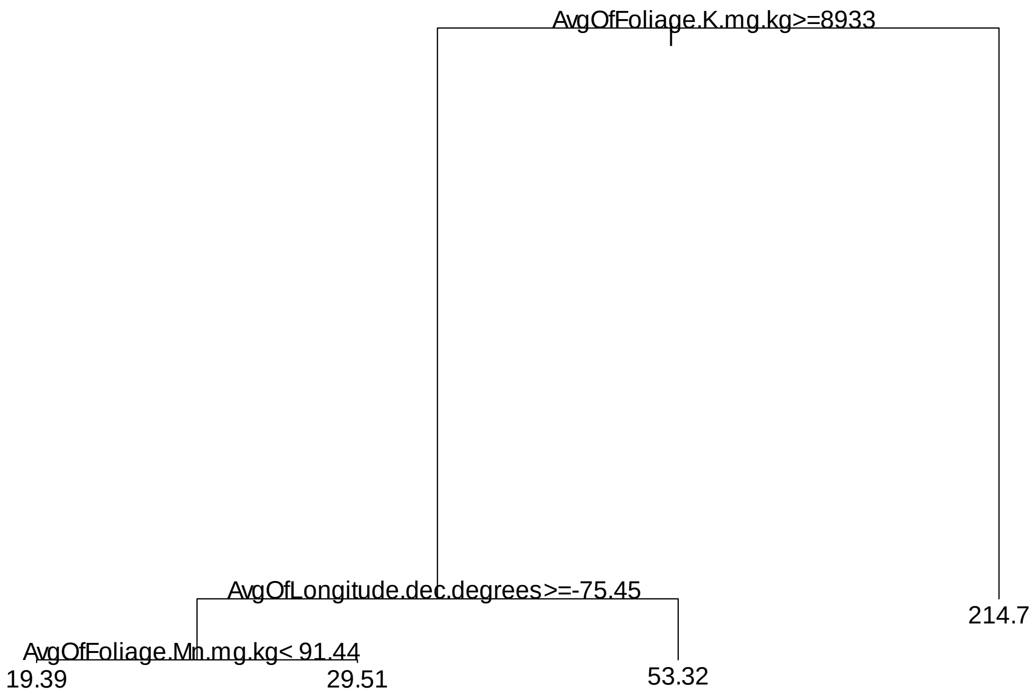
Al : *Acer rubrum*



Al : *Betula alleghaniensis*



AI : *Fraxinus americana*



AI : *Quercus rubra*

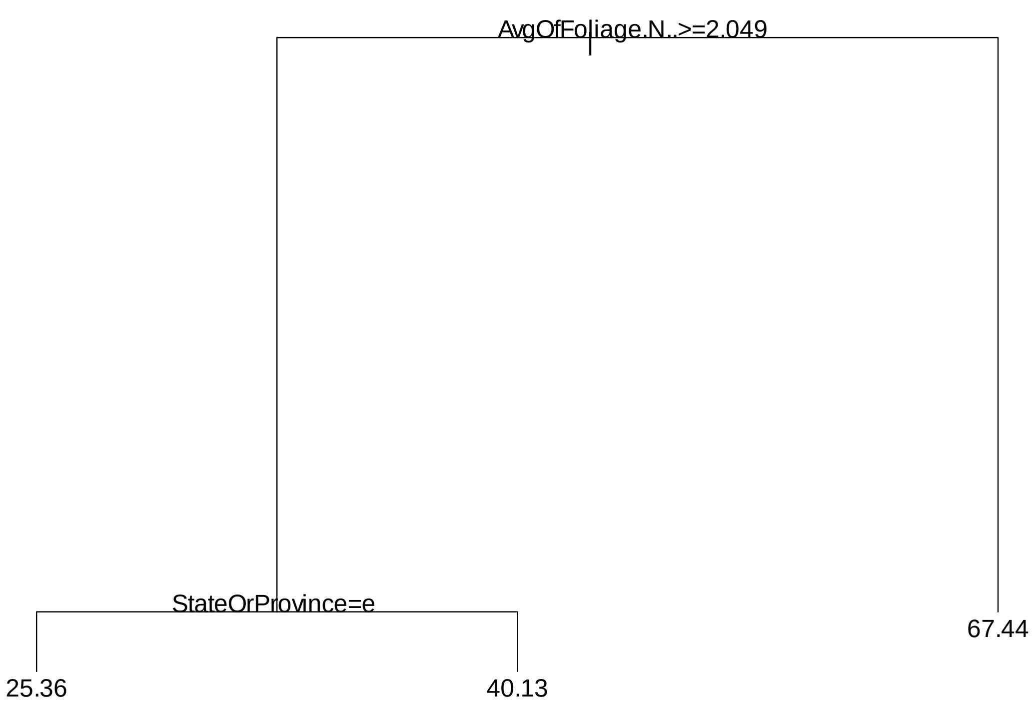
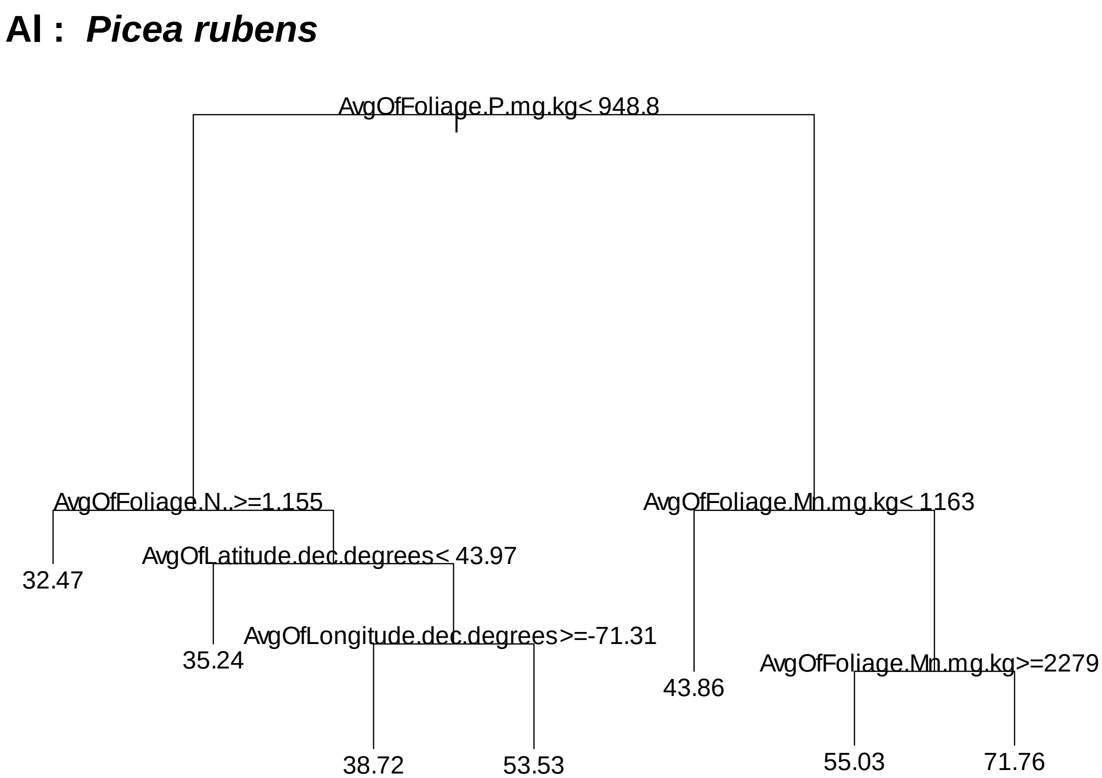


Figure 71. Classification and regression trees (CART) for foliar aluminum in softwood species.



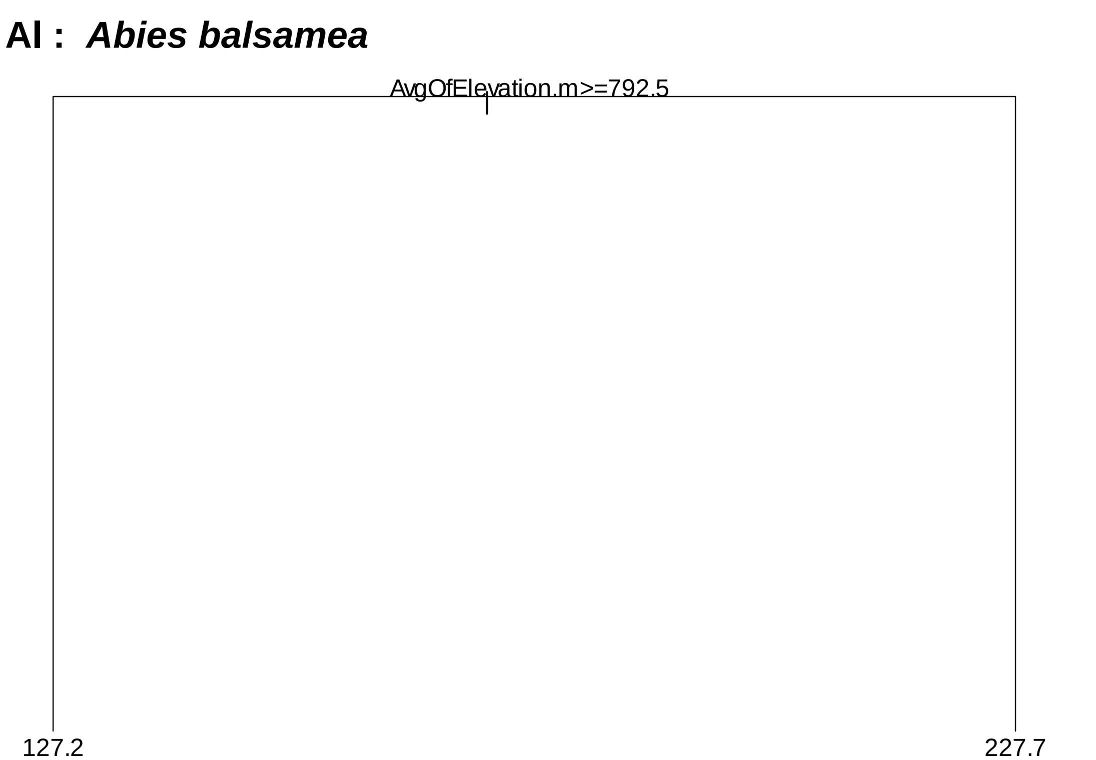
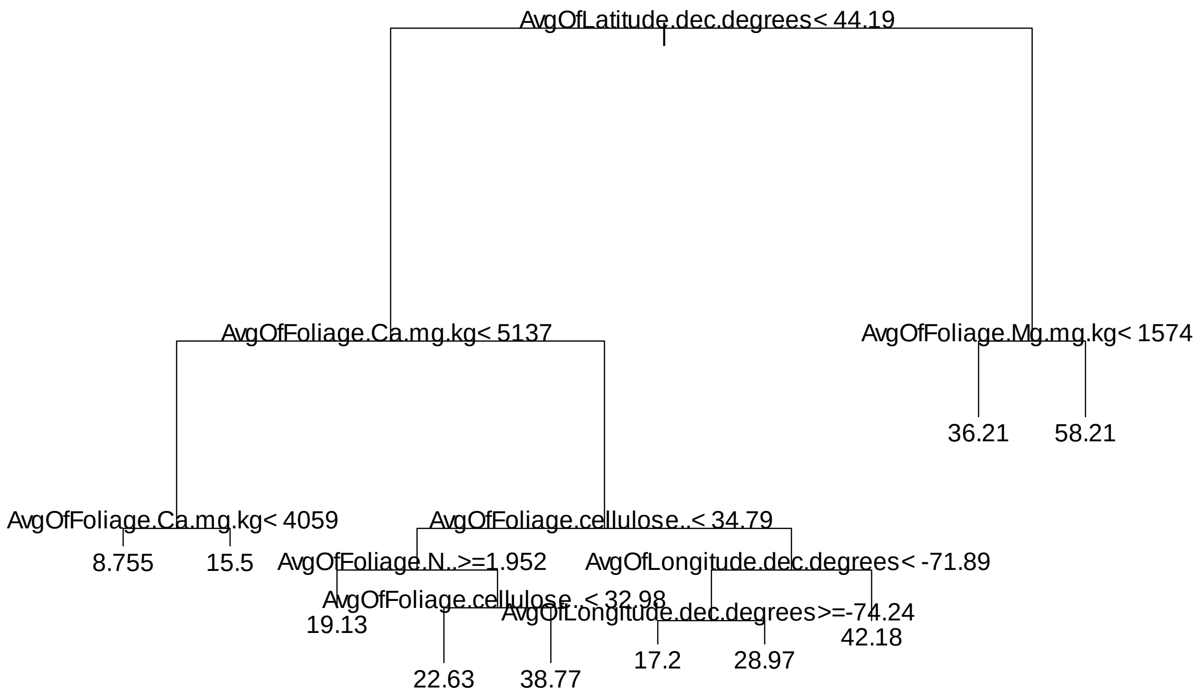
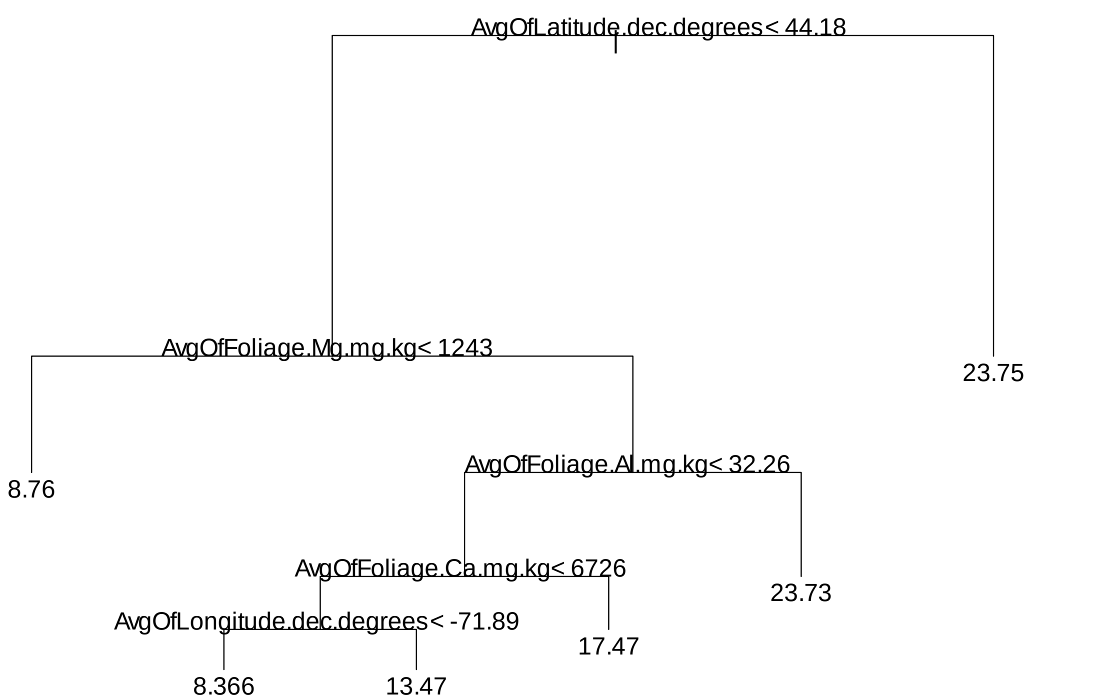


Figure 72. Classification and regression trees (CART) for foliar strontium in hardwood species. (figure spans multiple pages)

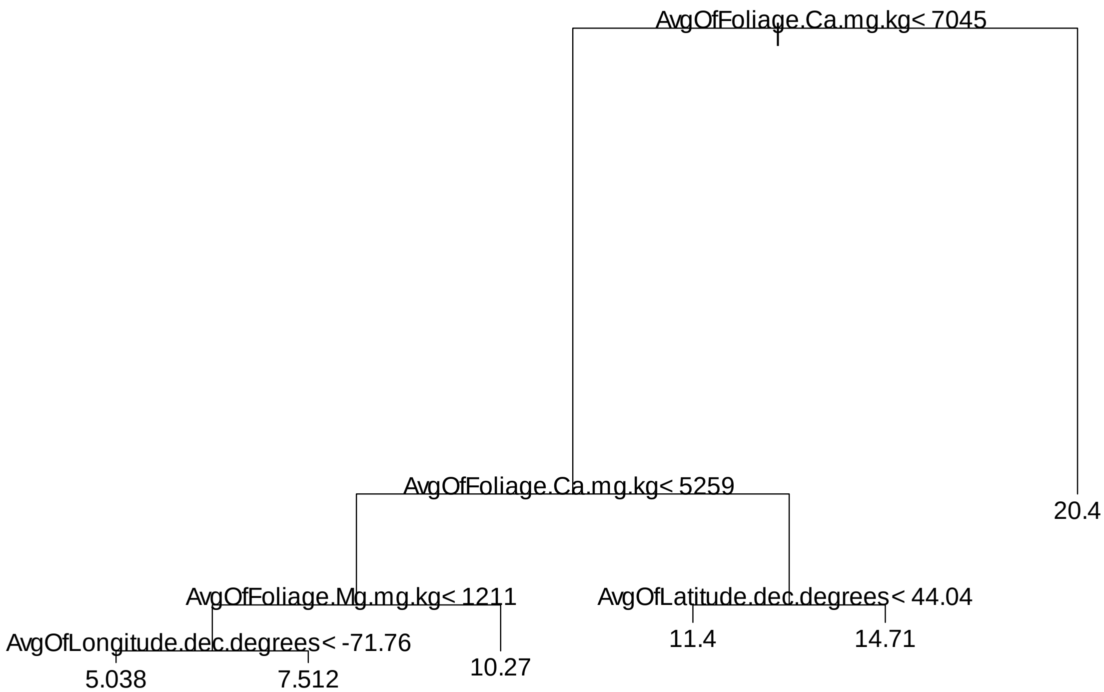
Sr : *Acer saccharum*



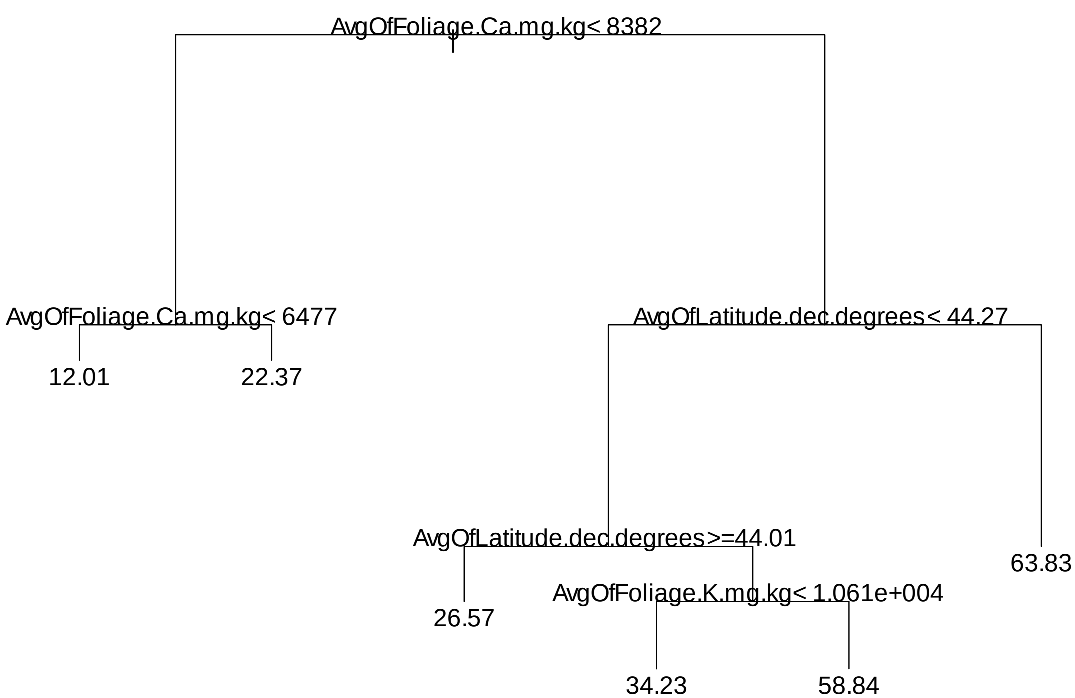
Sr : *Fagus grandifolia*



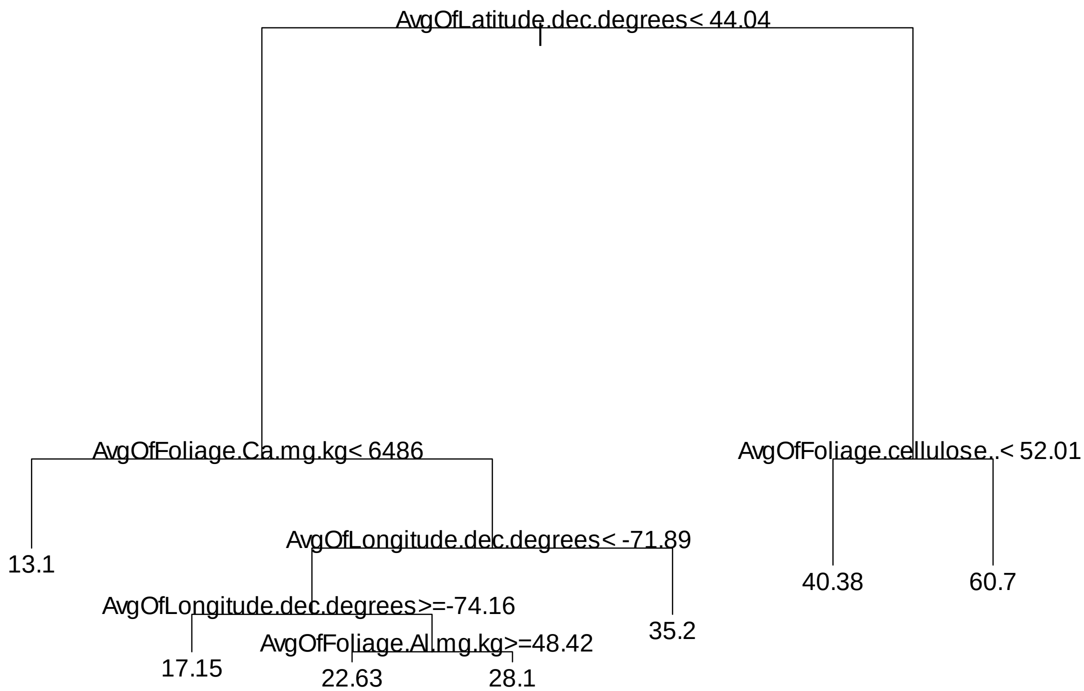
Sr : *Acer rubrum*



Sr : *Betula alleghaniensis*



Sr : *Fraxinus americana*



Sr : *Quercus rubra*

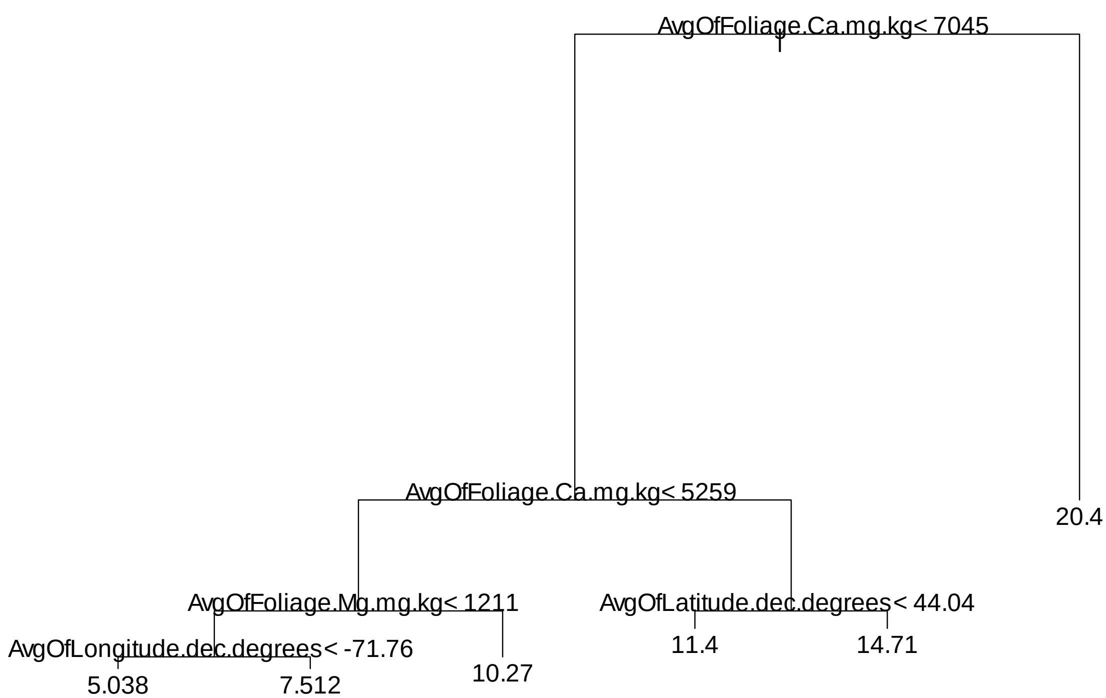
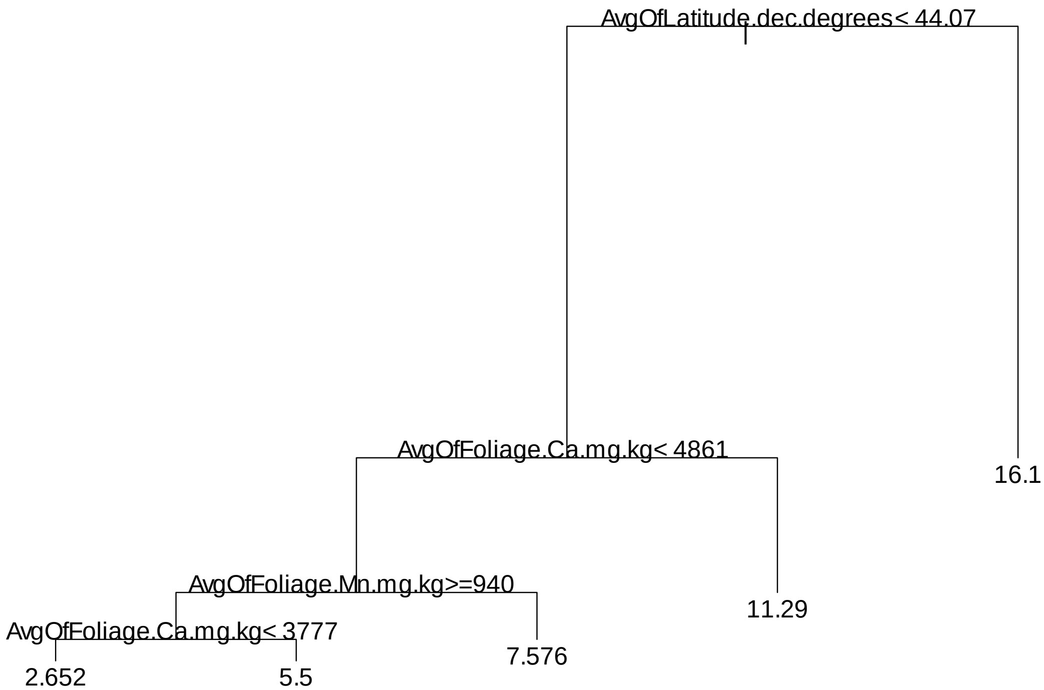


Figure 73. Classification and regression trees (CART) for foliar strontium in softwood species.

Sr : ***Picea rubens***

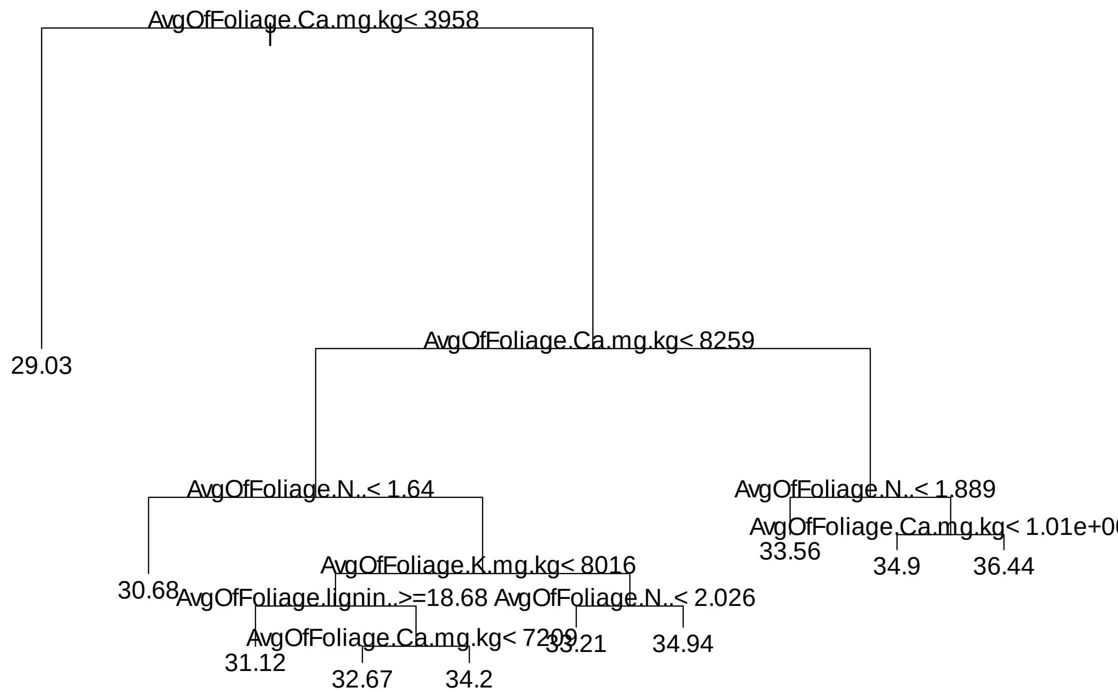


Sr : ***Abies balsamea***

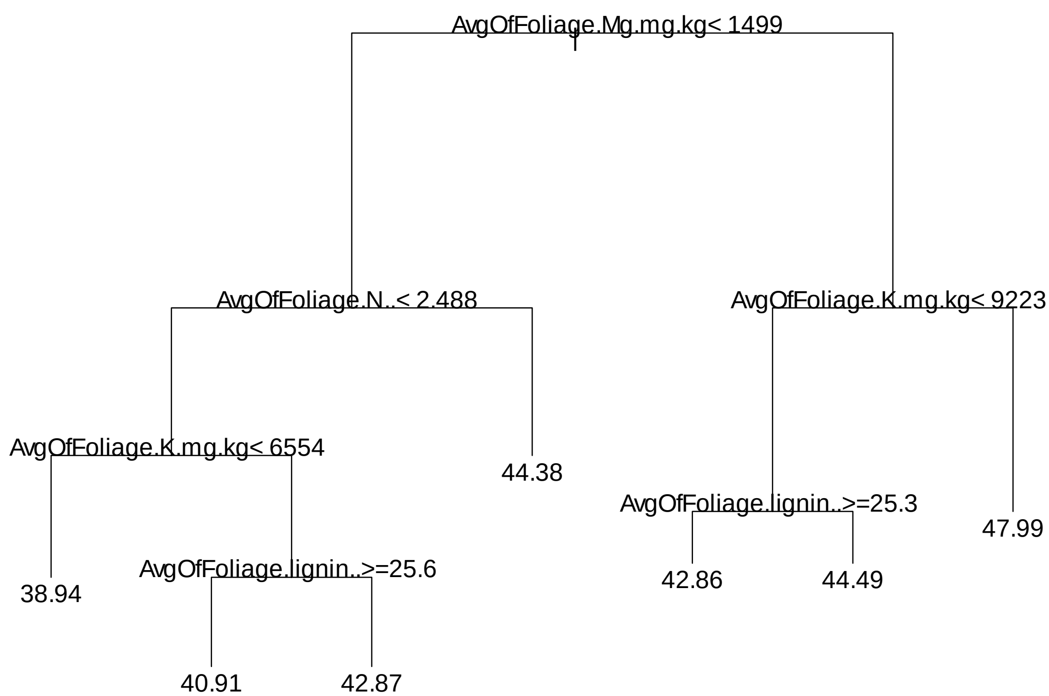
NA

Figure 74. Classification and regression trees (CART) for foliar cellulose in hardwood species. (figure spans multiple pages)

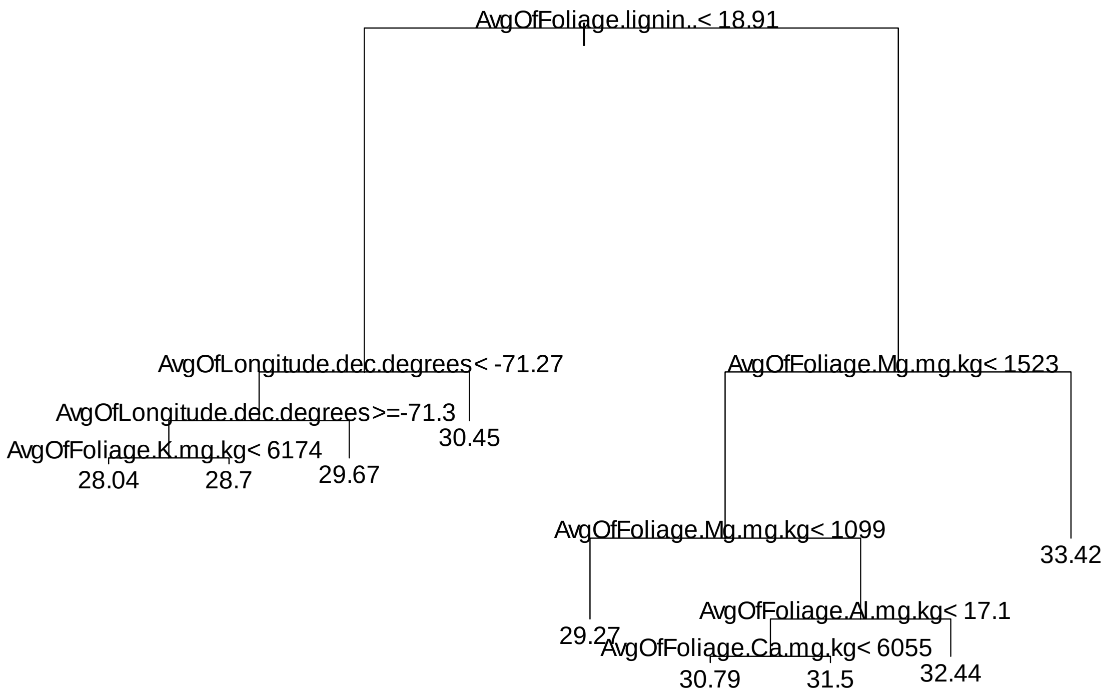
Cellulose : *Acer saccharum*



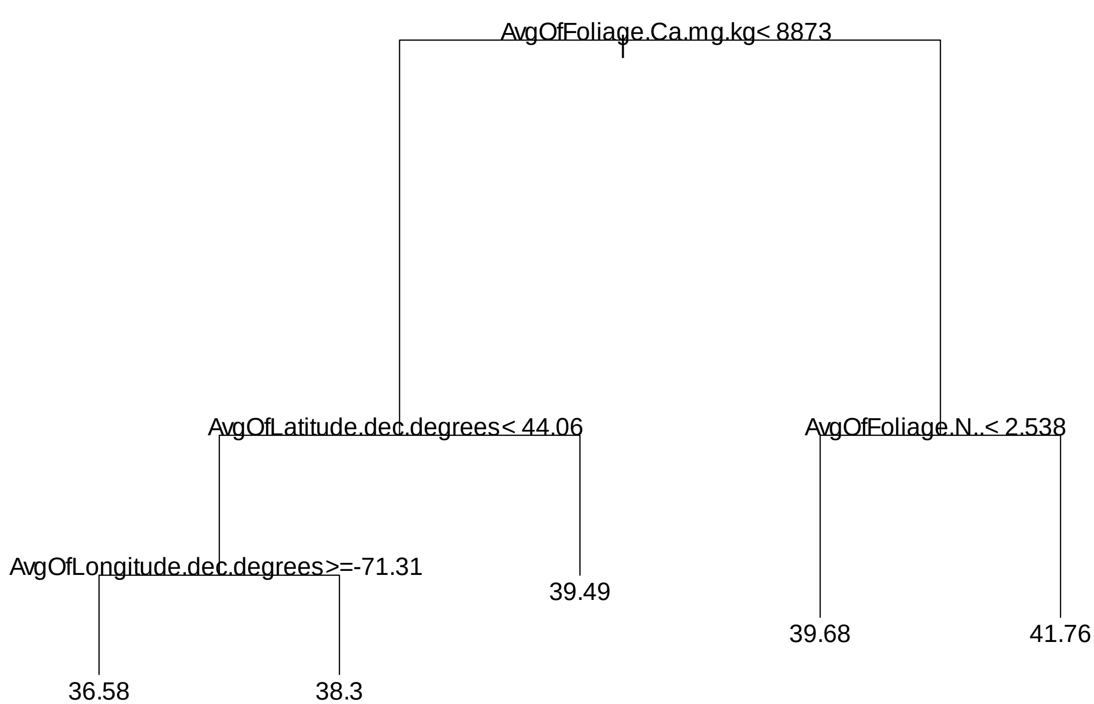
Cellulose : *Fagus grandifolia*



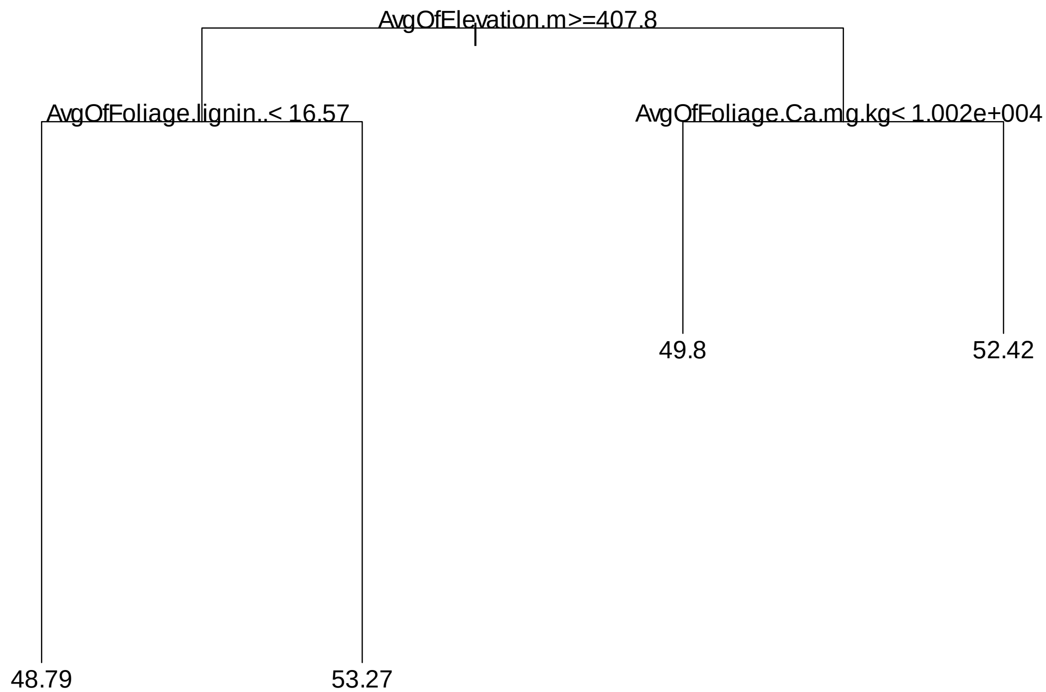
Cellulose : *Acer rubrum*



Cellulose : *Betula alleghaniensis*



Cellulose : *Fraxinus americana*



Celllulose : *Quercus rubra*

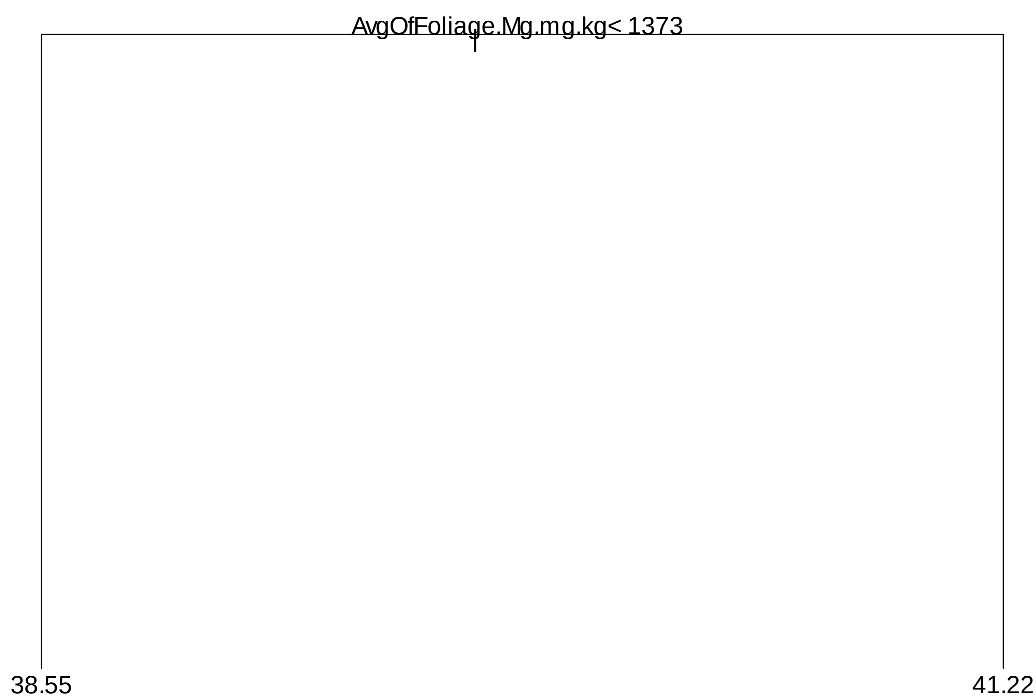
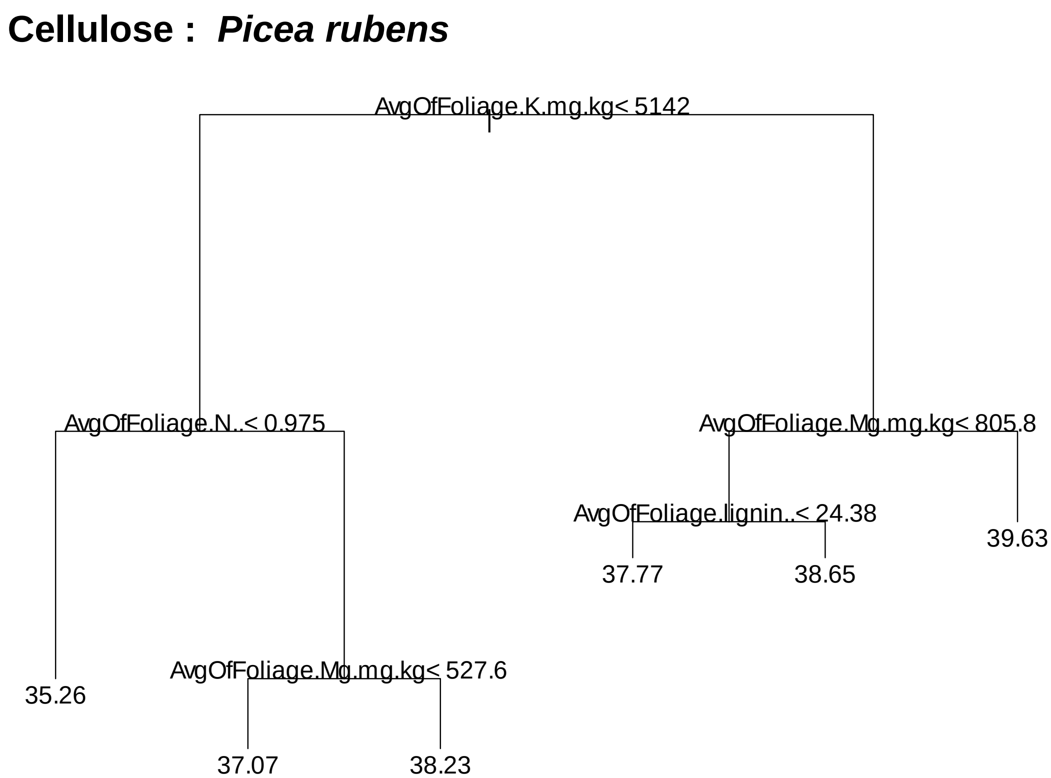


Figure 75. Classification and regression trees (CART) for foliar cellulose in softwood species.



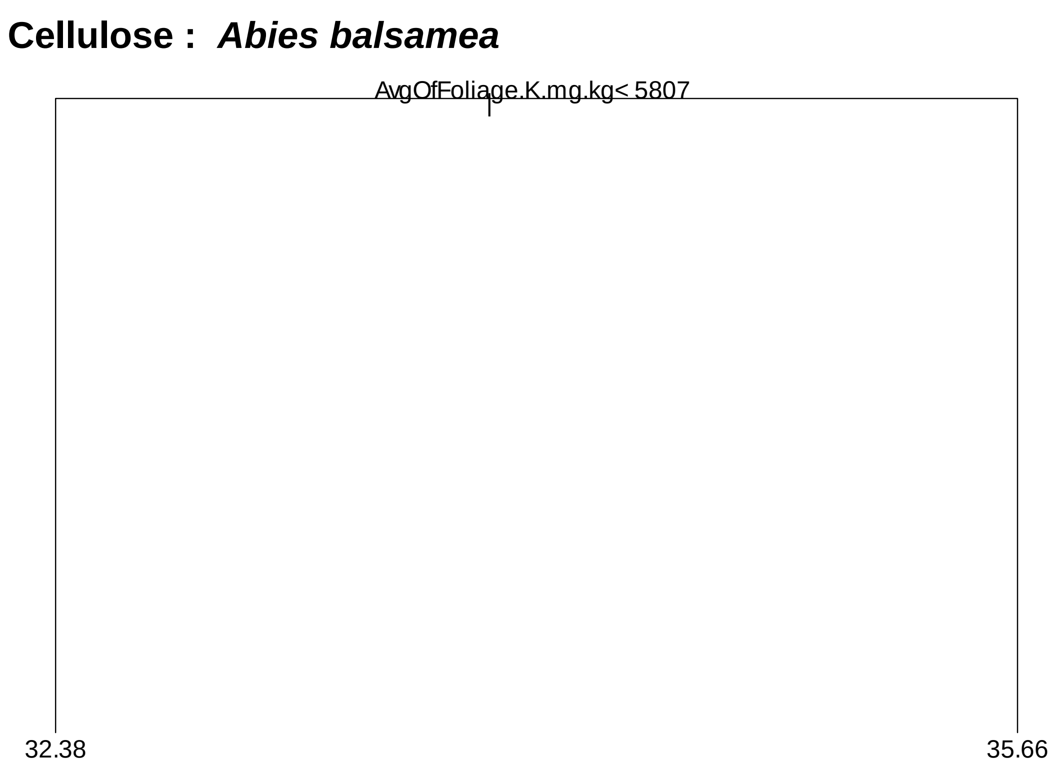
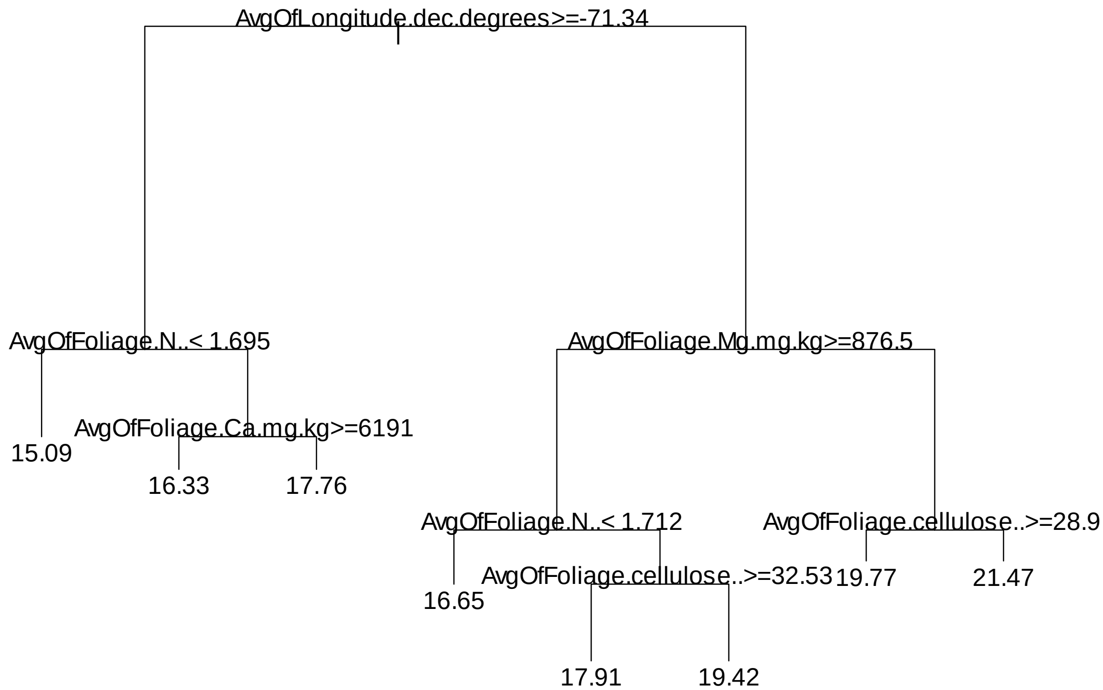
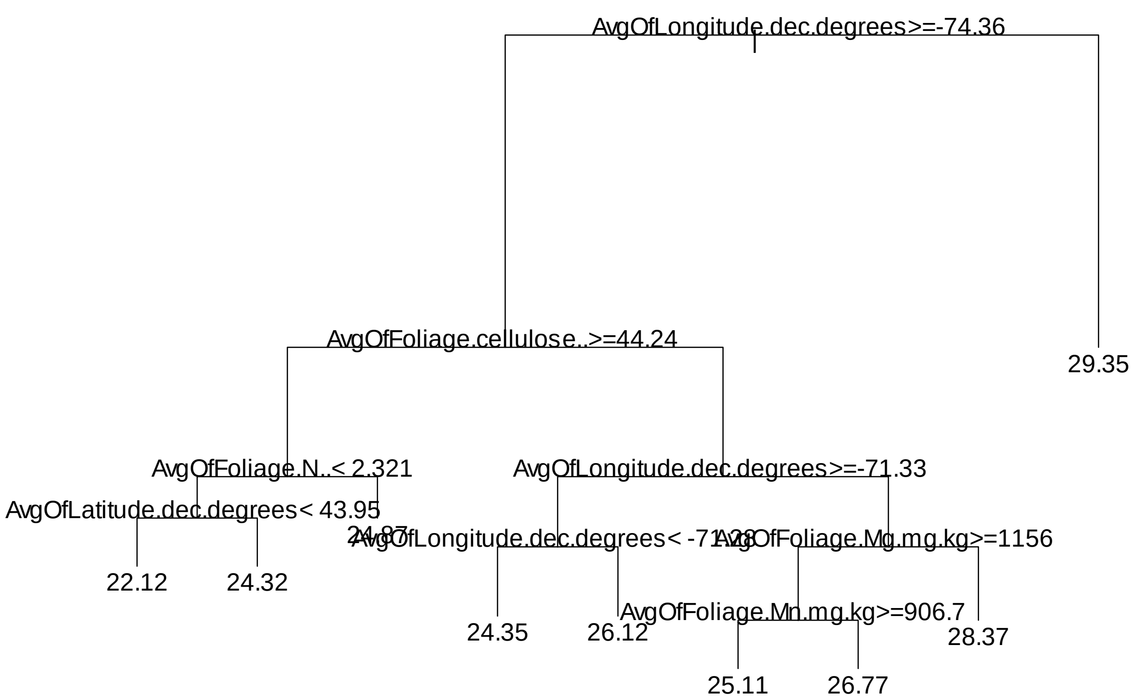


Figure 76. Classification and regression trees (CART) for foliar lignin in hardwood species. (figure spans multiple pages)

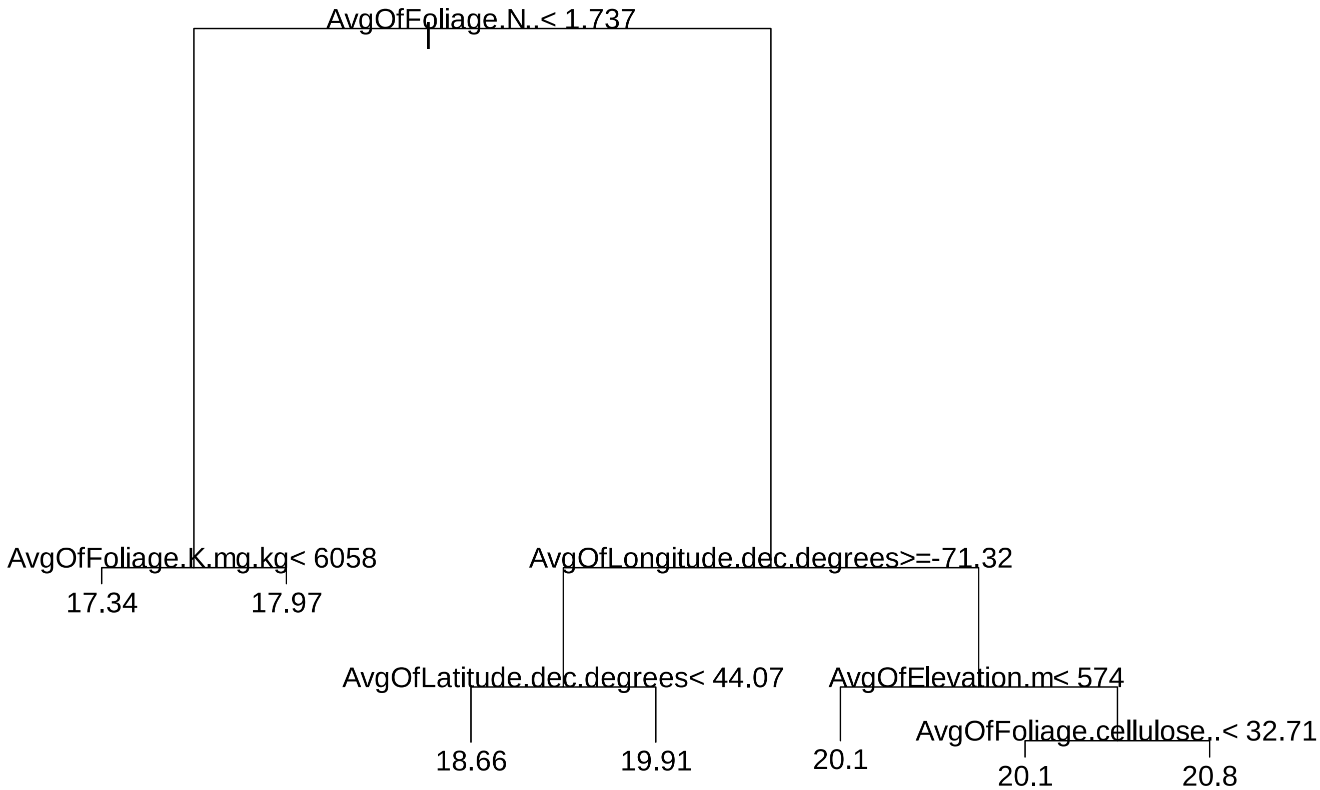
Lignin : *Acer saccharum*



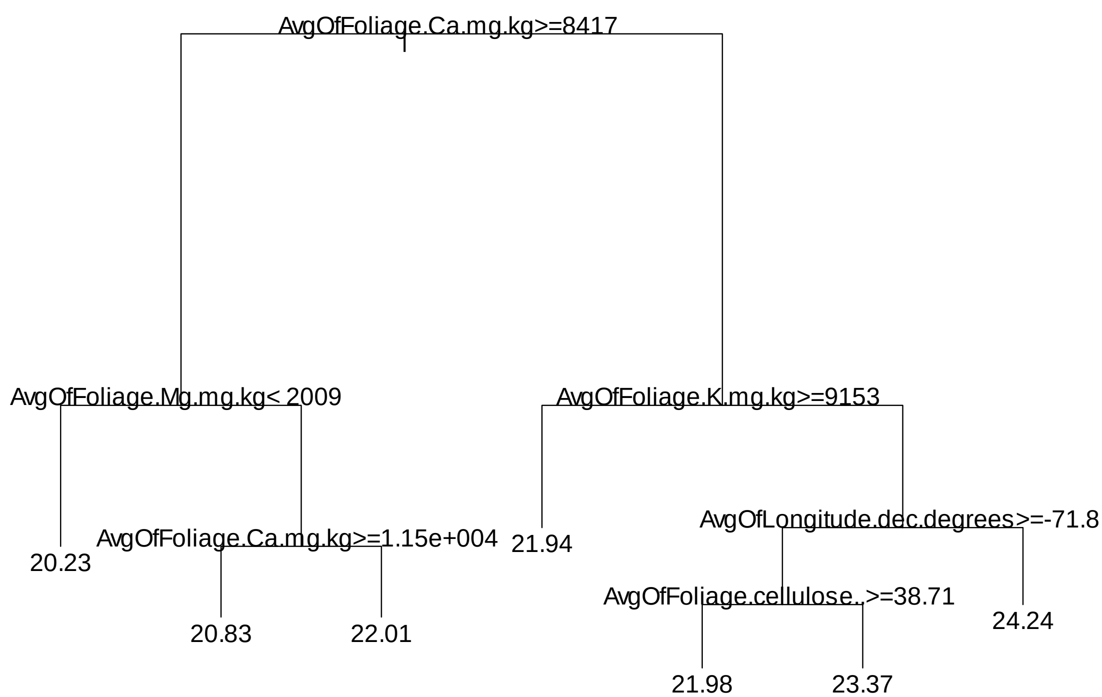
Lignin : *Fagus grandifolia*



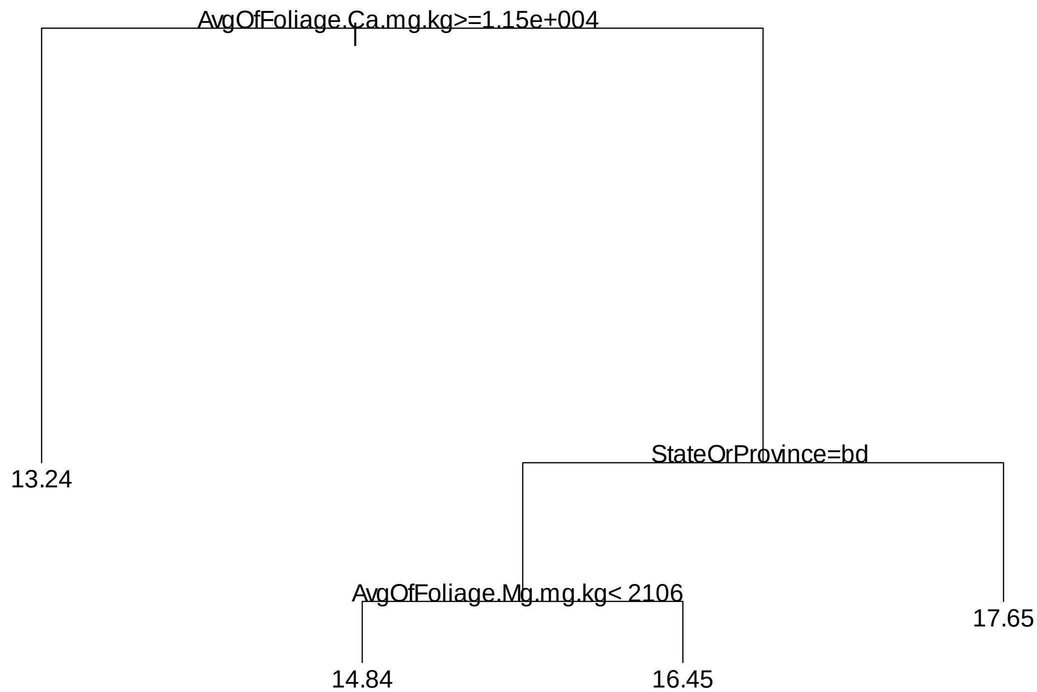
Lignin : *Acer rubrum*



Lignin : *Betula alleghaniensis*



Lignin : *Fraxinus americana*



Lignin : *Quercus rubra*

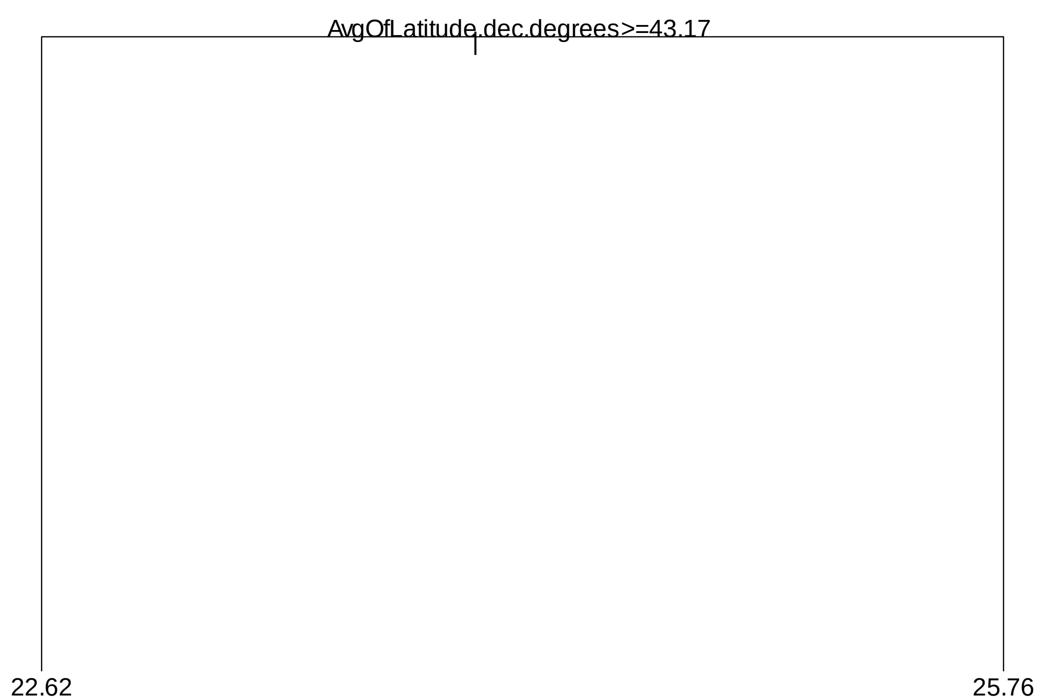
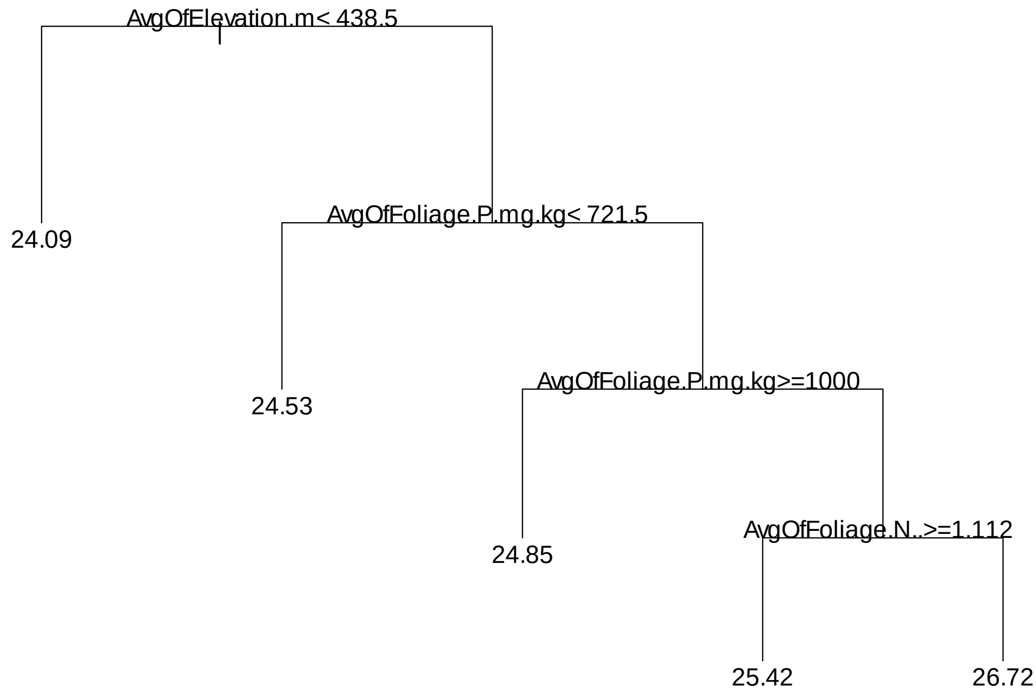


Figure 77. Classification and regression trees (CART) for foliar lignin in softwood species.

Lignin : *Picea rubens*



Lignin : *Abies balsamea*

Appendix B-7: Foliar Chemistry Random Forest Diagrams

Figure 78. Random Forest diagrams for foliar nitrogen in hardwood species. X axis is "IncnodePurity", which is an importance value.

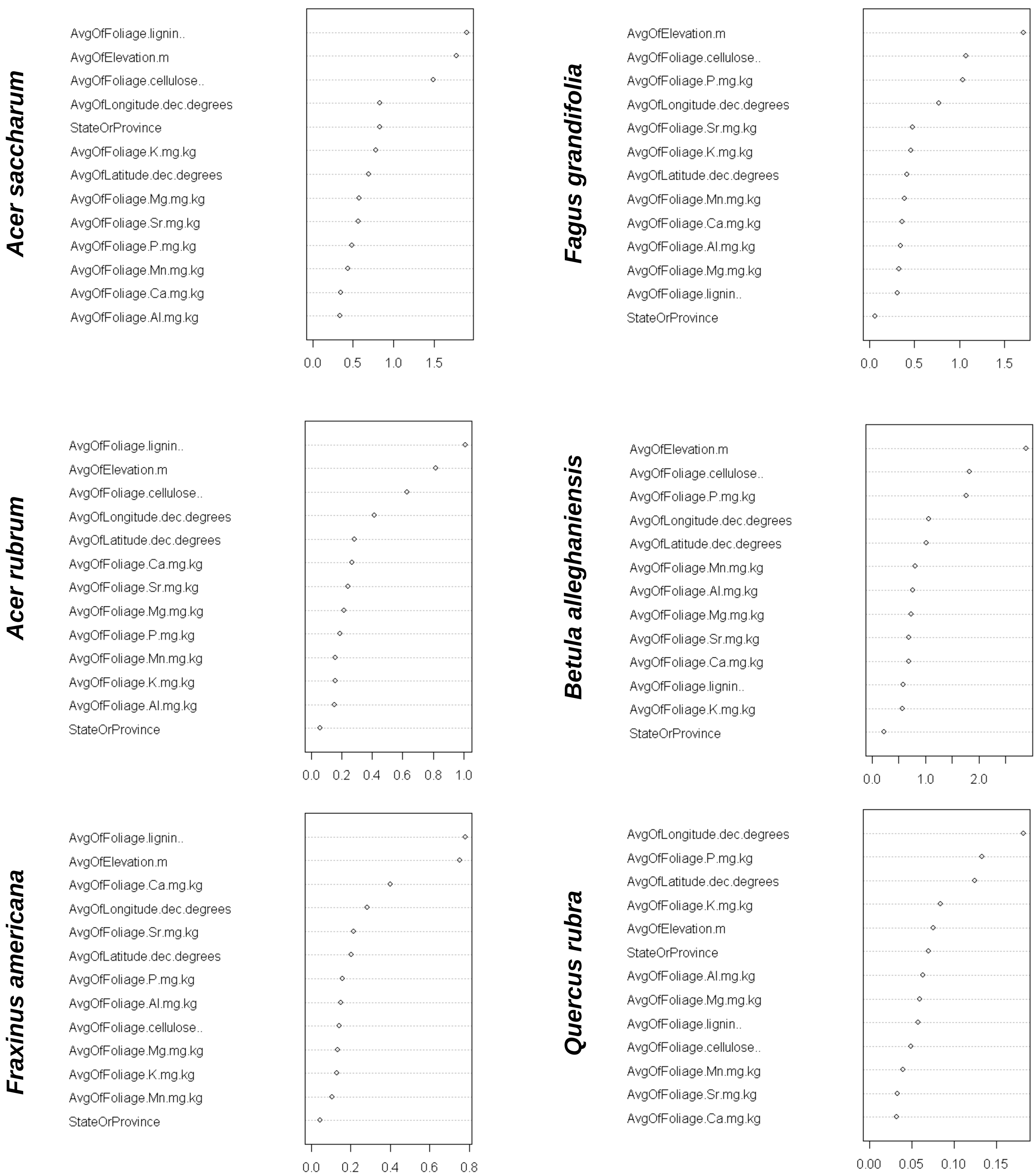
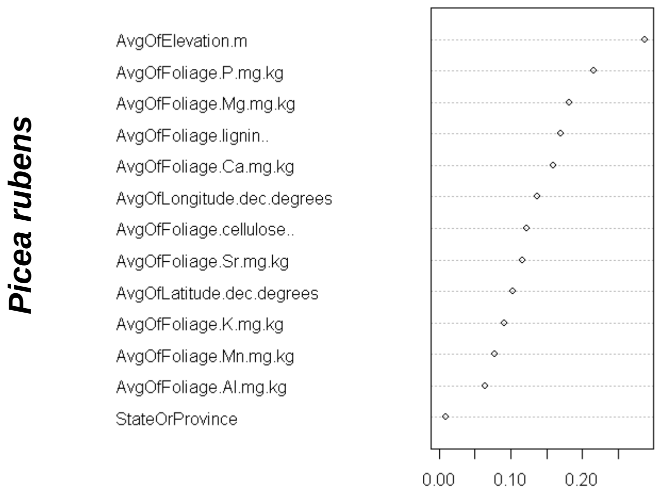


Figure 79. Random Forest diagrams for foliar nitrogen in softwood species. X axis is "IncnodePurity", which is an importance value.



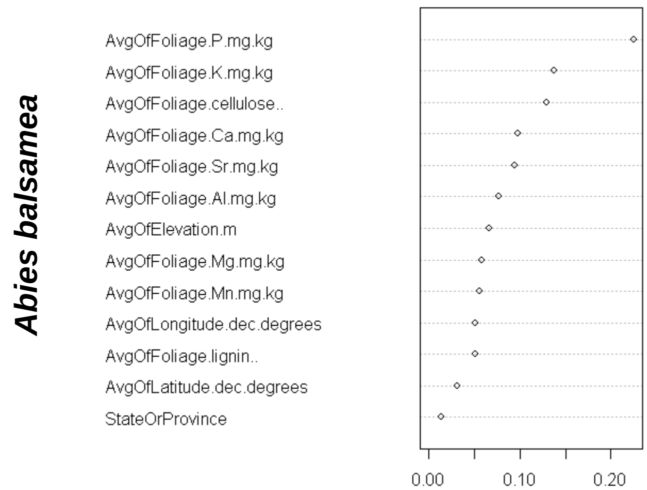


Figure 80. Random Forest diagrams for foliar calcium in hardwood species. X axis is "IncnodePurity", which is an importance value.

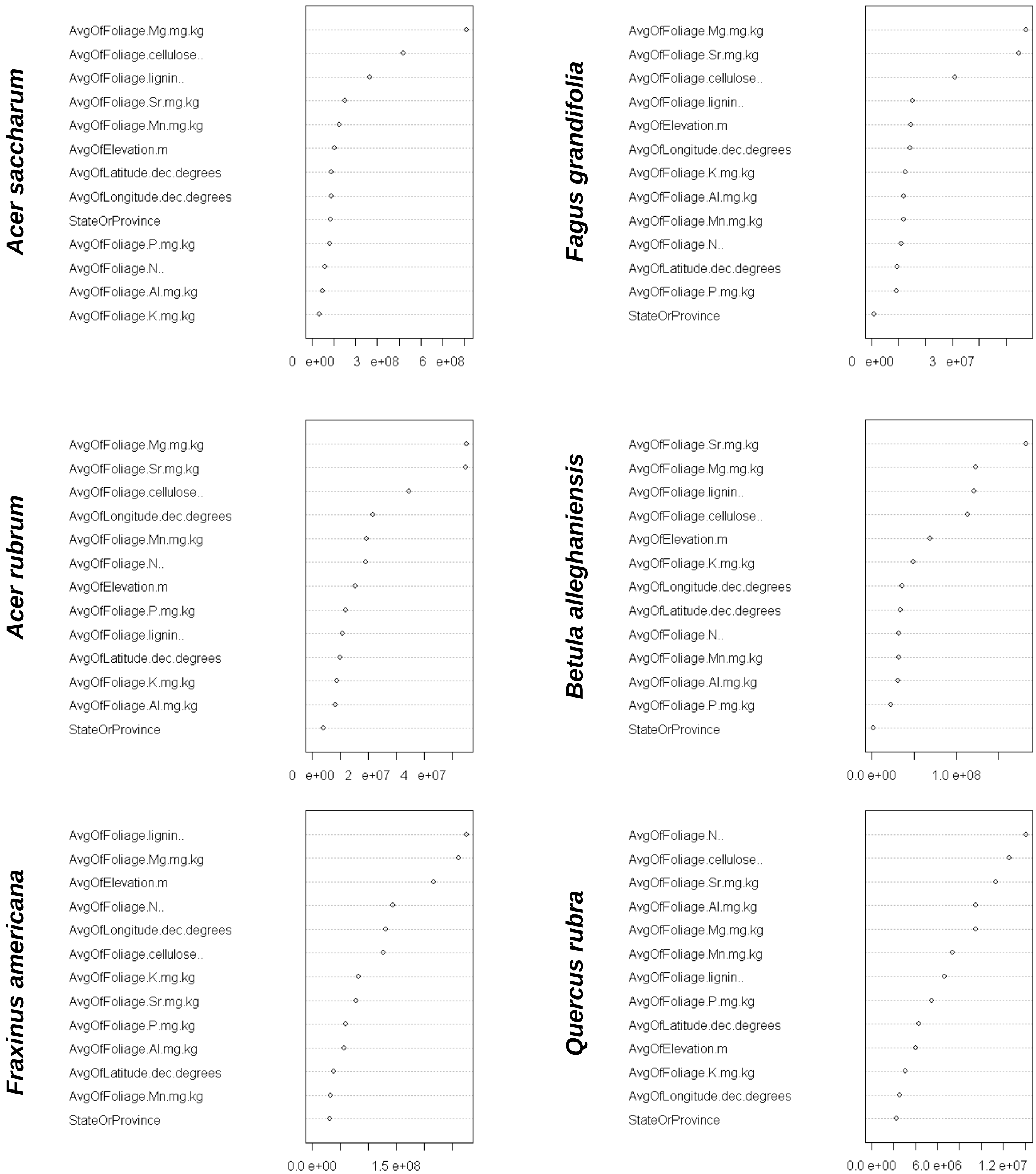


Figure 81. Random Forest diagrams for foliar calcium in softwood species. X axis is "IncnodePurity", which is an importance value.

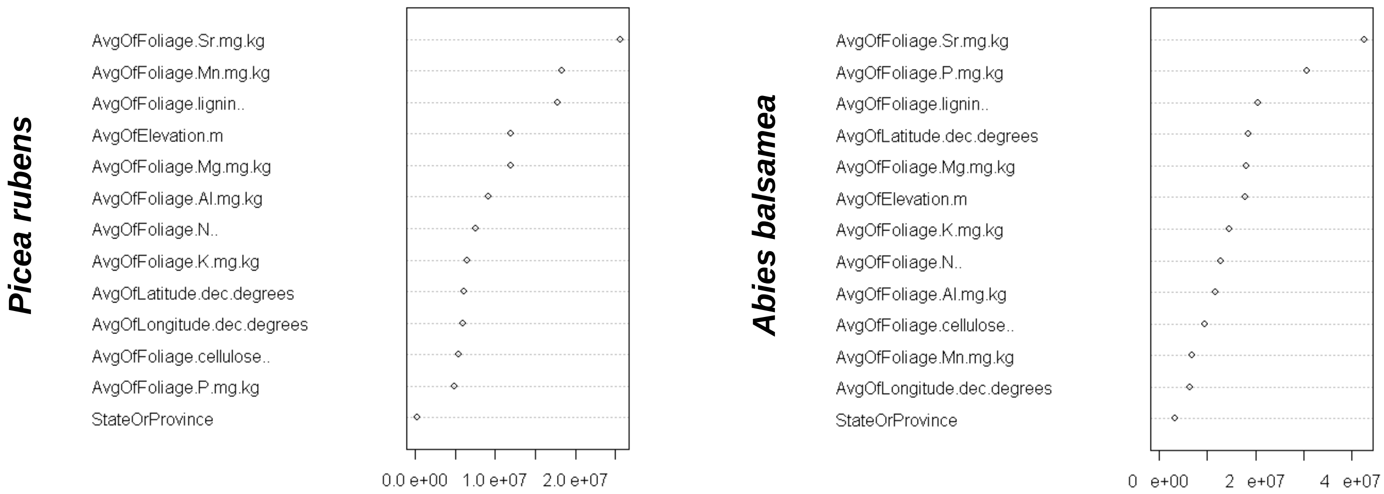


Figure 82. Random Forest diagrams for foliar magnesium in hardwood species. X axis is "IncnodePurity", which is an importance value.

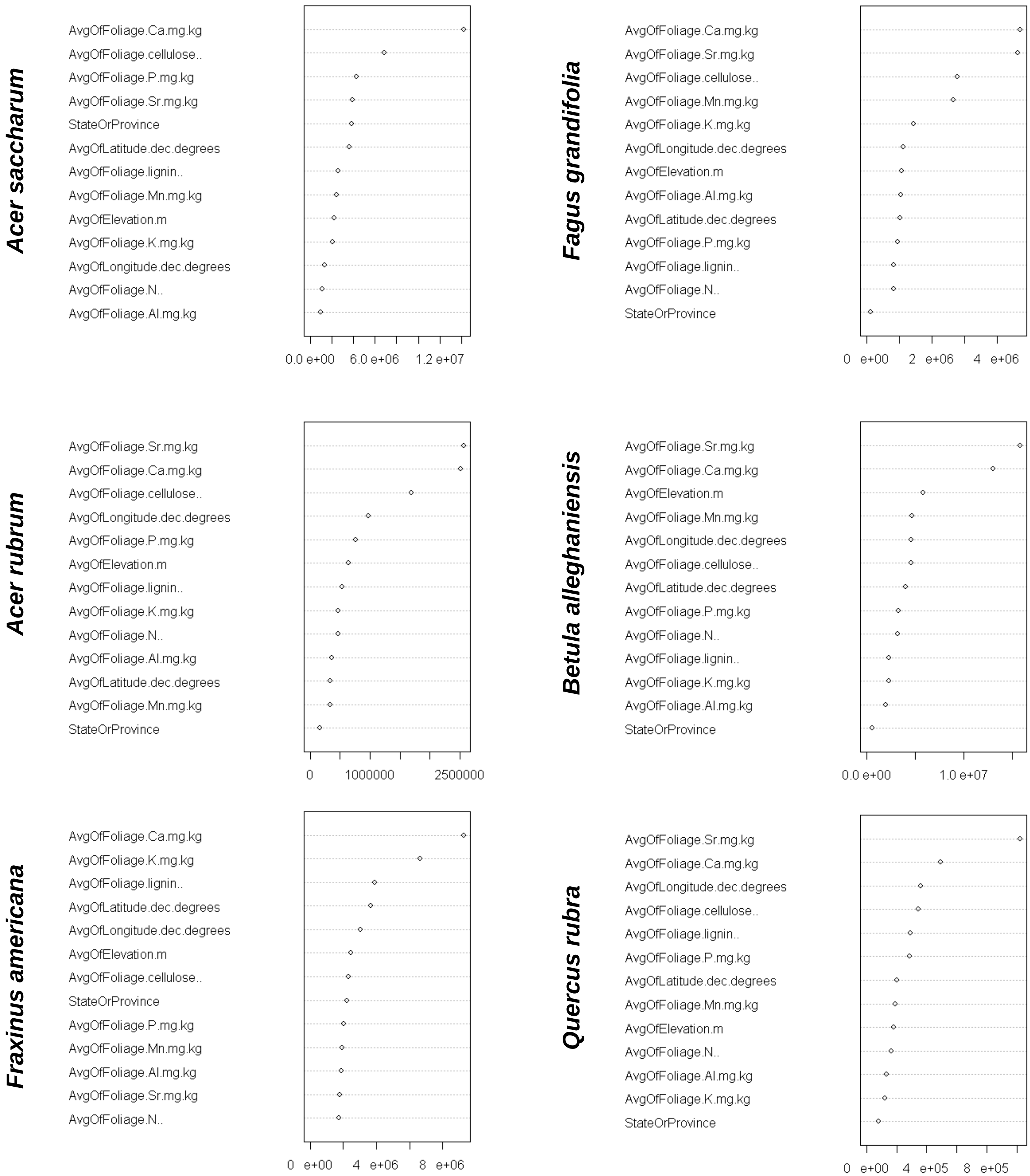


Figure 83. Random Forest diagrams for foliar magnesium in softwood species. X axis is "IncnodePurity", which is an importance value.

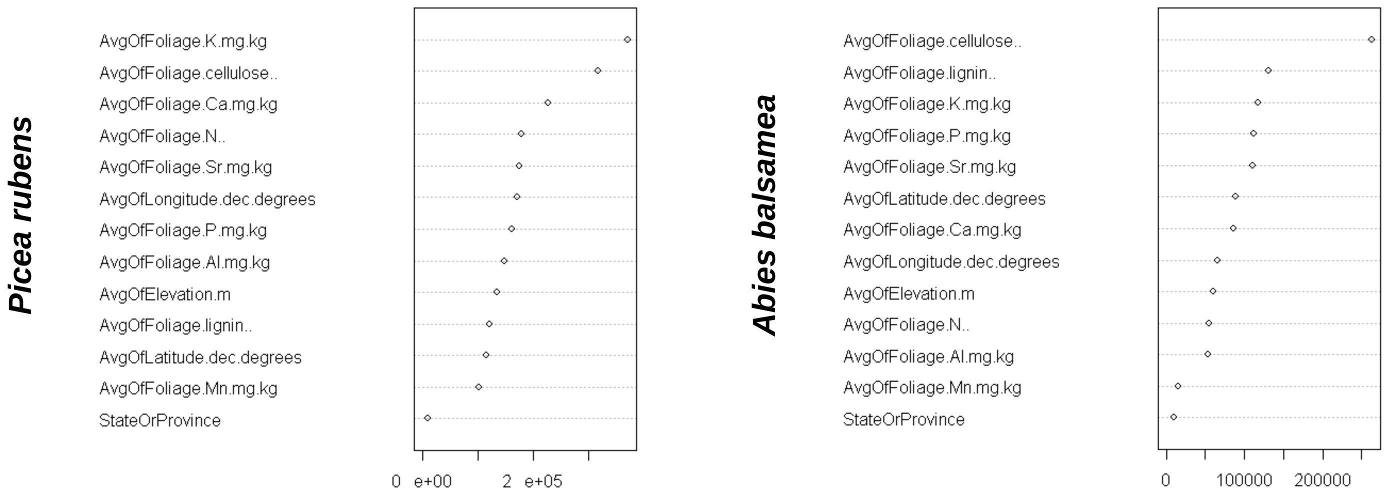


Figure 84. Random Forest diagrams for foliar potassium in hardwood species. X axis is "IncnodePurity", which is an importance value.

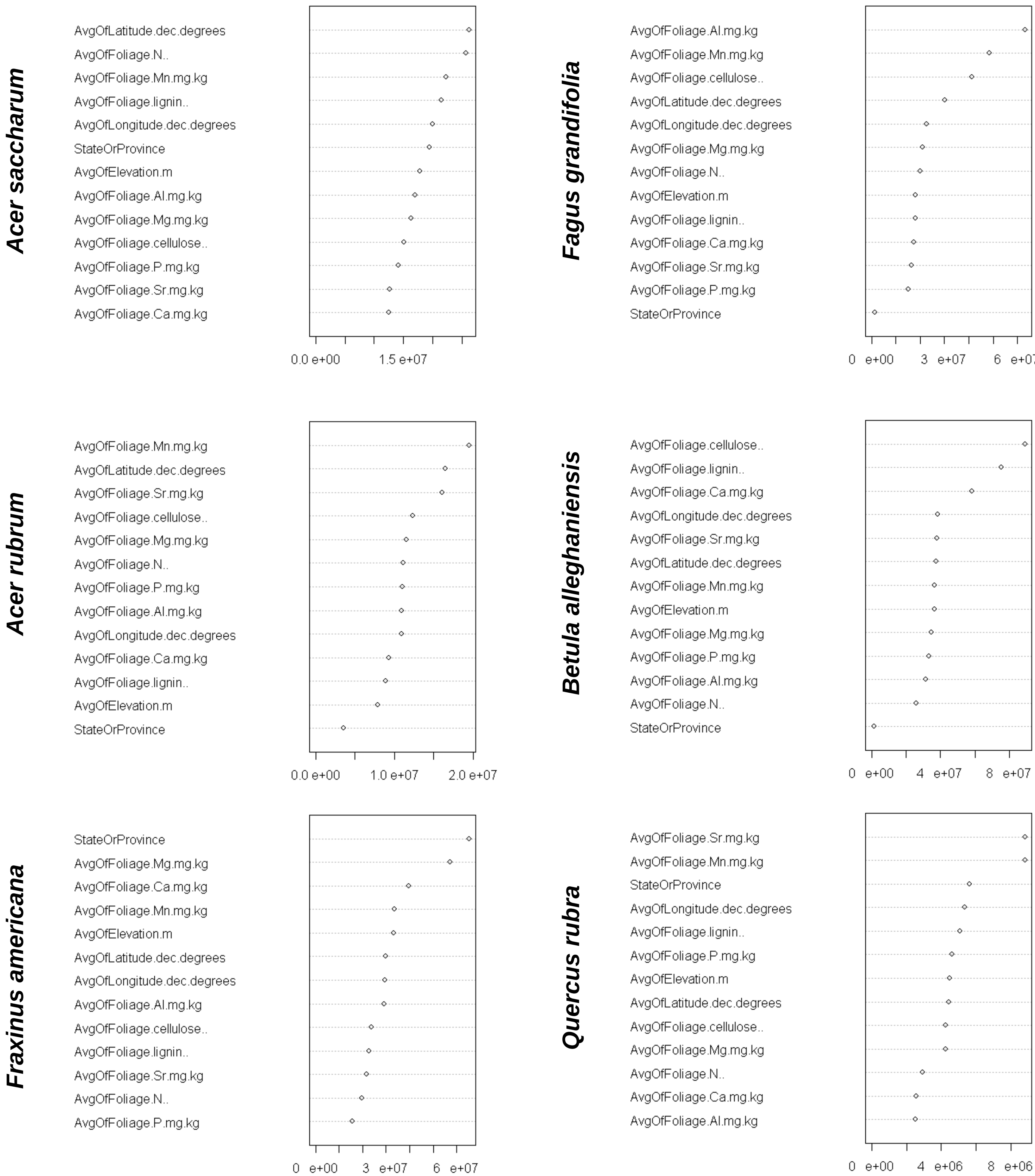


Figure 85. Random Forest diagrams for foliar potassium in softwood species. X axis is "IncnodePurity", which is an importance value.

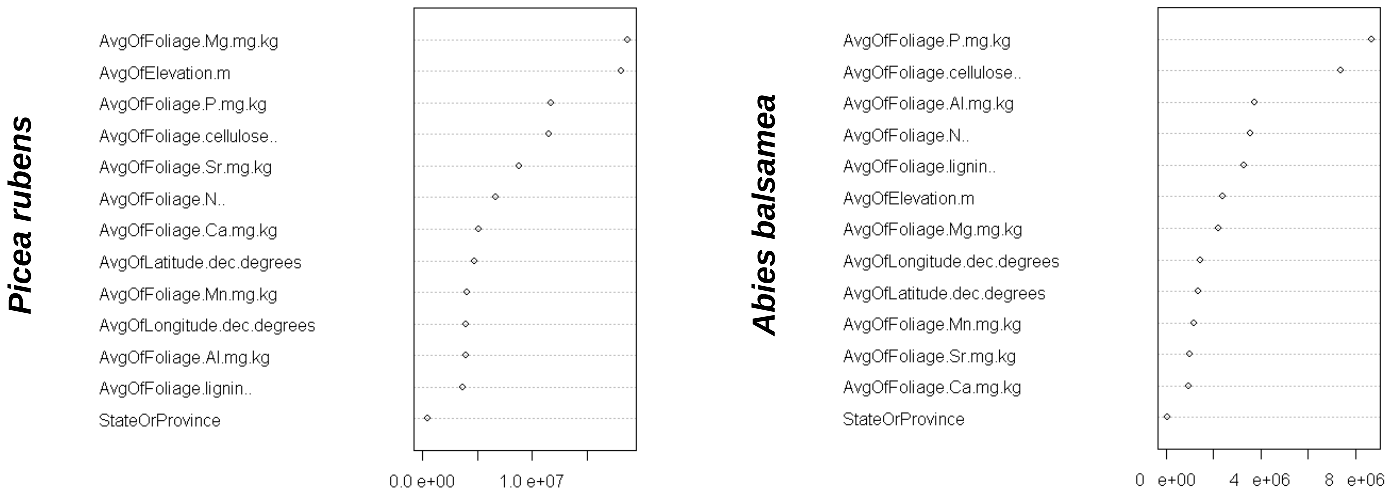


Figure 86. Random Forest diagrams for foliar phosphorus in hardwood species. X axis is "IncnodePurity", which is an importance value.

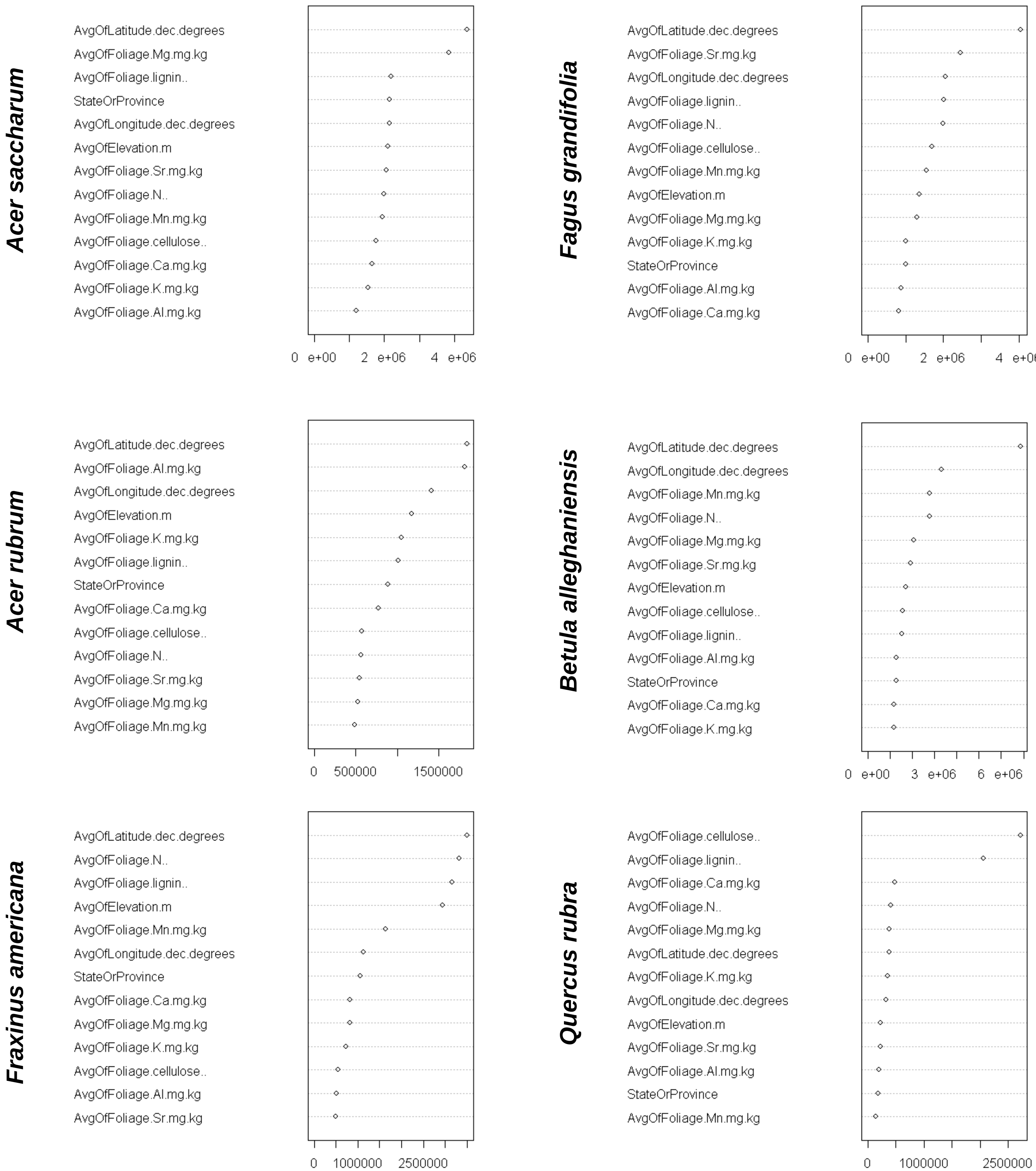


Figure 87. Random Forest diagrams for foliar phosphorus in softwood species. X axis is "IncnodePurity", which is an importance value.

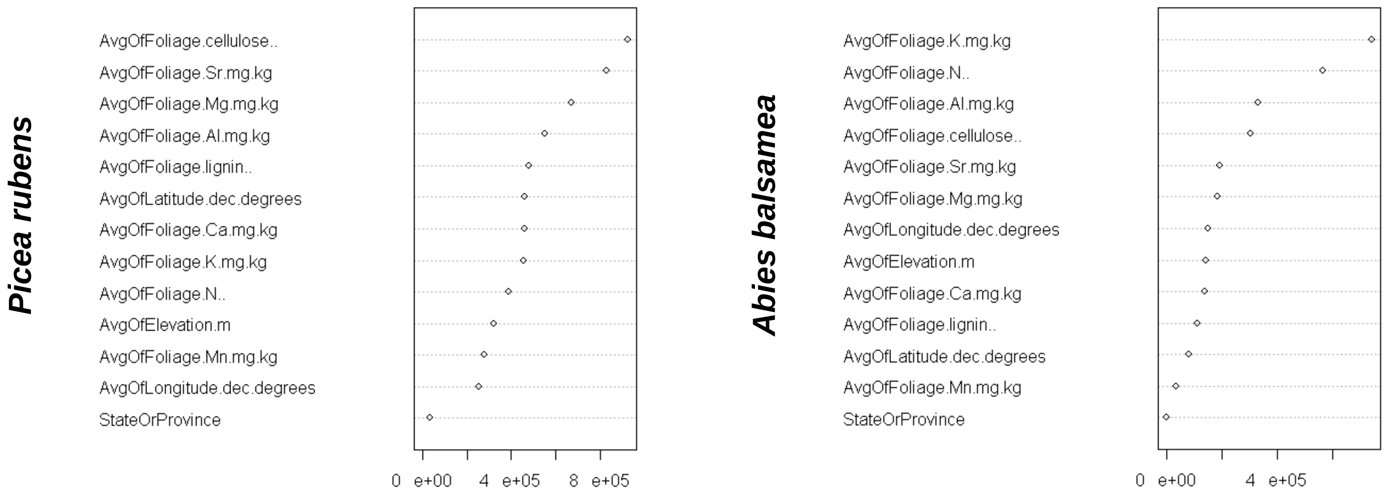


Figure 88. Random Forest diagrams for foliar aluminum in hardwood species. X axis is "IncnodePurity", which is an importance value.

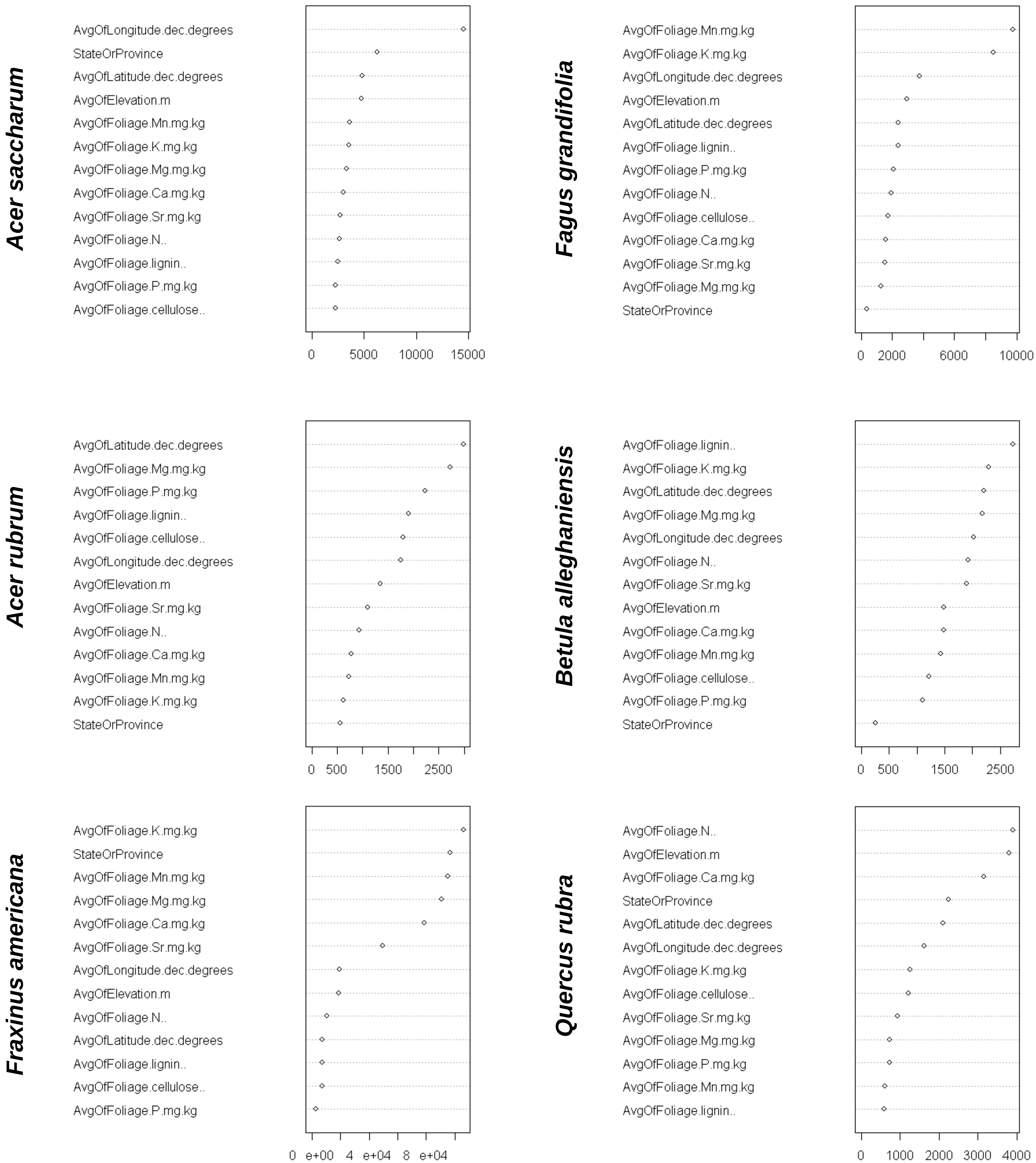


Figure 89. Random Forest diagrams for foliar aluminum in softwood species. X axis is "IncnodePurity", which is an importance value.

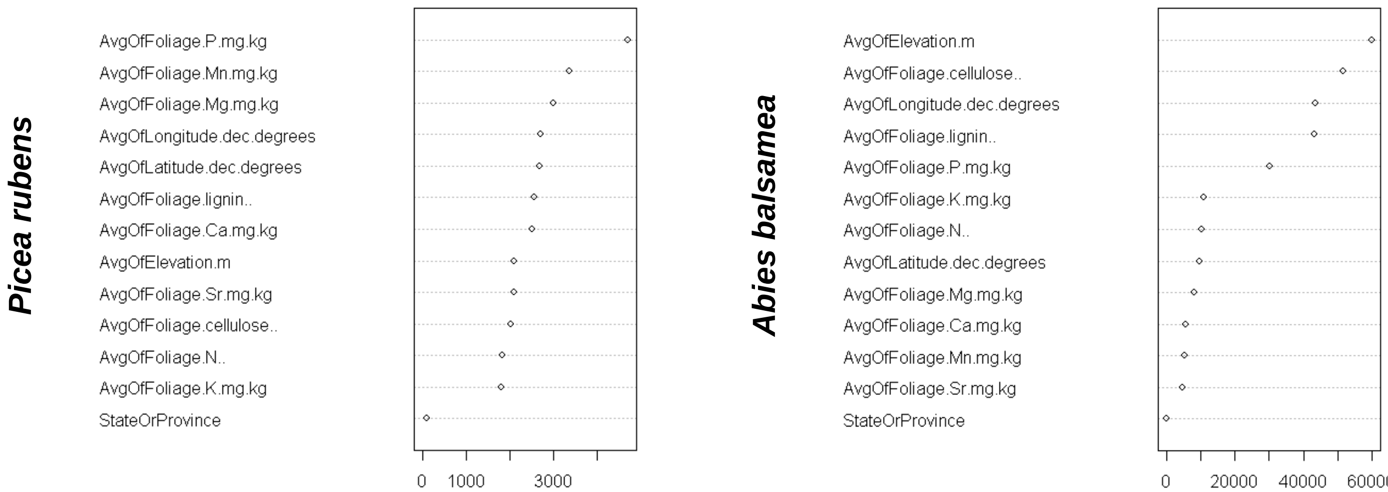


Figure 90. Random Forest diagrams for foliar strontium in hardwood species. X axis is "IncnodePurity", which is an importance value.

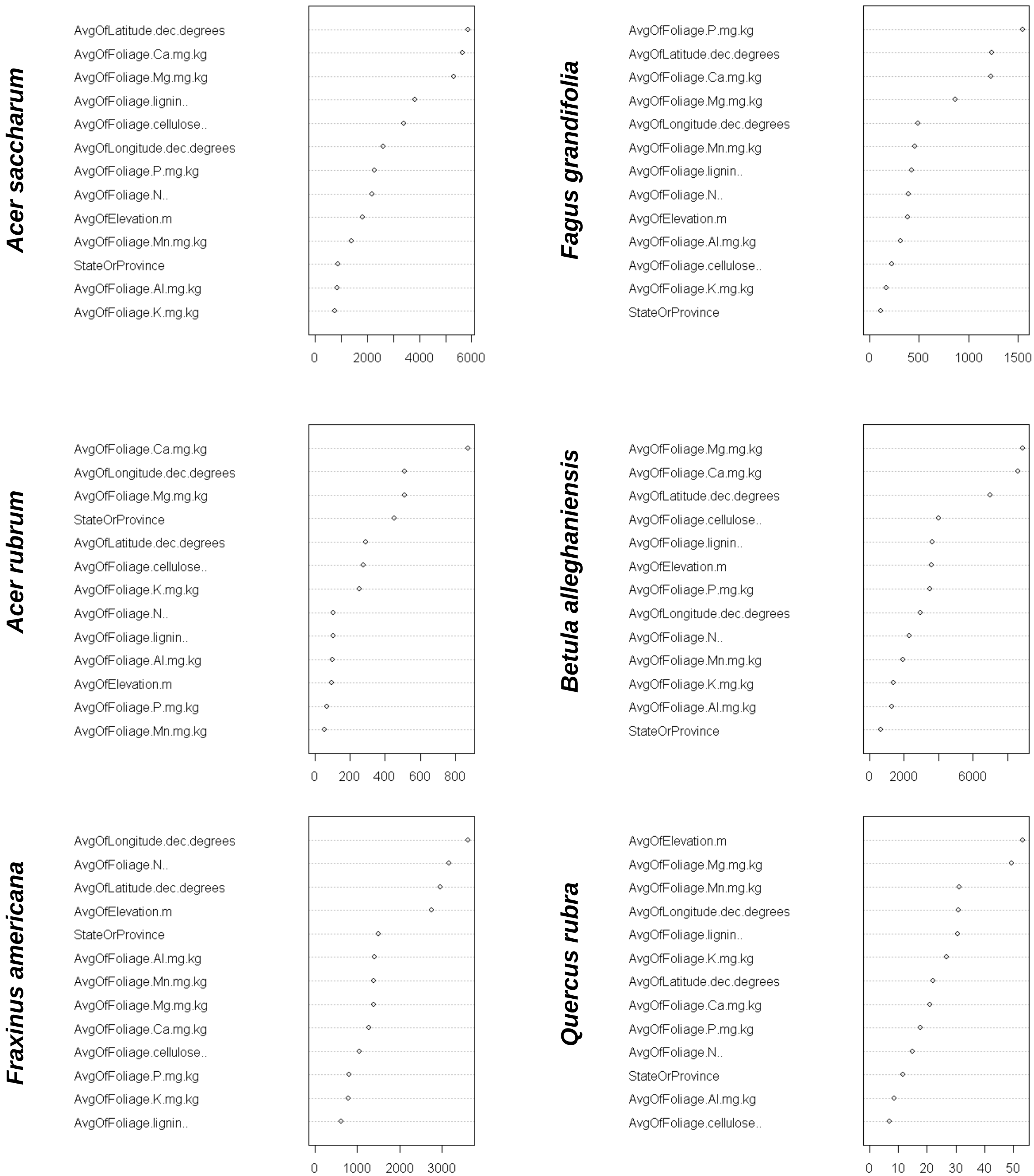


Figure 91. Random Forest diagrams for foliar strontium in softwood species. X axis is "IncnodePurity", which is an importance value.

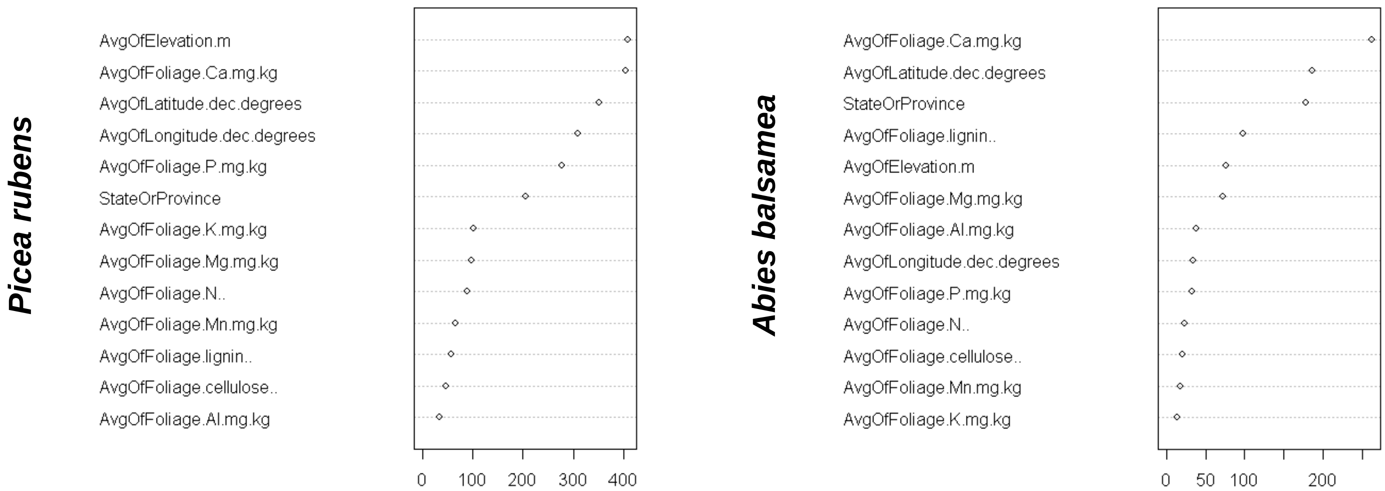


Figure 92. Random Forest diagrams for foliar cellulose in hardwood species. X axis is "IncnodePurity", which is an importance value.

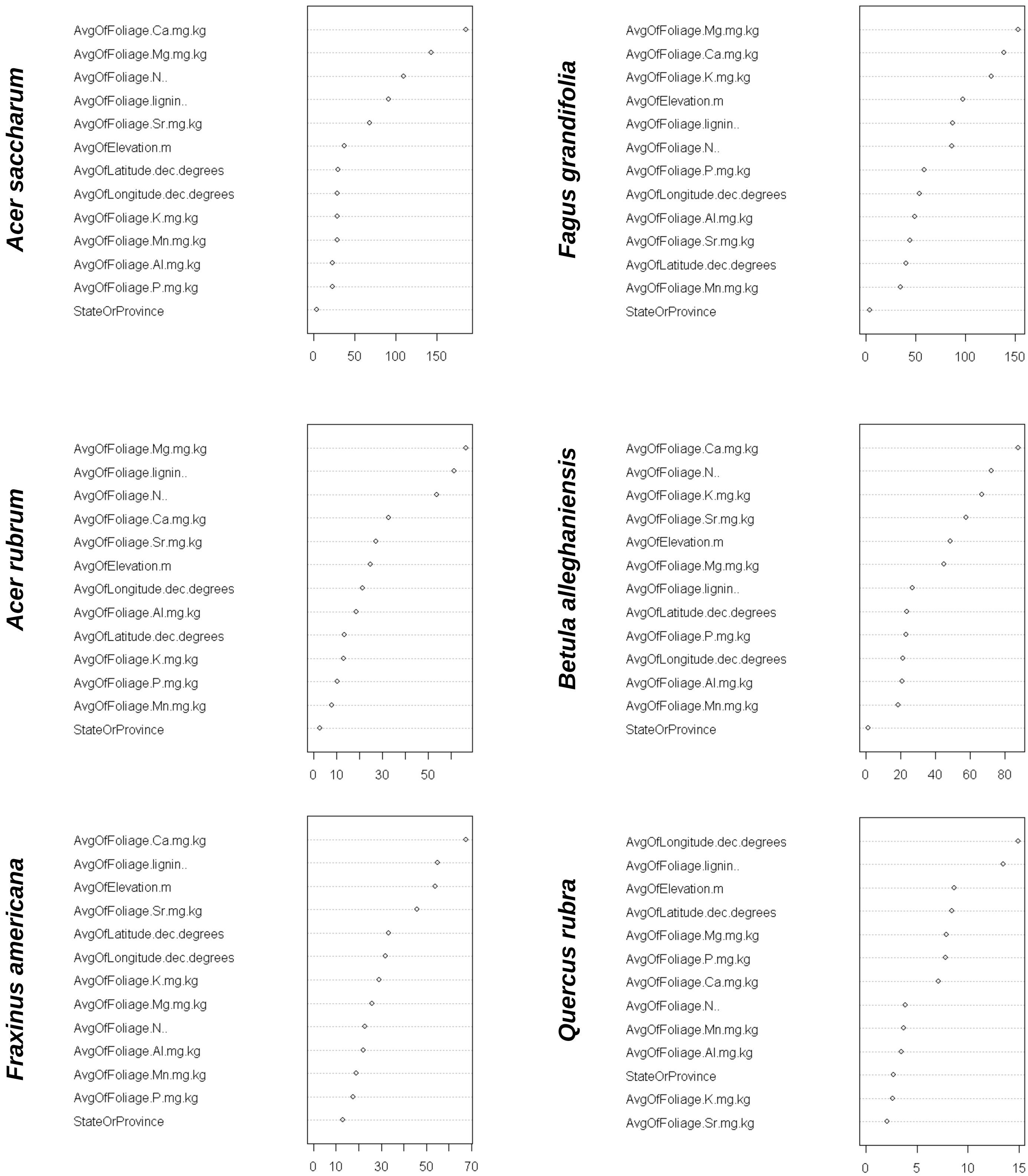
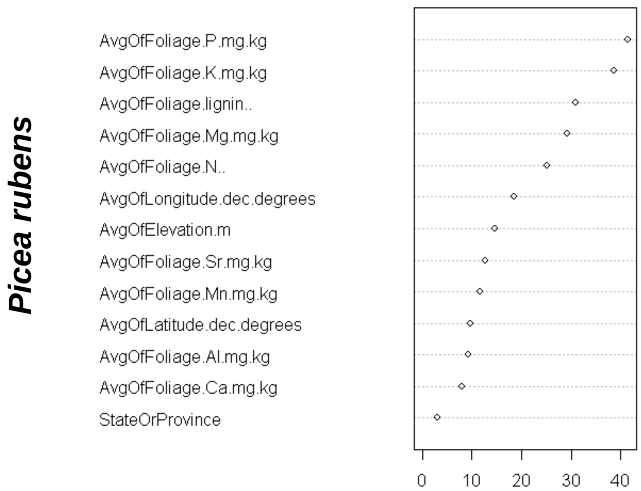


Figure 93. Random Forest diagrams for foliar cellulose in softwood species. X axis is "IncnodePurity", which is an importance value.



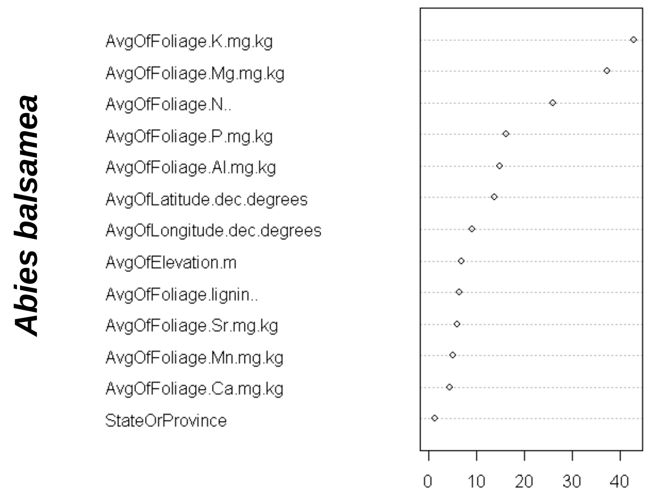


Figure 94. Random Forest diagrams for foliar lignin in hardwood species. X axis is "IncnodePurity", which is an importance value.

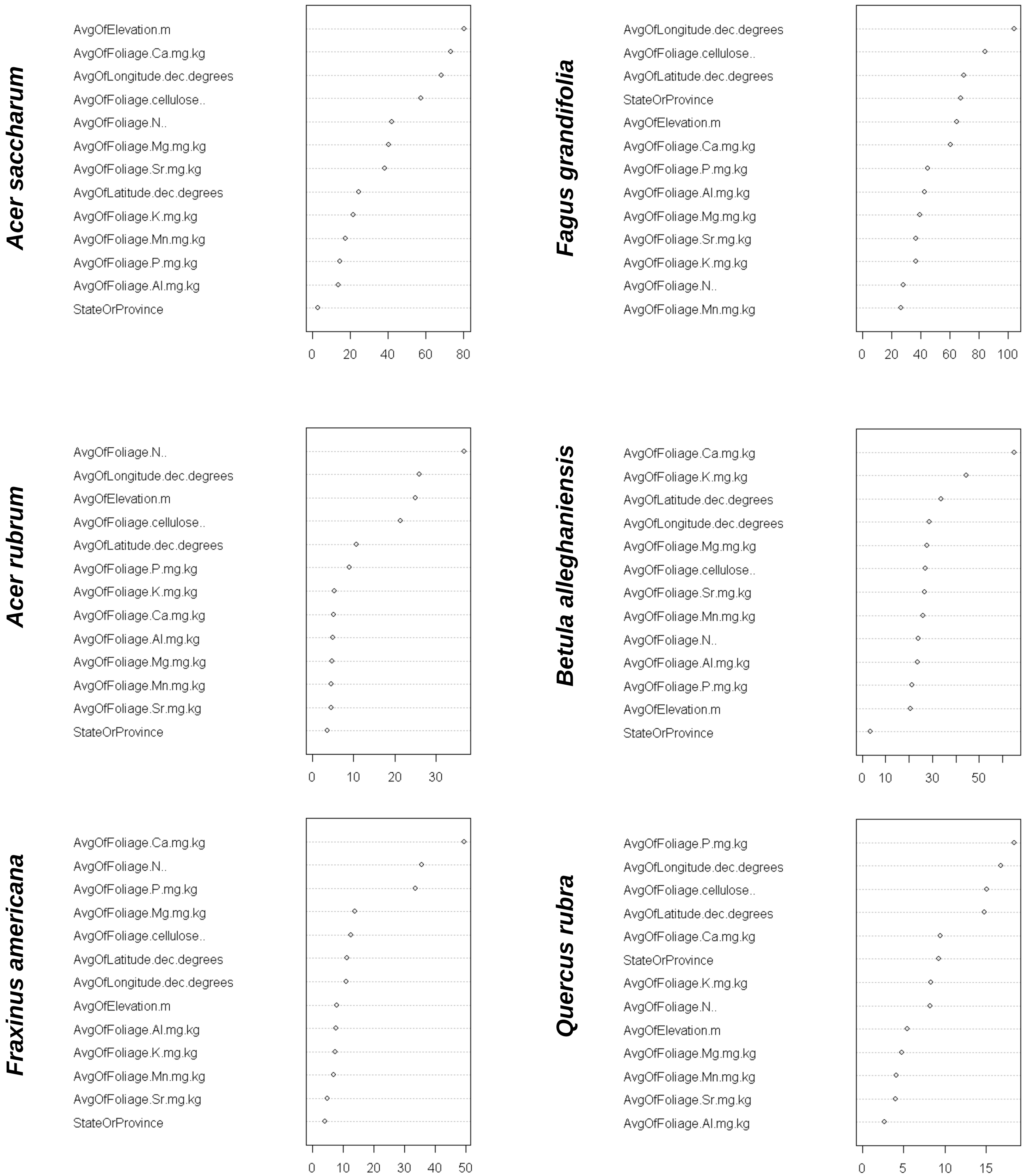
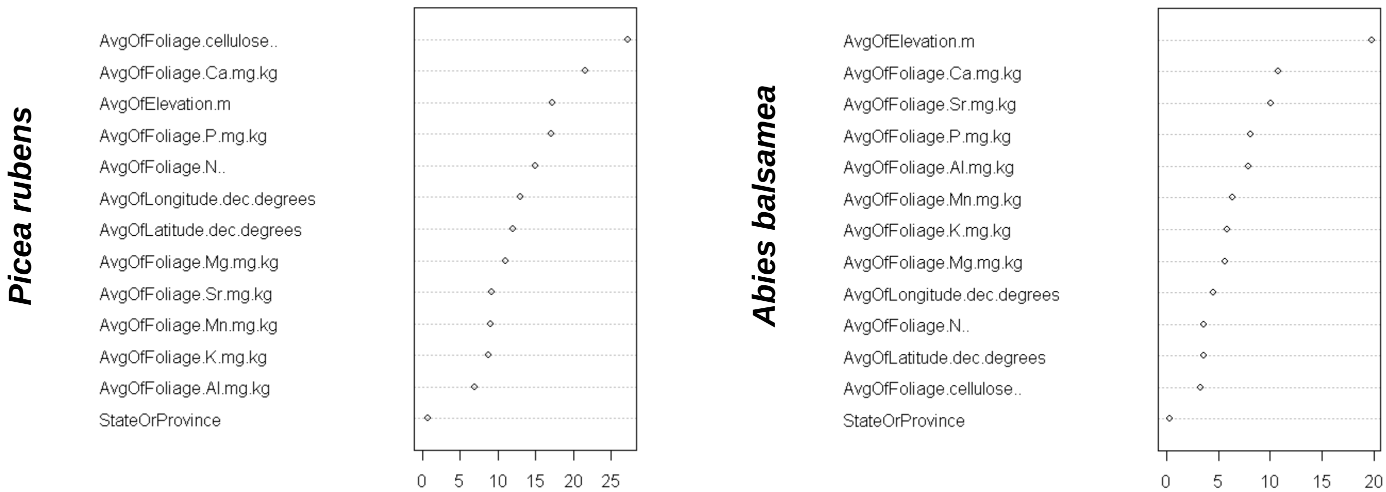


Figure 95. Random Forest diagrams for foliar lignin in softwood species. X axis is "IncnodePurity", which is an importance value.



Appendix C: Soil Chemistry Analysis

Table of Contents

Appendix C-5: Soil Chemistry Random Forest Diagrams

Appendix C-1: Soil Chemistry Summary Statistics

Table 1. Summary statistics for soil chemistry dataset. (table spans multiple pages)

Organic layer, hardwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	3.53	3.50	2.74	4.75	0.41	55
Total C (%)	35.89	36.34	12.23	50.61	7.59	95
Total N (%)	1.66	1.65	0.66	2.43	0.36	95
CN ratio	21.75	20.98	15.58	35.24	3.78	103
Ca (cmoles/kg)	15.75	14.90	0.10	44.90	10.10	15
Mg (cmoles/kg)	3.06	2.30	1.20	8.03	2.07	15
K (cmoles/kg)	1.45	1.50	0.30	2.70	0.79	14
Al (cmoles/kg)	1.46	1.02	0.20	5.67	1.45	13
Nitr/Min (%)	19.52	11.09	-0.49	100.00	22.56	96

Organic layer, mixed stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	3.44	3.38	2.75	4.25	0.44	24
Total C (%)	41.77	45.52	12.26	52.84	10.51	24
Total N (%)	1.50	1.62	0.44	2.61	0.63	23
CN ratio	26.36	25.00	15.81	42.67	6.74	14
Ca (cmoles/kg)	9.33	9.07	0.95	25.40	6.27	20
Mg (cmoles/kg)	2.41	2.52	0.00	5.85	1.47	22
K (cmoles/kg)	1.15	1.00	0.00	2.80	0.80	22
Al (cmoles/kg)	2.93	2.10	0.00	9.10	2.52	22
Nitr/Min (%)	32.90	29.52	0.20	72.38	37.59	4

Organic layer, softwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	3.27	3.22	2.64	4.90	0.41	62
Total C (%)	39.74	40.24	18.00	51.92	6.67	72
Total N (%)	1.56	1.56	0.91	2.34	0.29	71
CN ratio	26.79	25.70	14.60	43.67	5.67	68
Ca (cmoles/kg)	17.46	15.38	4.45	41.00	12.29	12
Mg (cmoles/kg)	3.17	2.50	0.90	8.65	2.36	12
K (cmoles/kg)	1.52	1.30	0.50	3.30	0.81	11
Al (cmoles/kg)	1.99	1.80	0.00	4.25	1.48	11
Nitr/Min (%)	7.91	1.67	-0.67	54.03	12.53	56

Upper mineral layer, hardwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	3.80	3.71	3.15	4.65	0.41	52
Total C (%)	8.27	7.47	2.41	43.93	5.15	80
Total N (%)	0.42	0.37	0.05	1.56	0.23	81
CN ratio	18.25	17.97	10.50	30.00	3.73	77
Ca (cmoles/kg)	1.71	0.58	0.00	18.95	3.74	27
Mg (cmoles/kg)	0.22	0.15	0.00	1.35	0.31	27
K (cmoles/kg)	0.14	0.10	0.00	0.43	0.12	23
Al (cmoles/kg)	3.58	2.30	0.40	11.40	3.10	23
Nitr/Min (%)	52.13	55.26	0.03	100.00	28.74	77

Upper mineral layer, mixed stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	4.01	3.92	3.10	6.40	0.56	32
Total C (%)	6.27	5.56	1.49	20.51	4.33	22
Total N (%)	0.24	0.18	0.02	1.01	0.22	26
CN ratio	20.87	19.46	10.50	52.00	8.90	20
Ca (cmoles/kg)	0.76	0.20	0.00	9.20	1.87	32
Mg (cmoles/kg)	0.34	0.15	0.00	1.80	0.47	32
K (cmoles/kg)	0.14	0.10	0.00	0.60	0.15	32
Al (cmoles/kg)	5.37	3.75	0.80	16.20	4.28	31
Nitr/Min (%)	6.86	3.05	0.04	17.48	9.32	3

Upper mineral layer, softwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	3.77	3.66	3.09	4.76	0.44	53
Total C (%)	6.62	6.29	1.94	13.66	2.68	57
Total N (%)	0.29	0.28	0.04	0.79	0.14	56
CN ratio	23.38	22.27	16.58	38.82	4.80	54
Ca (cmoles/kg)	0.55	0.40	0.17	1.60	0.41	13
Mg (cmoles/kg)	0.46	0.20	0.04	3.15	0.83	13
K (cmoles/kg)	0.18	0.17	0.00	0.30	0.10	10
Al (cmoles/kg)	5.53	3.74	0.13	17.50	5.35	12
Nitr/Min (%)	32.75	32.60	0.02	82.10	22.56	34

Lower mineral layer, hardwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	4.70	4.65	3.15	6.45	0.59	22
Total C (%)	1.96	1.91	0.15	6.69	1.79	17
Total N (%)	0.09	0.07	0.01	0.37	0.09	22
CN ratio	16.73	14.50	6.50	32.00	8.59	8
Ca (cmoles/kg)	0.95	0.28	0.00	10.15	2.16	23
Mg (cmoles/kg)	0.15	0.06	0.00	0.97	0.25	23
K (cmoles/kg)	0.09	0.10	0.00	0.23	0.07	23
Al (cmoles/kg)	1.69	0.93	0.14	10.98	2.40	23
Nitr/Min (%)	NA	NA	NA	NA	NA	0

Lower mineral layer, mixed stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	4.67	4.60	4.15	6.72	0.45	33
Total C (%)	1.71	1.50	0.19	6.51	1.58	20
Total N (%)	0.11	0.06	0.01	0.53	0.13	30
CN ratio	15.48	15.33	5.40	33.50	7.90	16
Ca (cmoles/kg)	0.50	0.10	0.00	7.57	1.38	33
Mg (cmoles/kg)	0.27	0.07	0.00	4.70	0.82	33
K (cmoles/kg)	0.10	0.07	0.00	0.57	0.11	33
Al (cmoles/kg)	1.61	0.86	0.00	6.85	1.81	33
Nitr/Min (%)	NA	NA	NA	NA	NA	0

Lower mineral layer, softwood stand

	mean	median	min	max	sd	n
pH ($CaCl_2$)	4.73	4.72	4.47	5.03	0.19	11
Total C (%)	1.38	0.62	0.24	4.80	1.71	7
Total N (%)	0.08	0.03	0.01	0.25	0.09	9
CN ratio	16.21	15.42	8.00	26.00	8.49	4
Ca (cmoles/kg)	0.21	0.13	0.05	0.95	0.25	11
Mg (cmoles/kg)	0.16	0.07	0.00	0.72	0.23	11
K (cmoles/kg)	0.10	0.09	0.03	0.40	0.11	10
Al (cmoles/kg)	0.90	0.53	0.20	2.83	0.82	11
Nitr/Min (%)	NA	NA	NA	NA	NA	0

Appendix B-2: Soil Chemistry Boxplots

Figure 1. Boxplots for soil pH in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

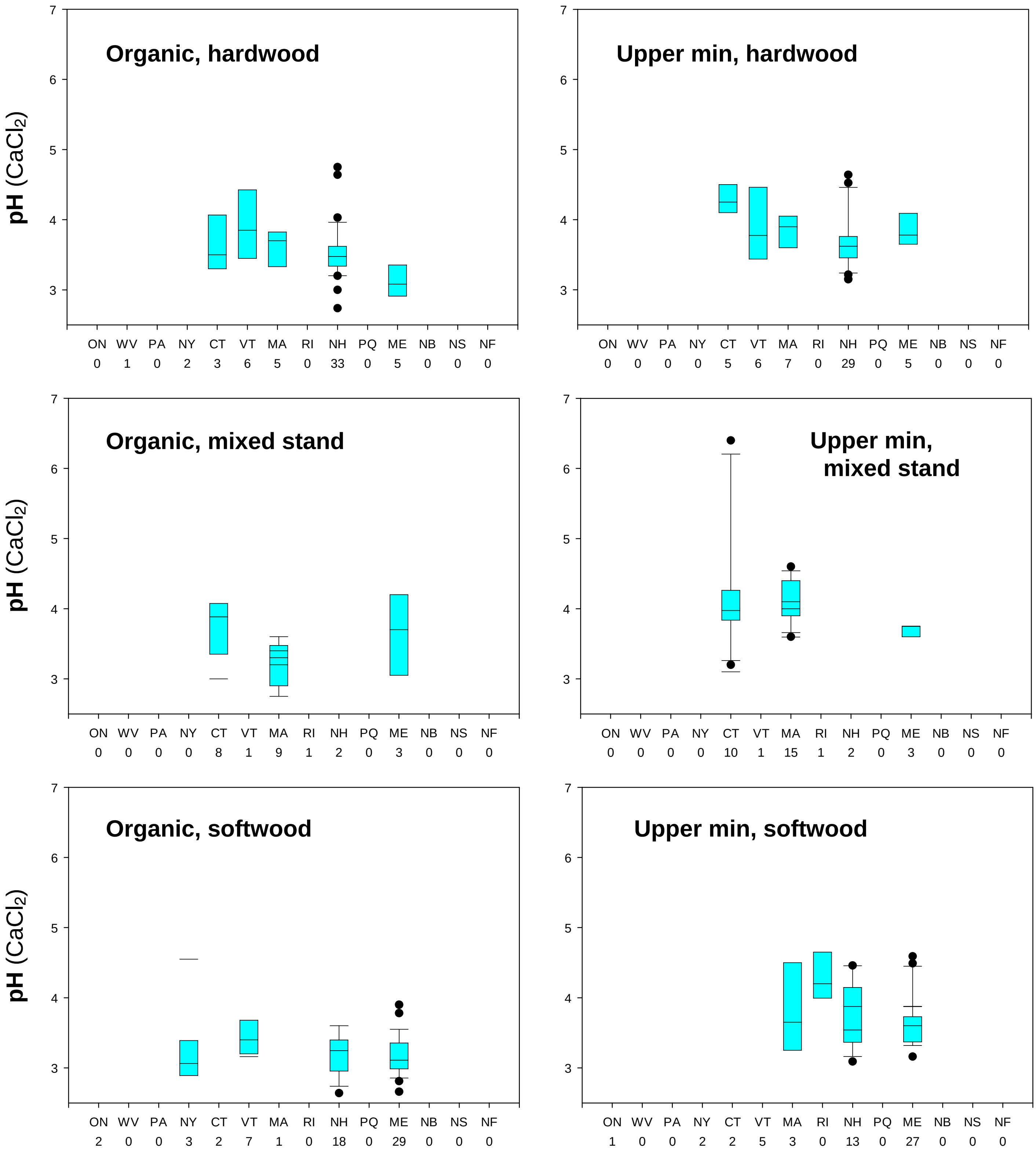


Figure 2. Boxplots for soil pH in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

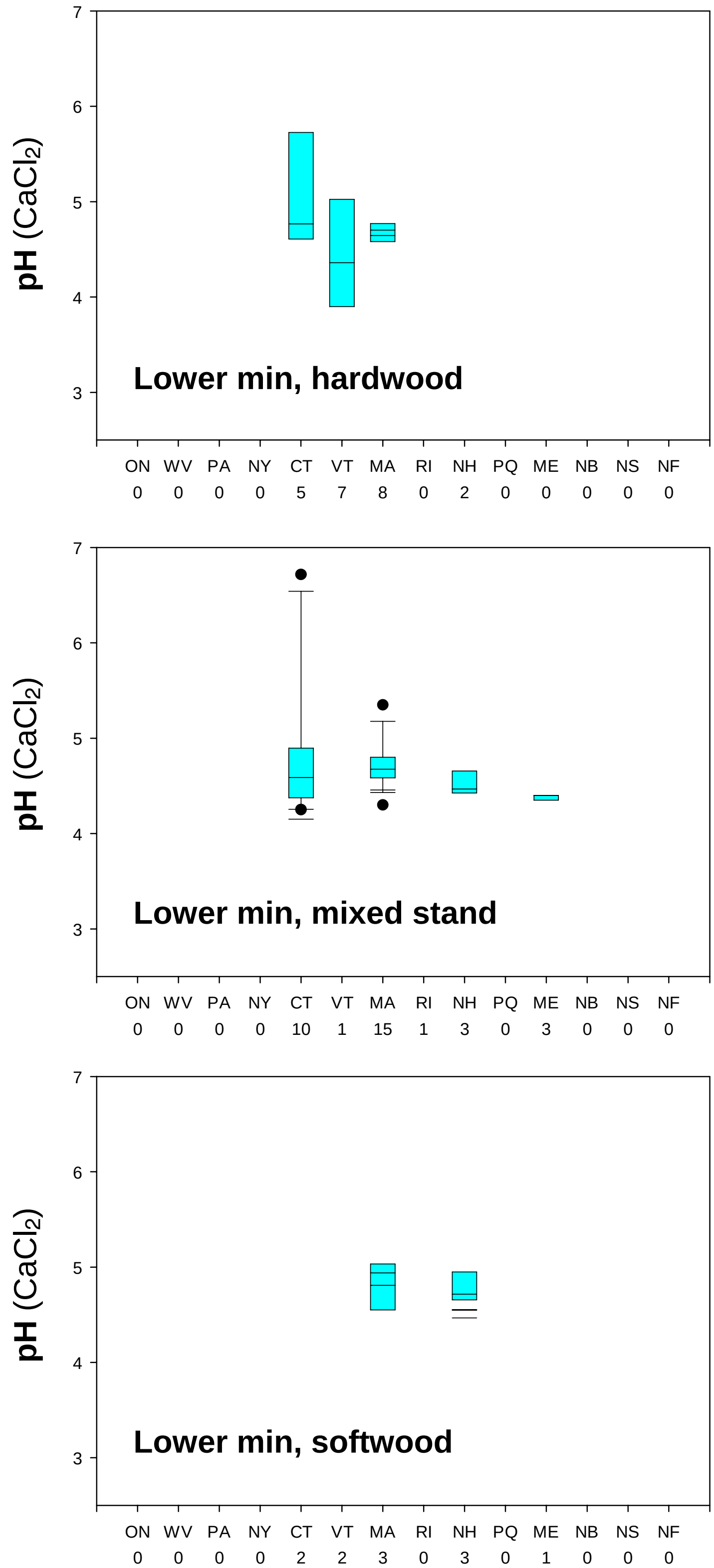


Figure 3. Boxplots for soil carbon in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

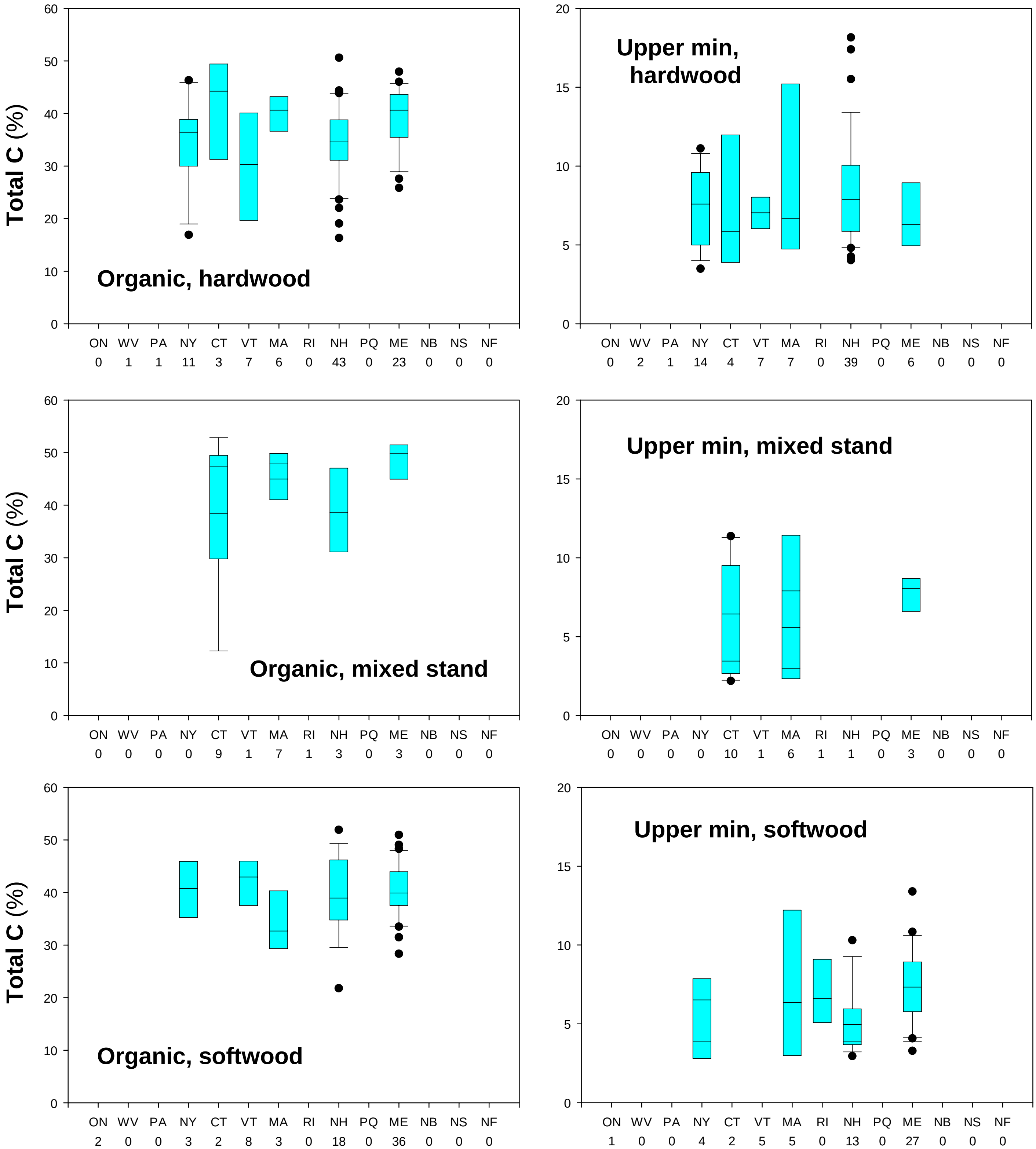
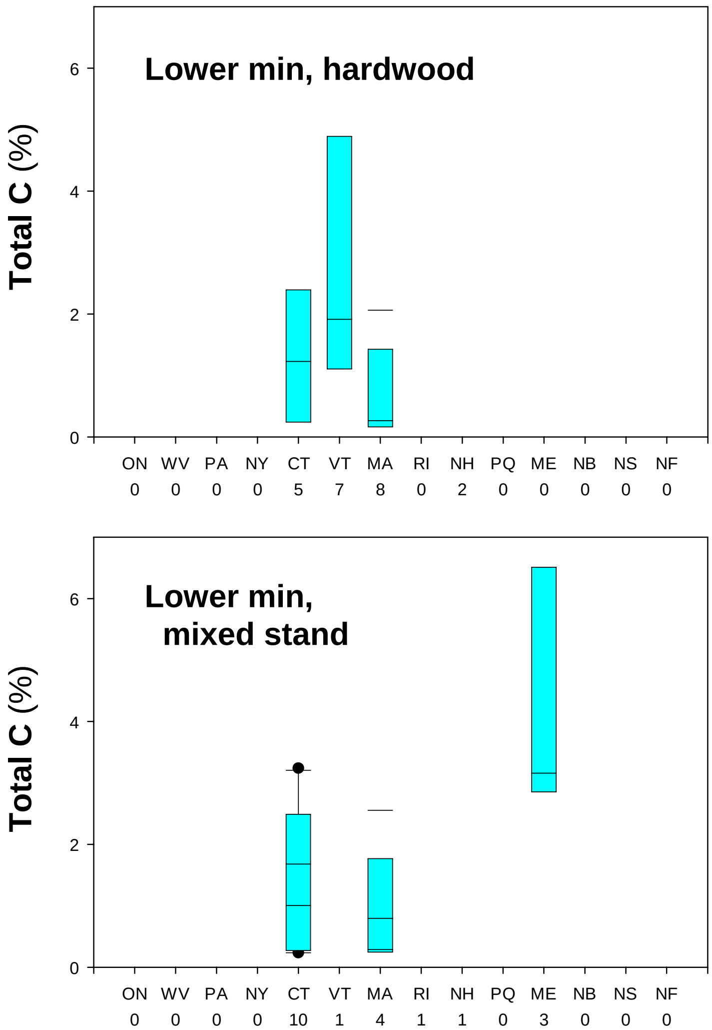


Figure 4. Boxplots for soil carbon in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.



Lower min, softwood

Not enough data

Figure 5. Boxplots for soil nitrogen in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

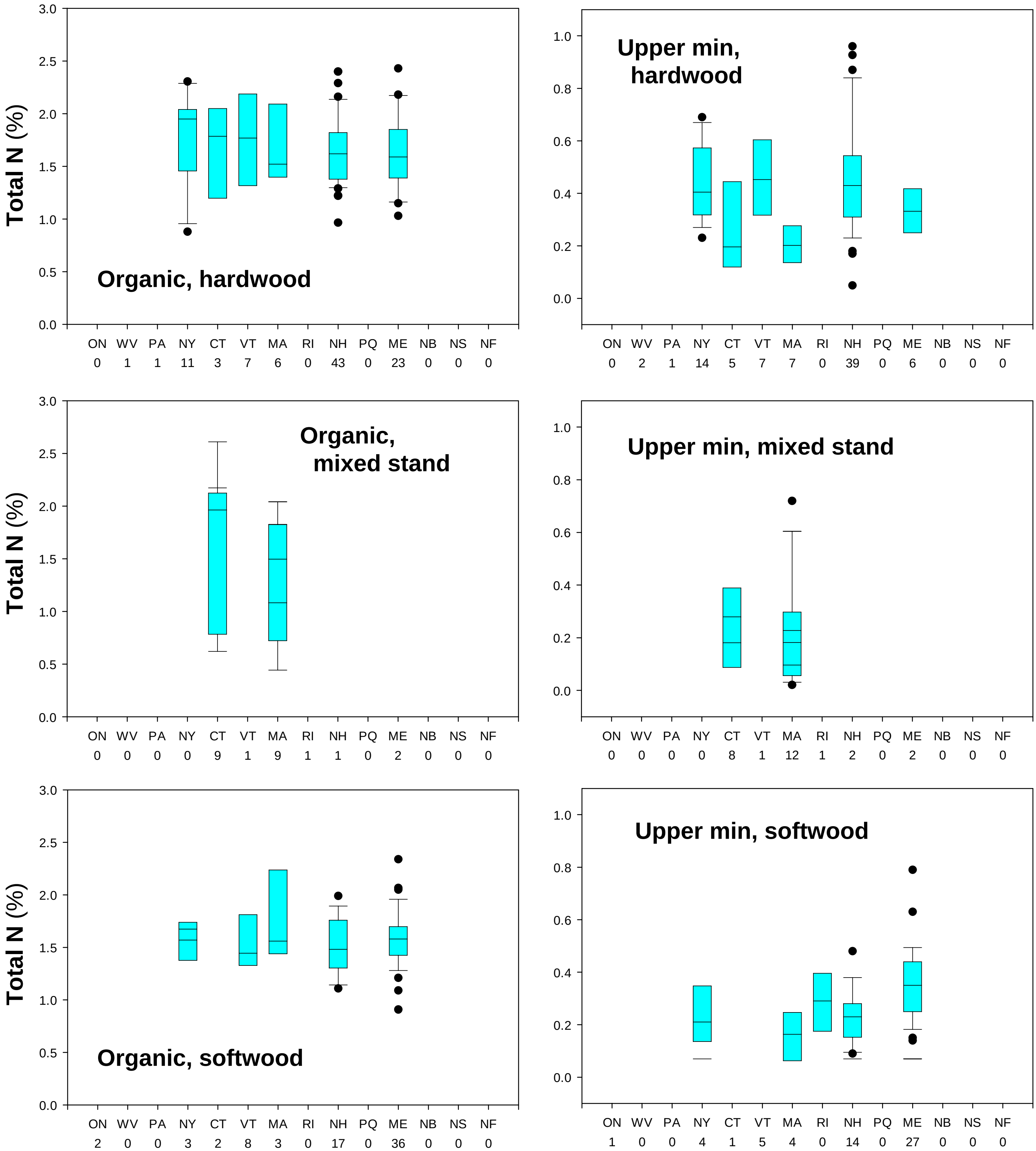


Figure 6. Boxplots for soil nitrogen in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

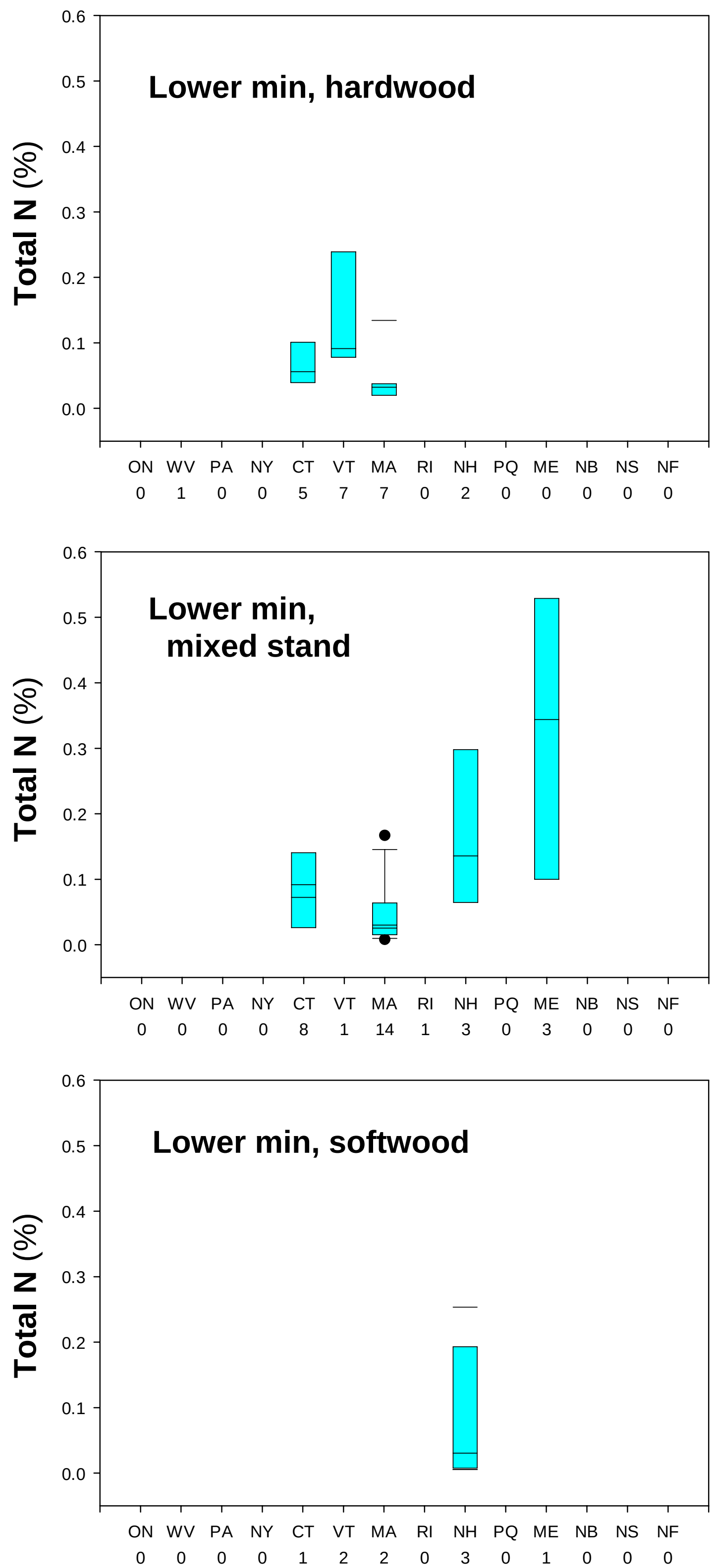


Figure 7. Boxplots for soil CN ratio in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

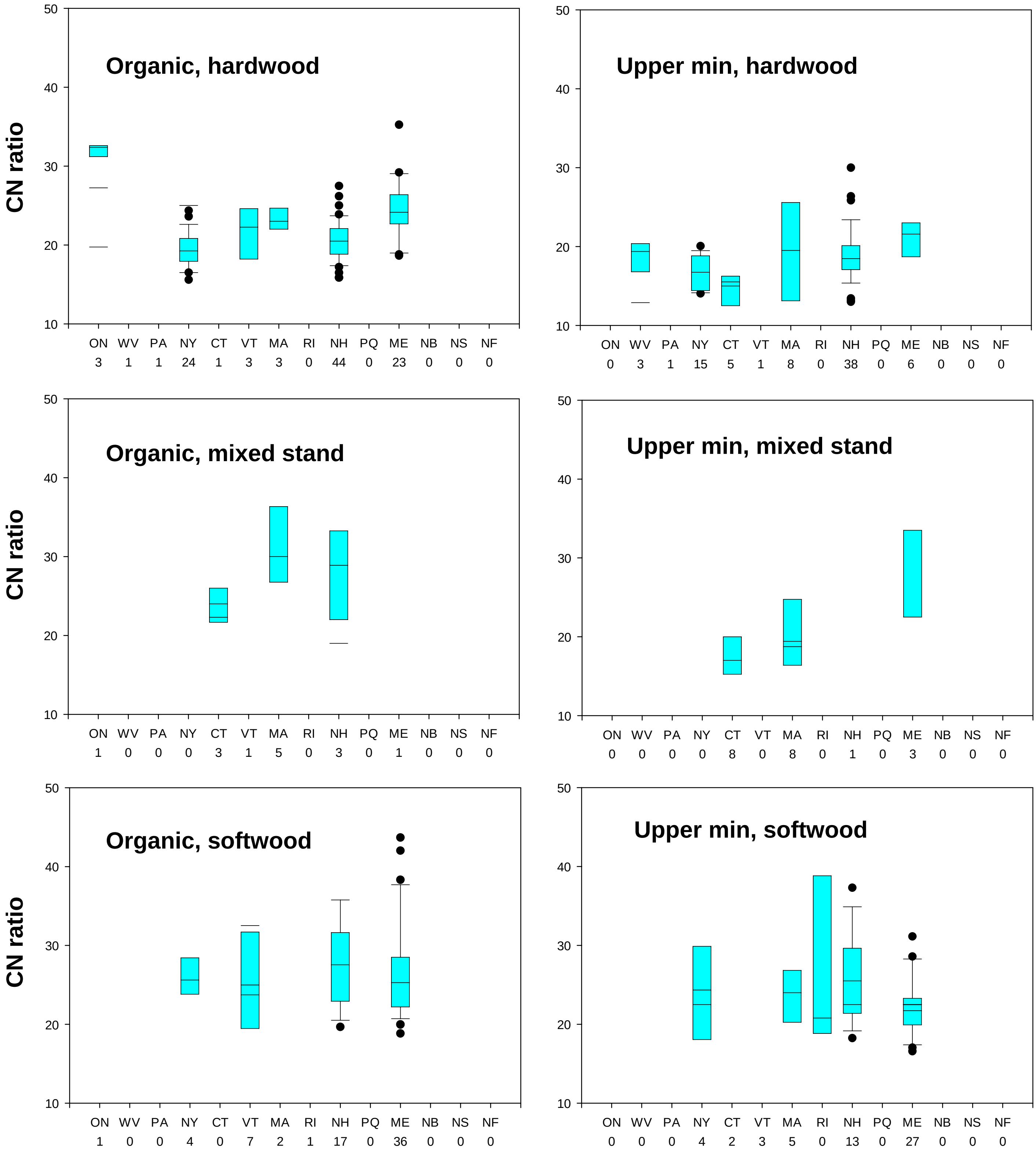
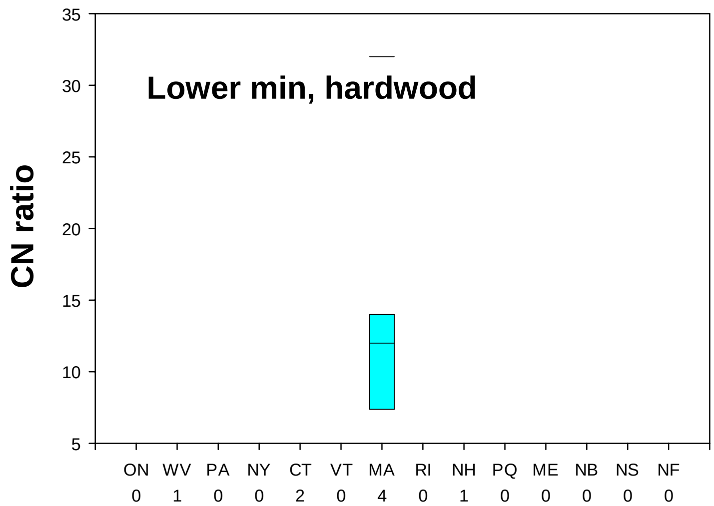
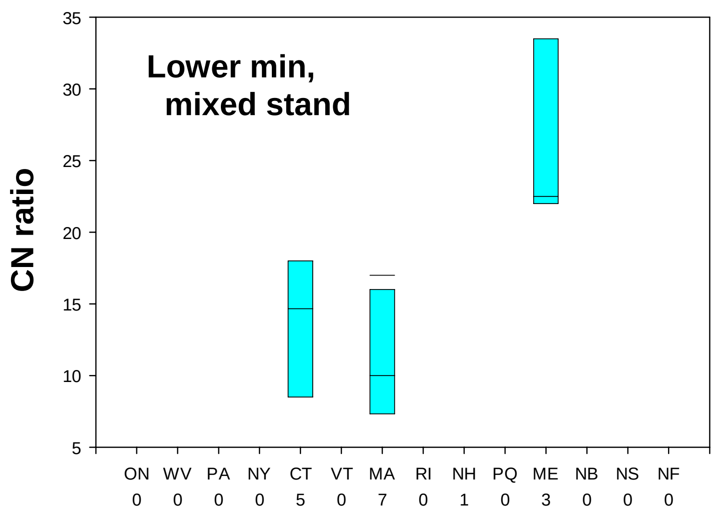


Figure 8. Boxplots for soil CN ratio in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.





Lower min, softwood

Not enough data

Figure 9. Boxplots for soil calcium in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

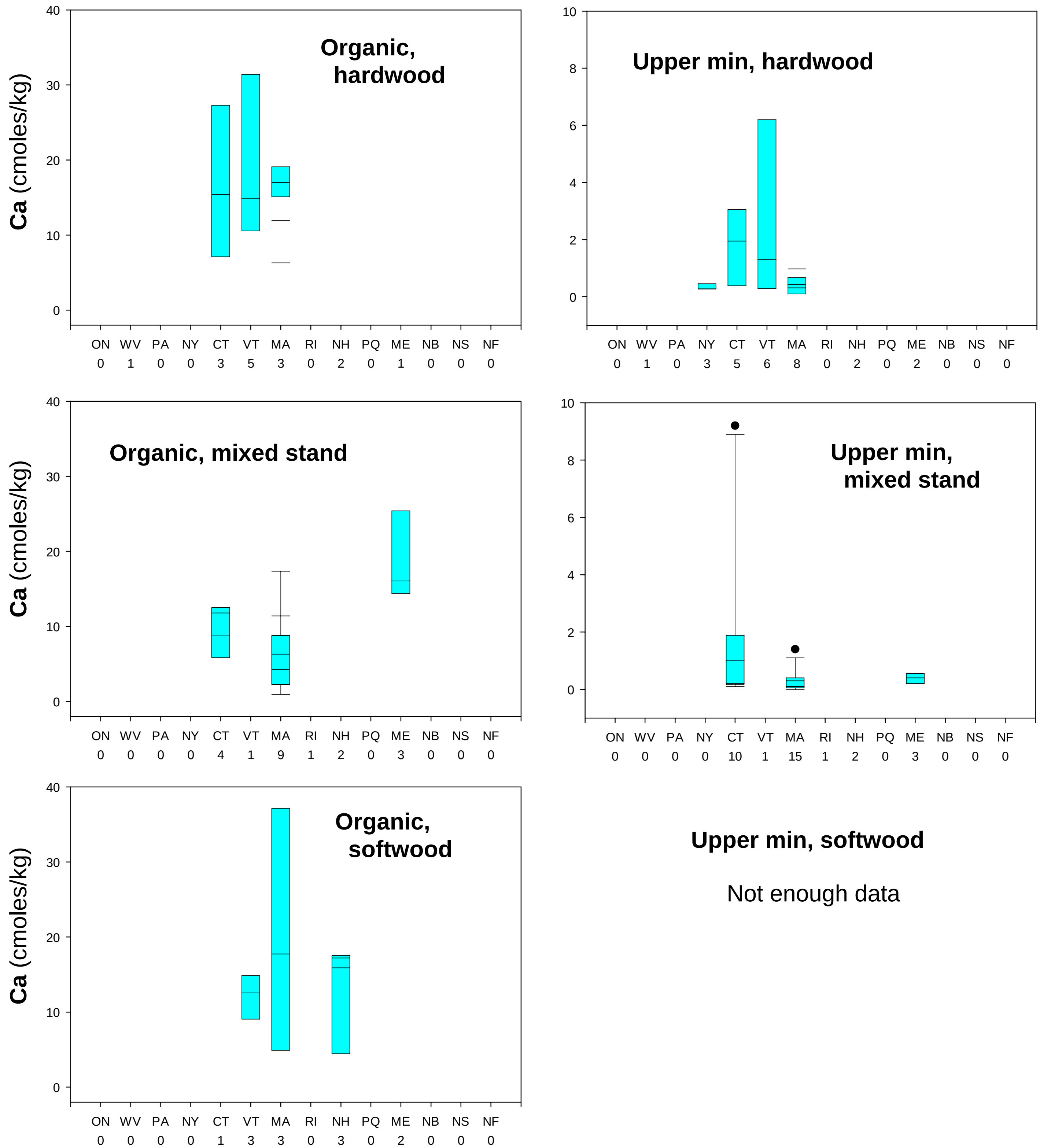


Figure 10. Boxplots for soil calcium in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

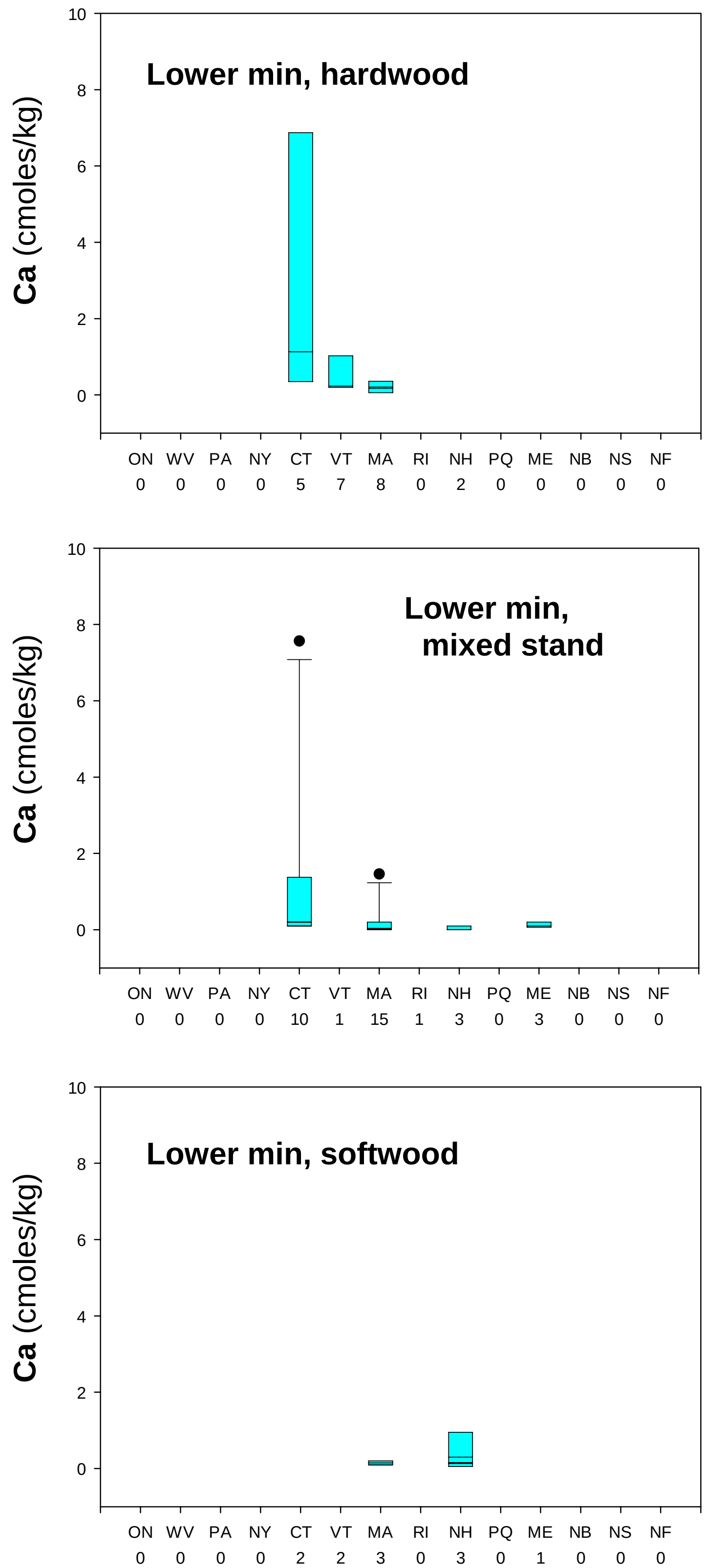


Figure 11. Boxplots for soil magnesium in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

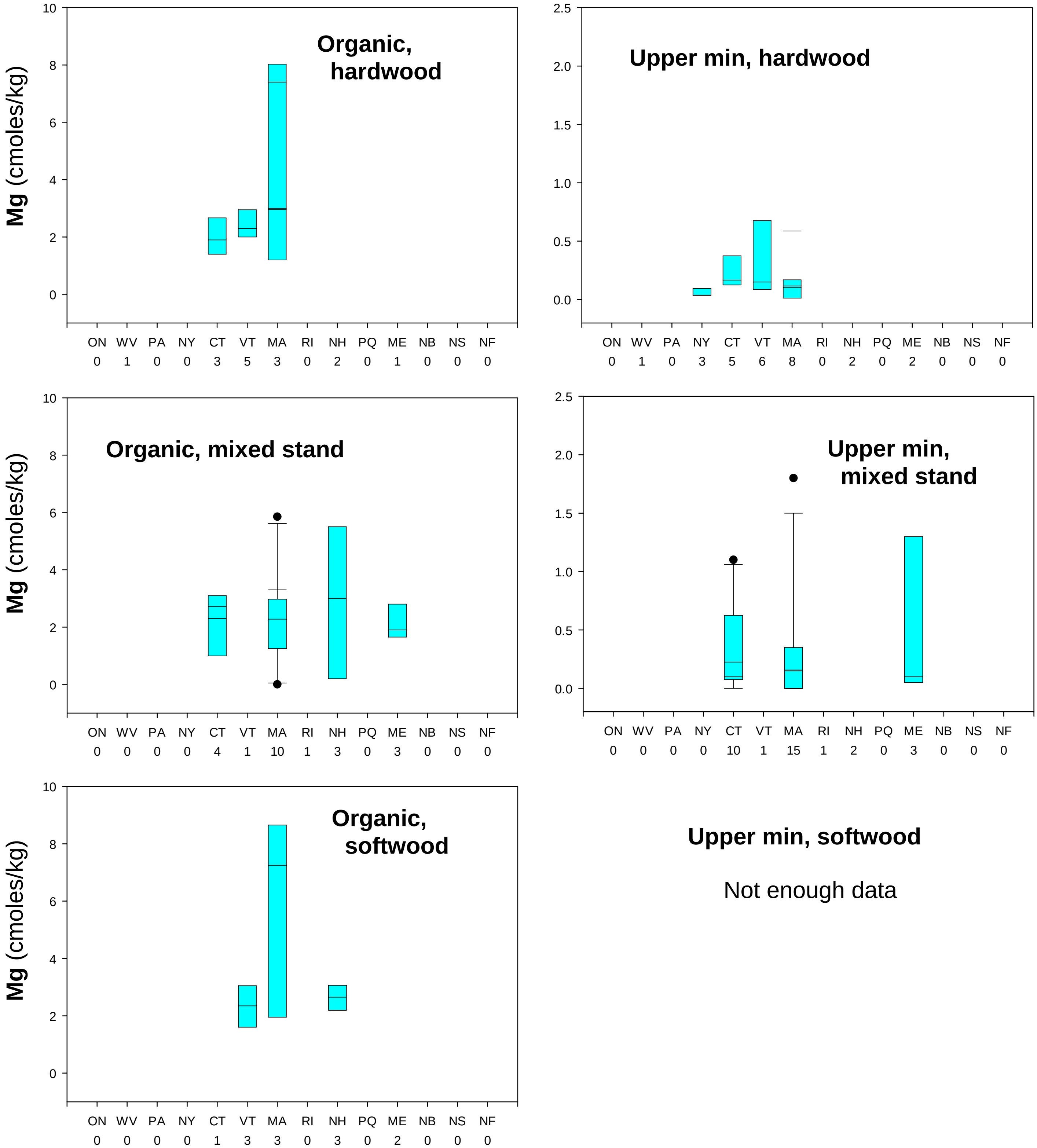


Figure 12. Boxplots for soil magnesium in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

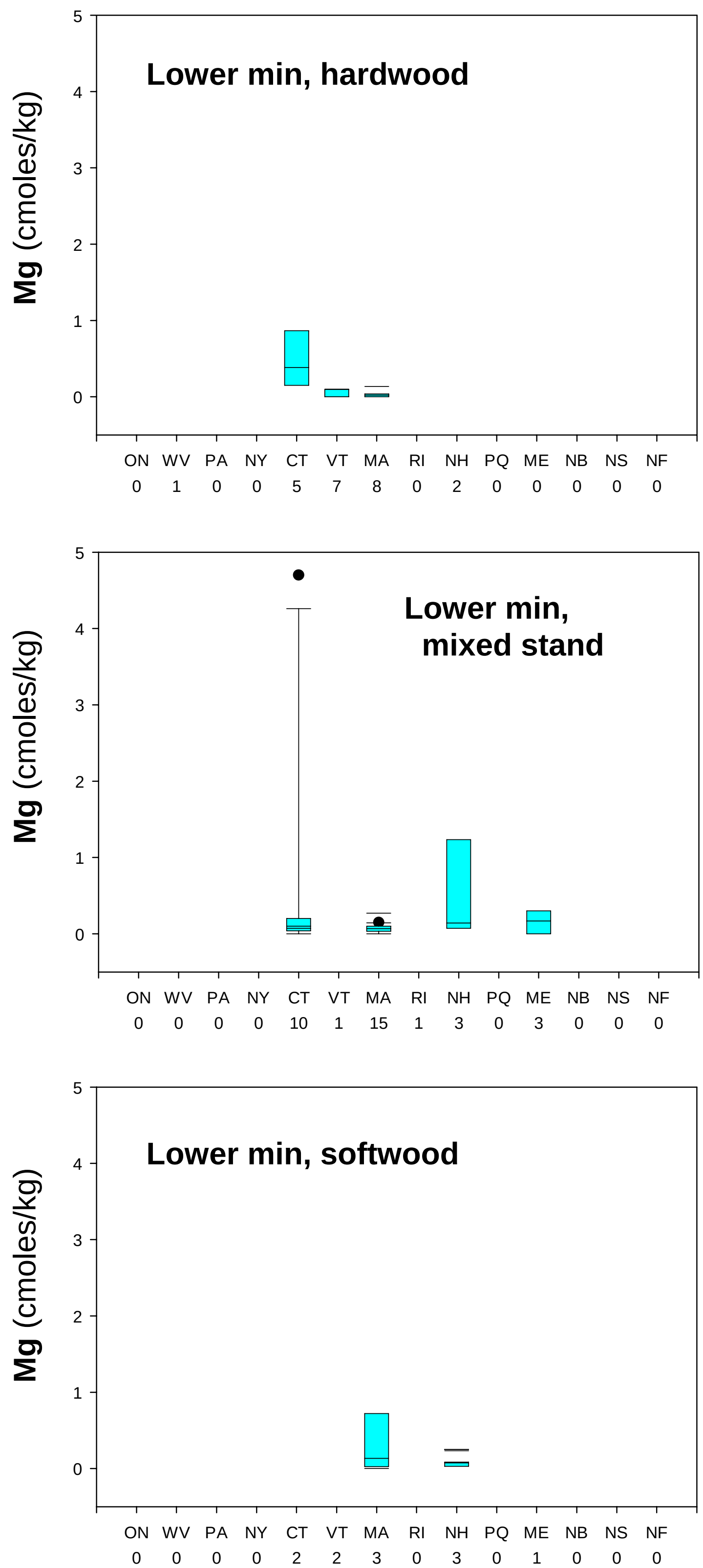


Figure 13. Boxplots for soil potassium in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

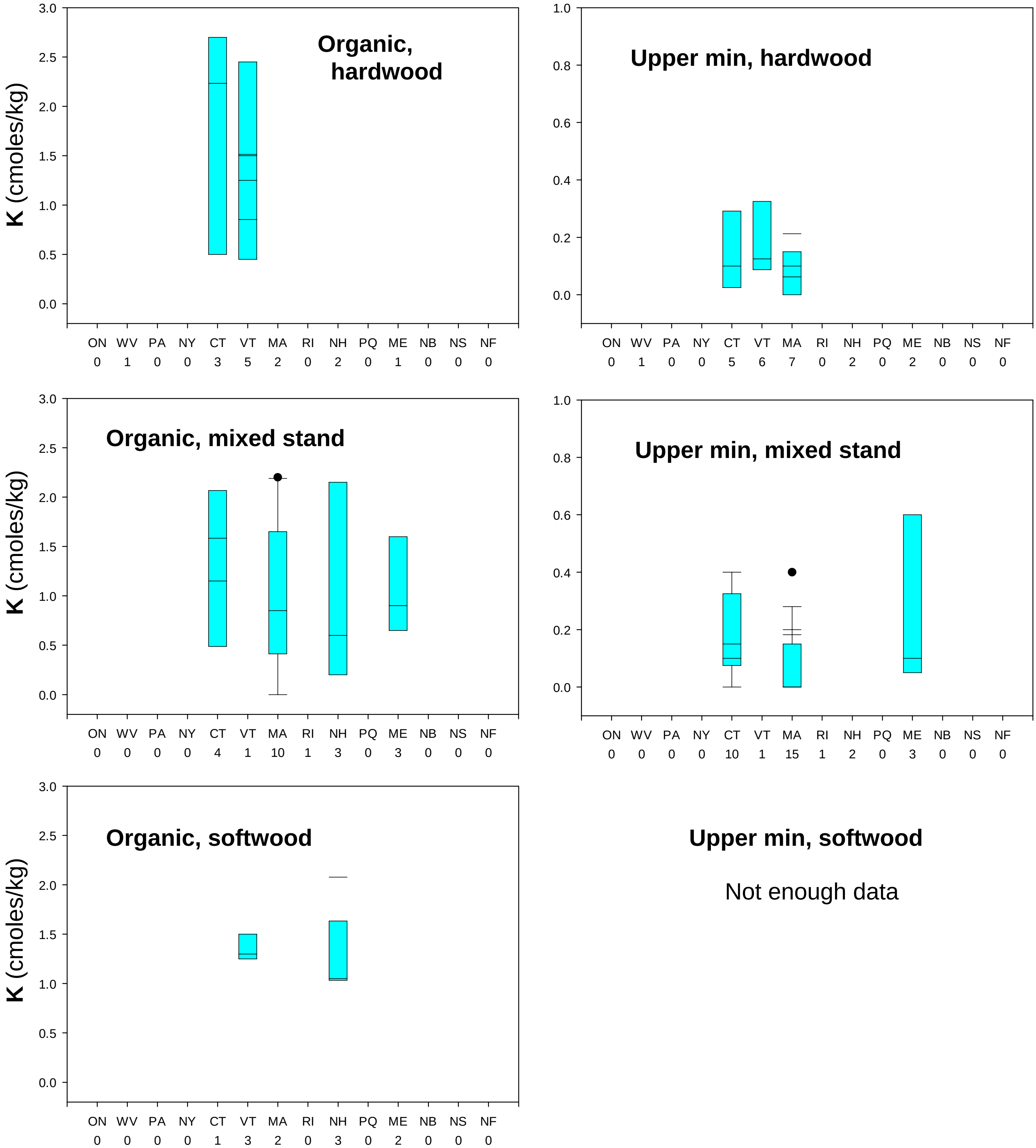
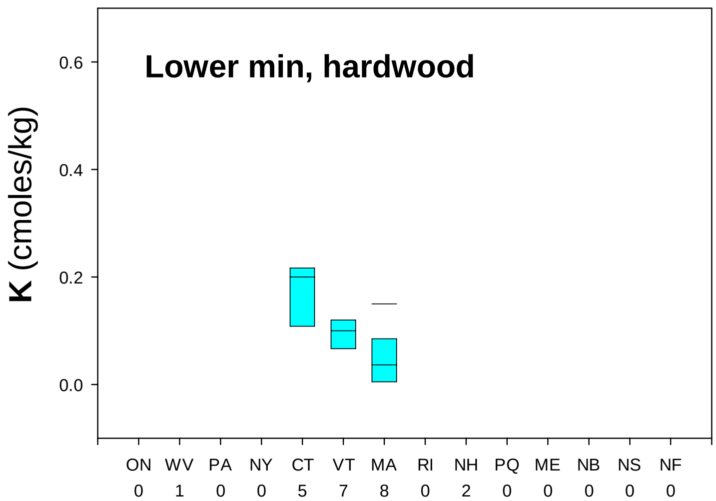
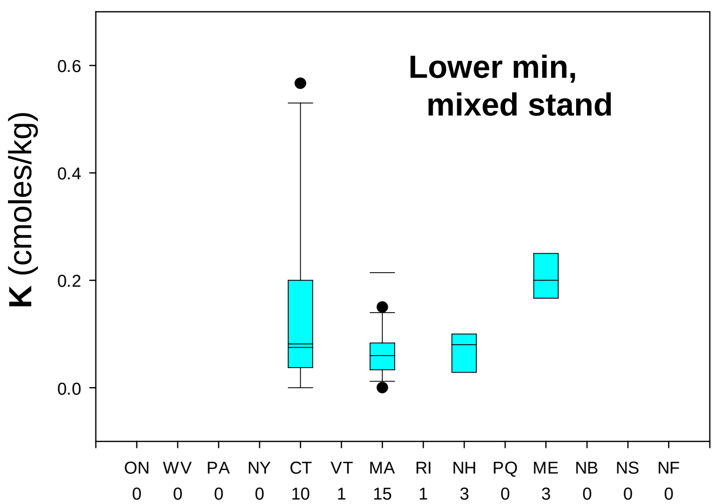


Figure 14. Boxplots for soil potassium in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.





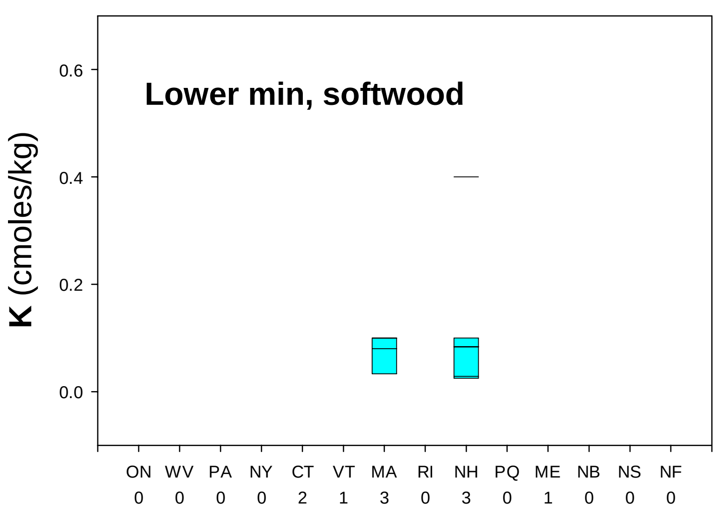


Figure 15. Boxplots for soil aluminum in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

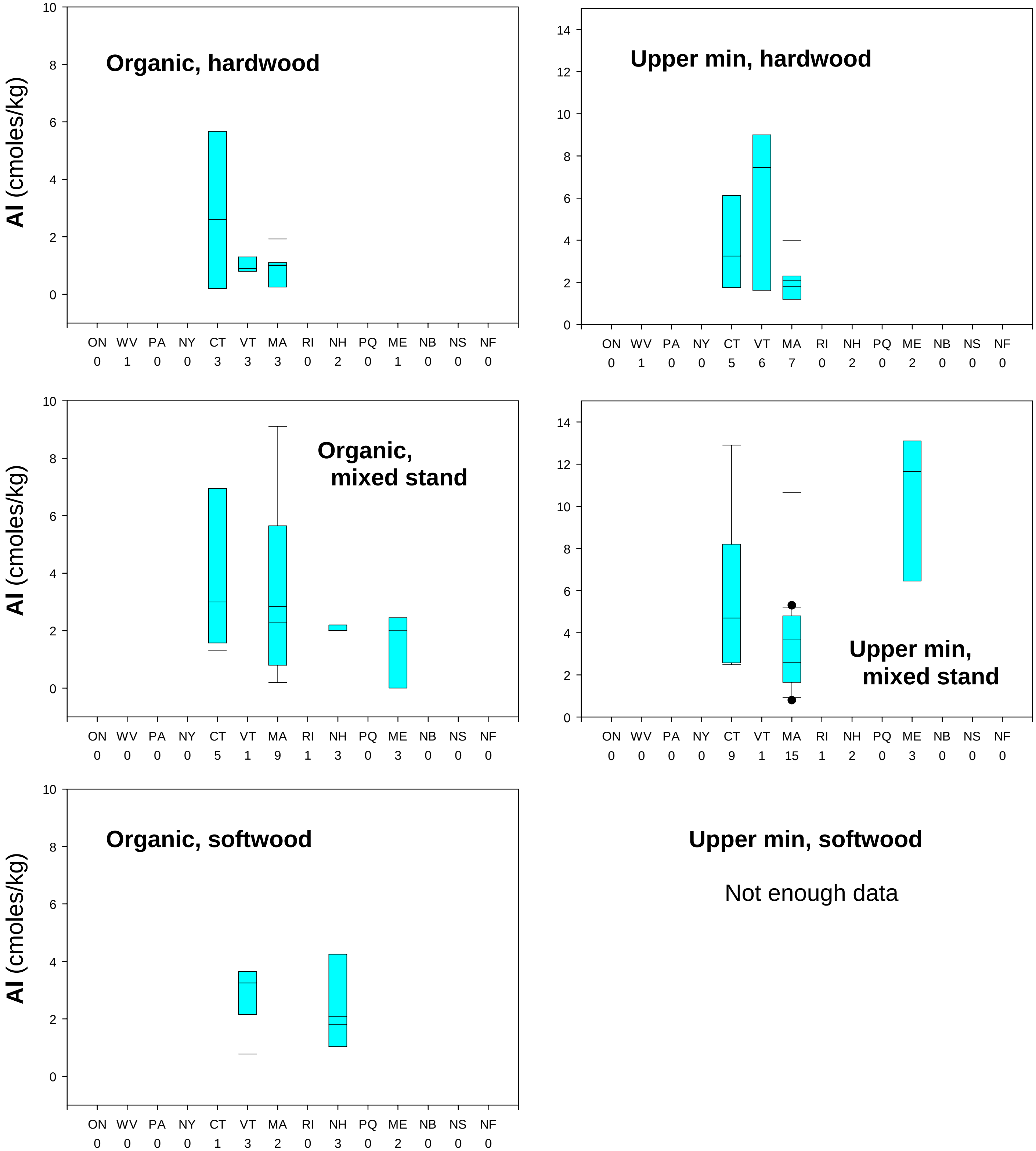


Figure 16. Boxplots for soil aluminum in lower mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

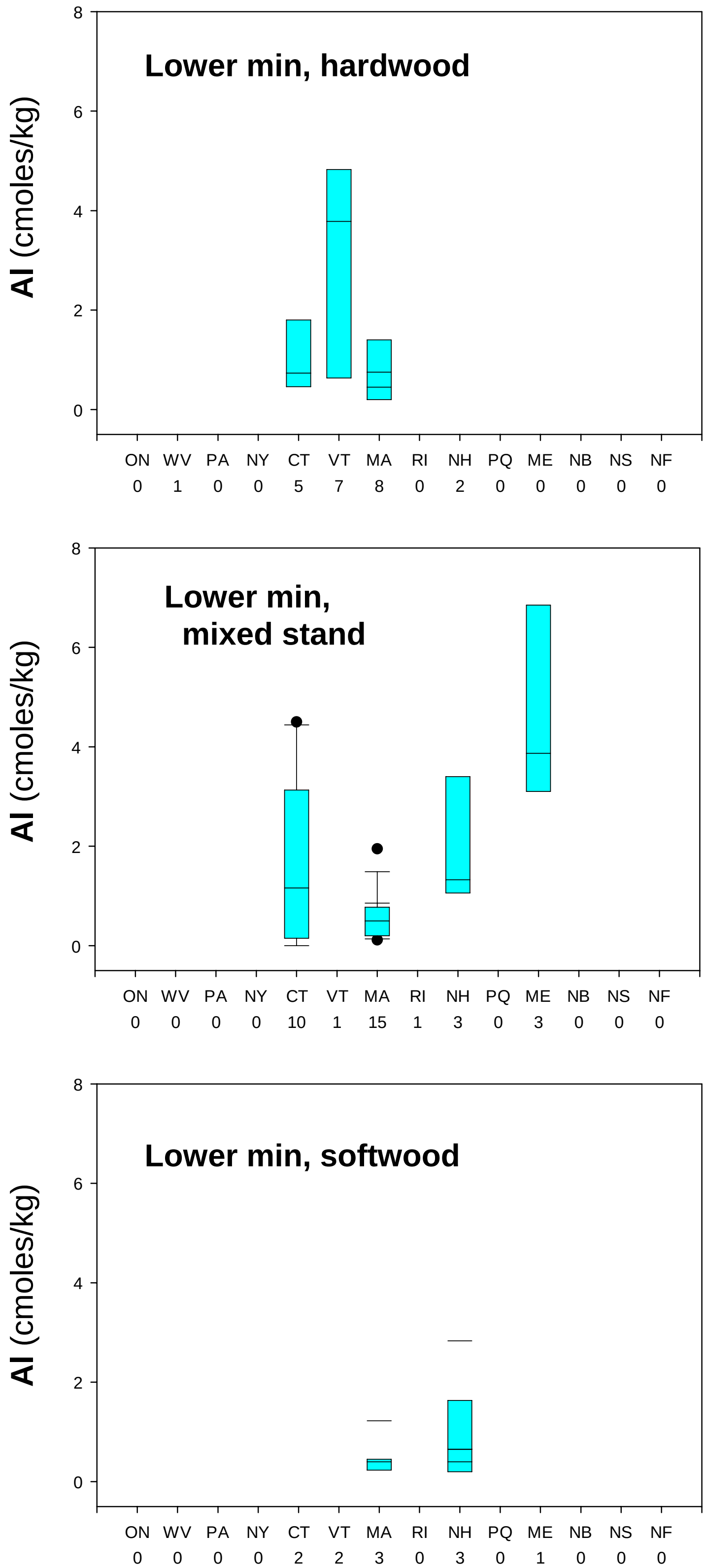
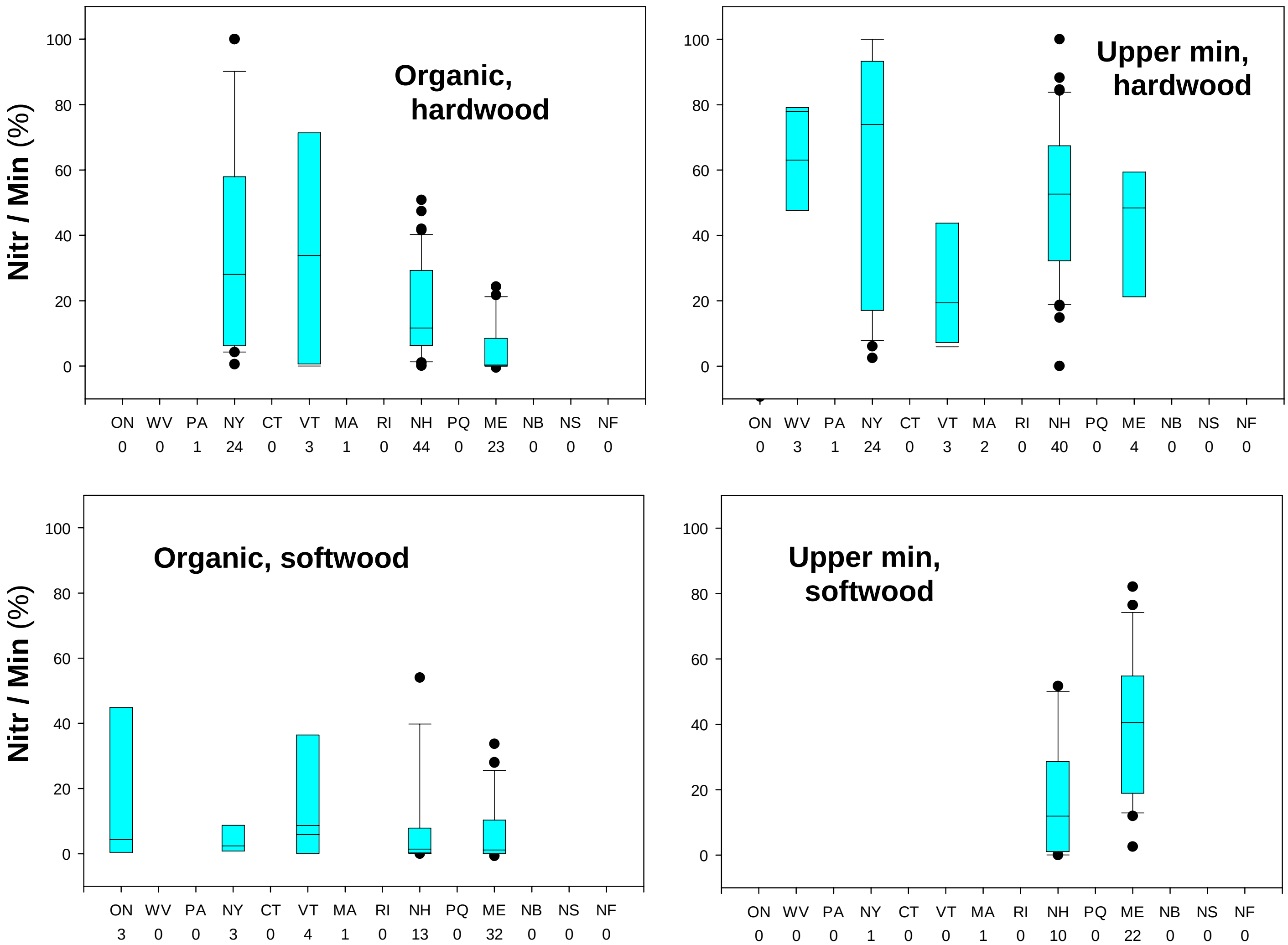
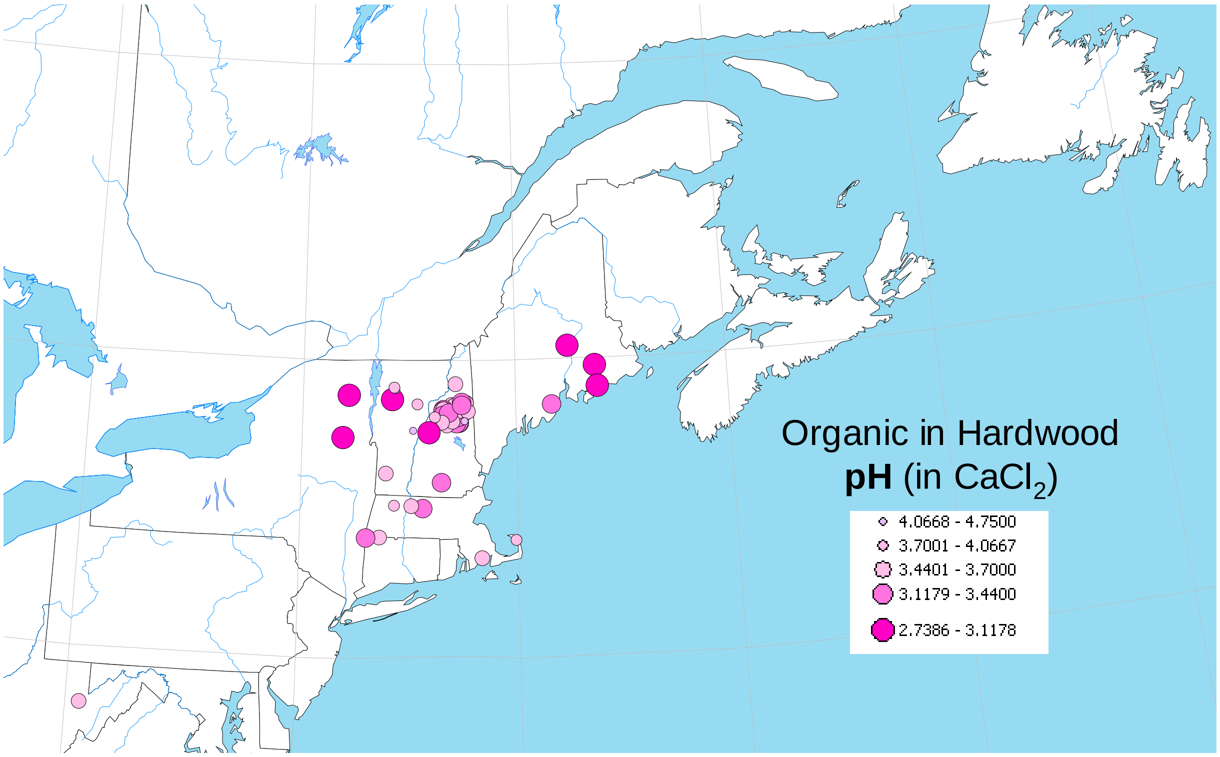


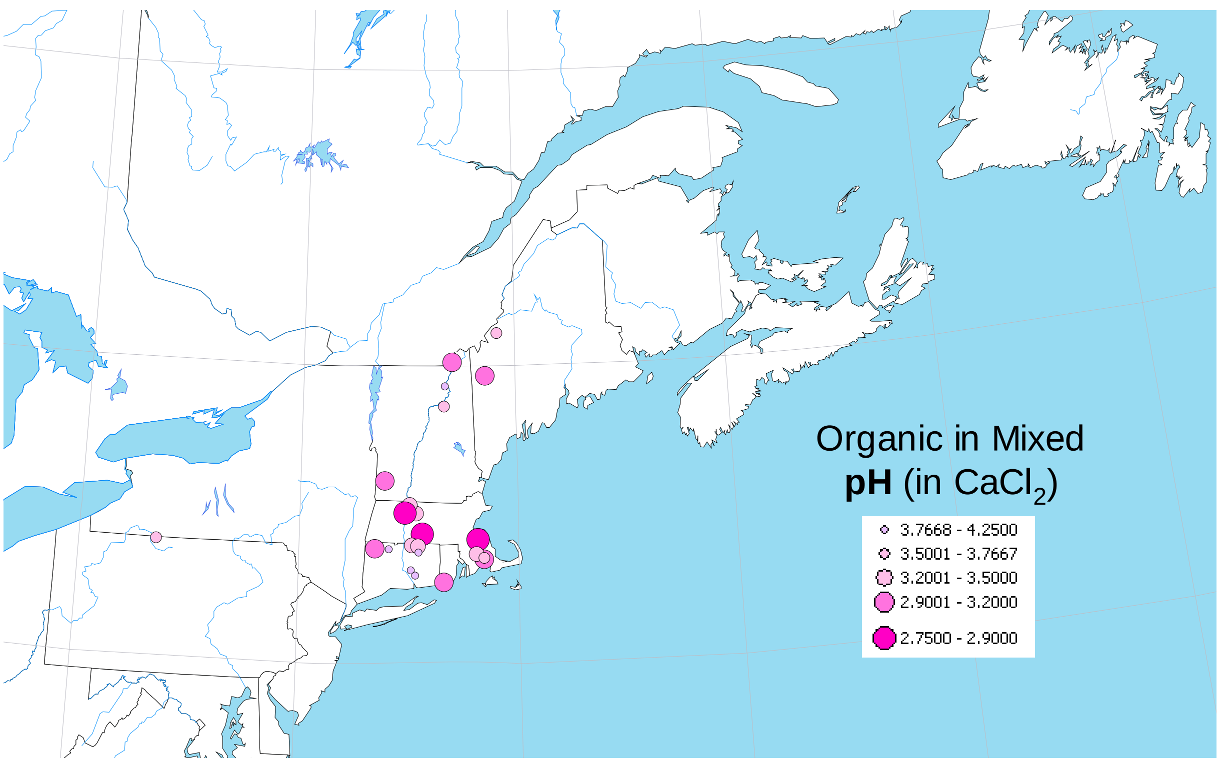
Figure 17. Boxplots for soil nitrification/mineralization in organic and upper mineral layers. Box boundaries indicate 25th and 75th percentile, line in box indicates the median, whiskers represent 10th and 90th percentile, and dots represent outliers. X axis includes US states and Canadian provinces listed in a rough west to east order, with the number of included sites listed below each label. At least three sites are required to generate a boxplot.

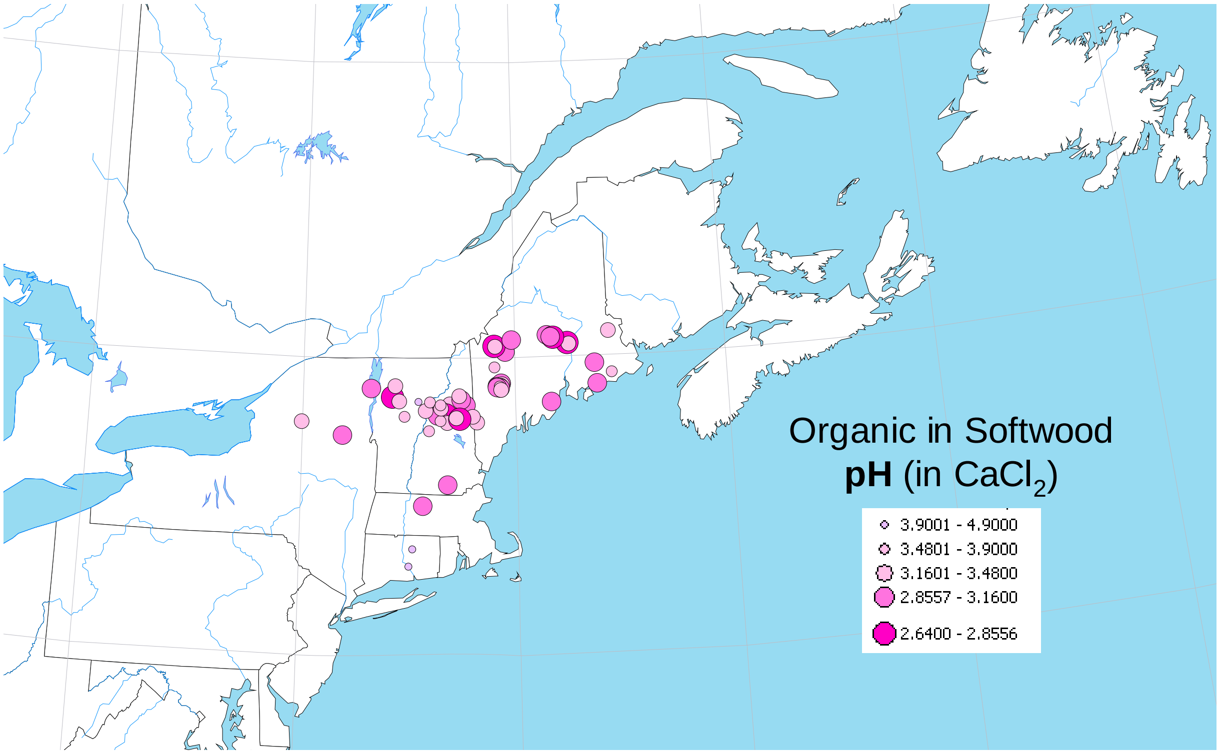


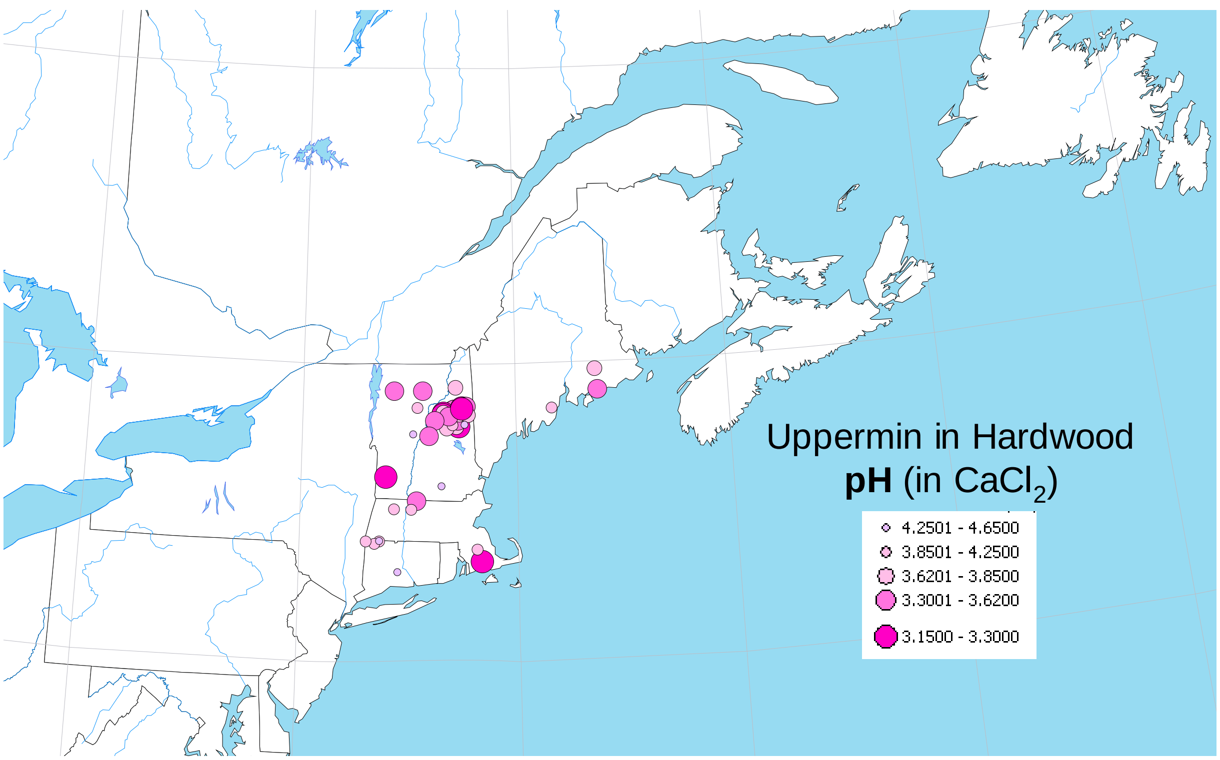
Appendix C-3: Soil Chemistry Maps

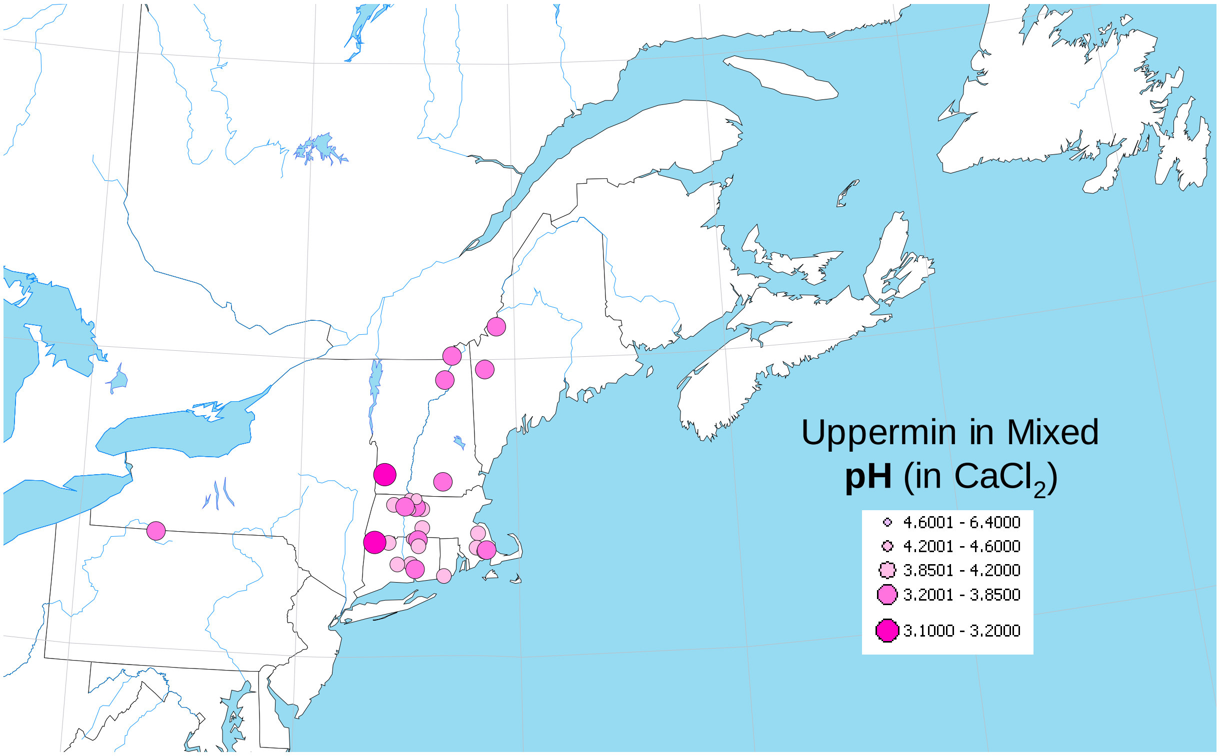
Figure 18. Maps for soil pH. (figure spans multiple pages)

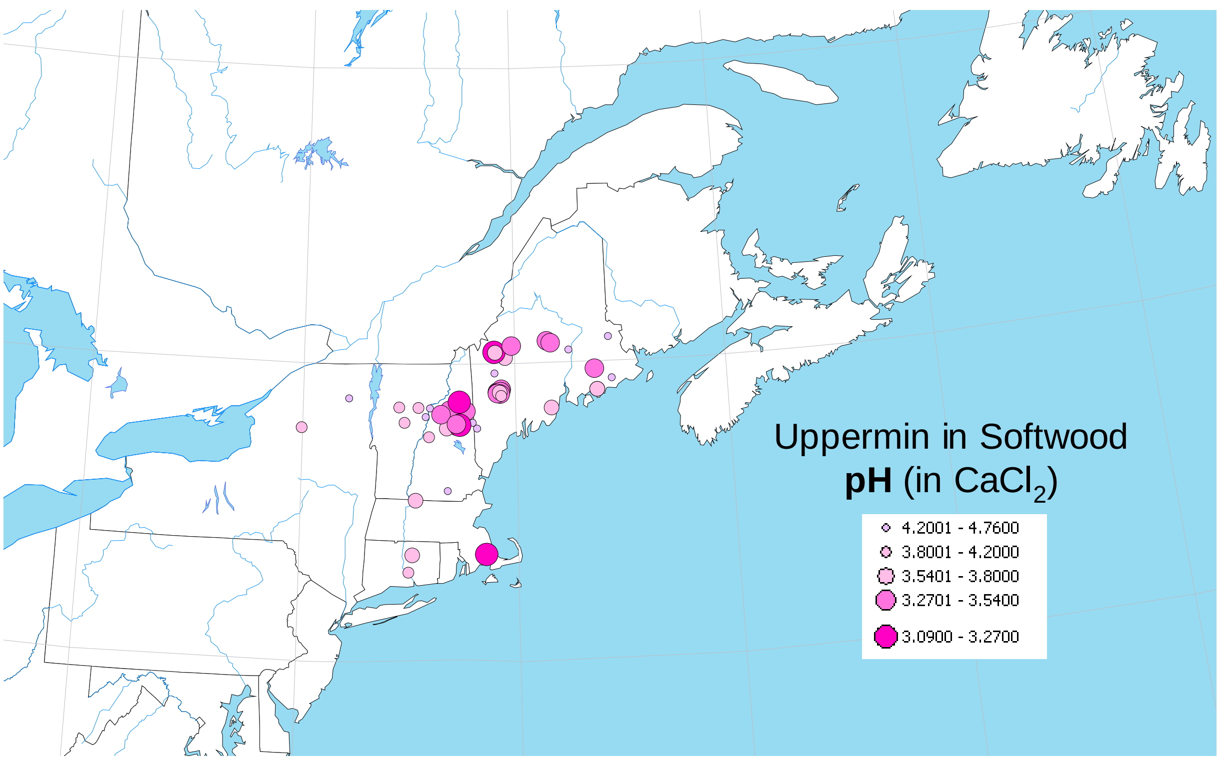


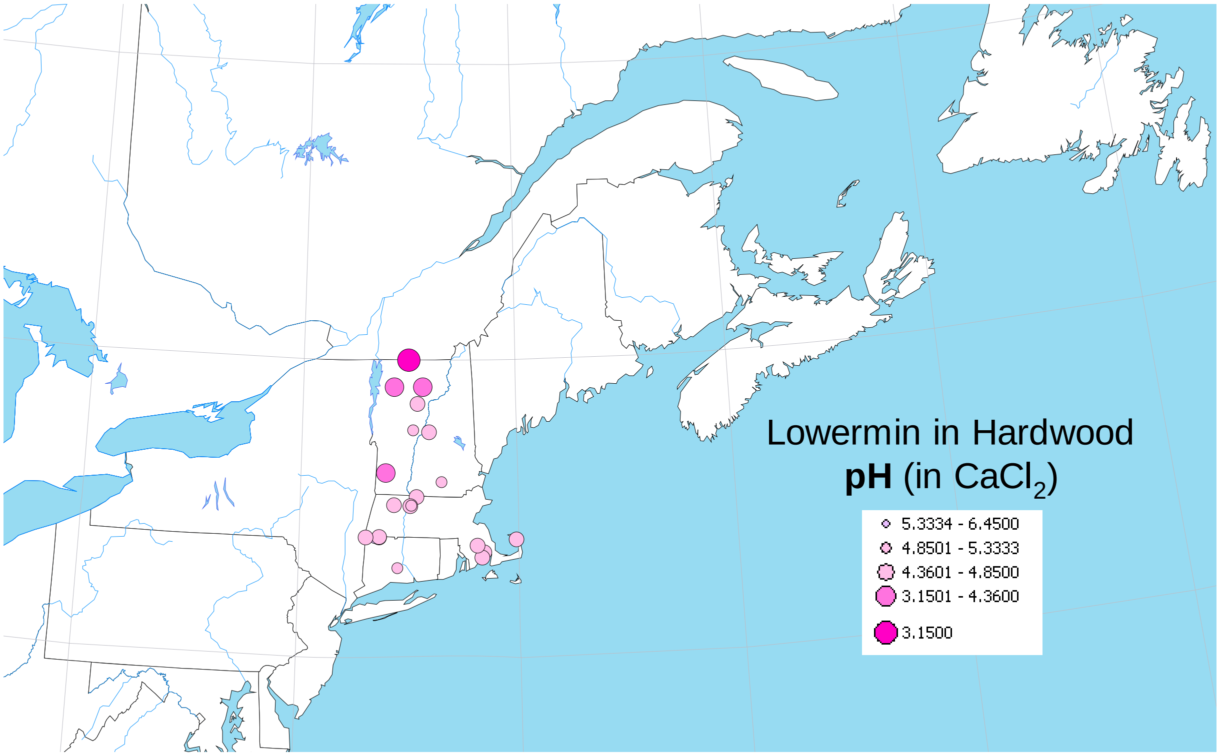


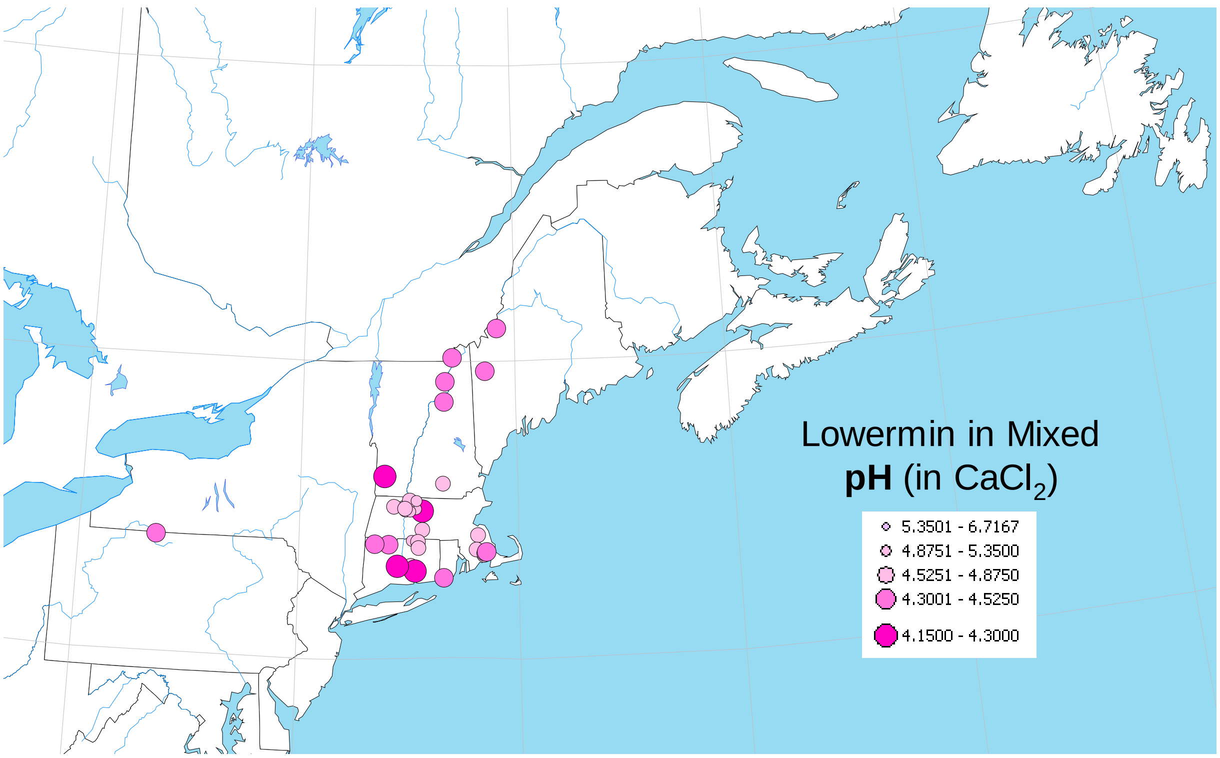

Organic in Softwood
pH (in $CaCl_2$)
3.9001 - 4.9000
3.4801 - 3.9000
3.1601 - 3.4800
2.8557 - 3.1600
2.6400 - 2.8556


Uppermin in Hardwood
pH (in $CaCl_2$)
4.2501 - 4.6500
3.8501 - 4.2500
3.6201 - 3.8500
3.3001 - 3.6200
3.1500 - 3.3000


Uppermin in Mixed
pH (in CaCl2)
4.6001 - 6.4000
4.2001 - 4.6000
3.8501 - 4.2000
3.2001 - 3.8500
3.1000 - 3.2000


Uppermin in Softwood
pH (in CaCl2)
4.2001 - 4.7600
3.8001 - 4.2000
3.5401 - 3.8000
3.2701 - 3.5400
3.0900 - 3.2700


Lowermin in Hardwood
pH (in $CaCl_2$)
5.3334 - 6.4500
4.8501 - 5.3333
4.3601 - 4.8500
3.1501 - 4.3600
3.1500


Lowermin in Mixed
pH (in $CaCl_2$)
5.3501 - 6.7167
4.8751 - 5.3500
4.5251 - 4.8750
4.3001 - 4.5250
4.1500 - 4.3000

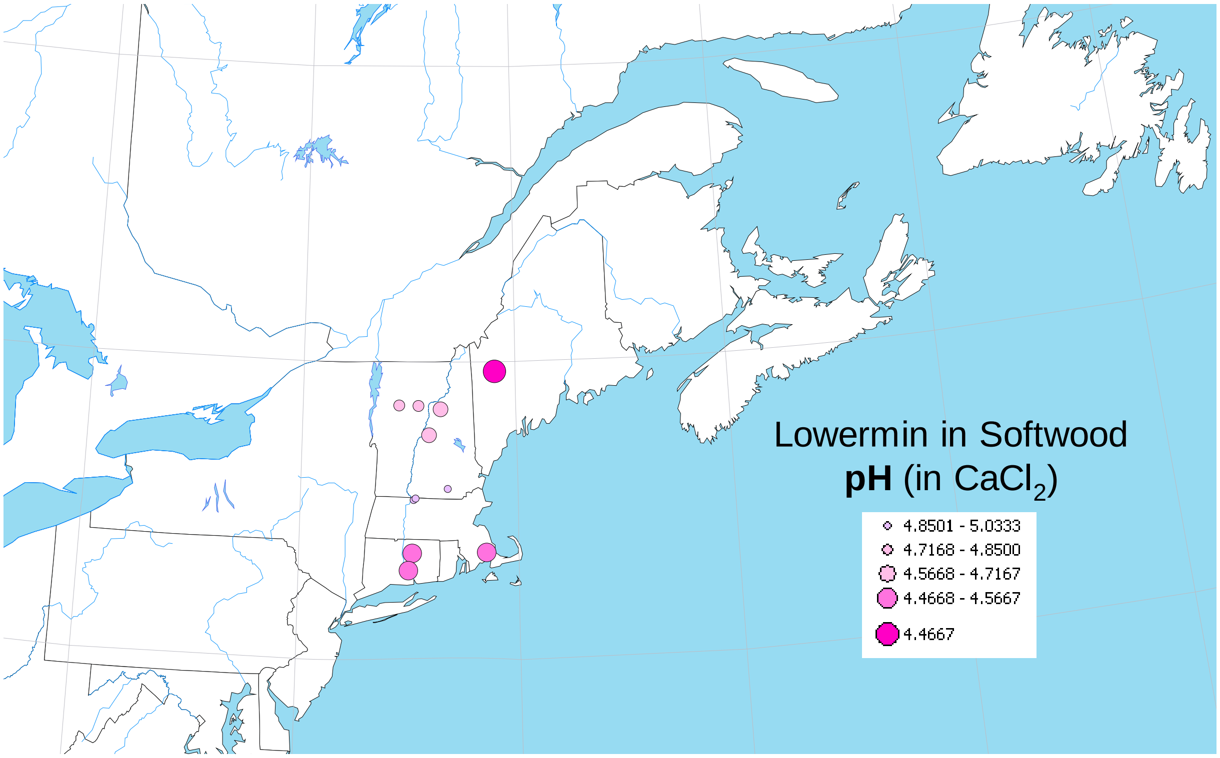
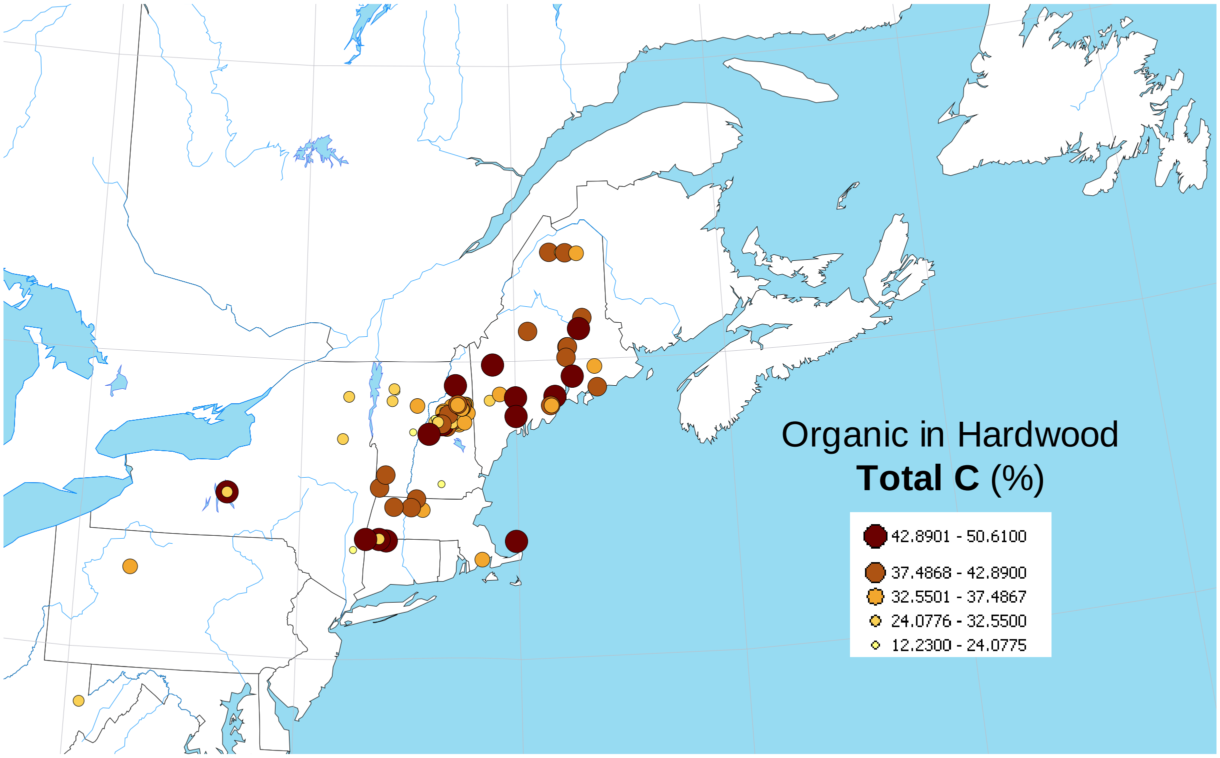
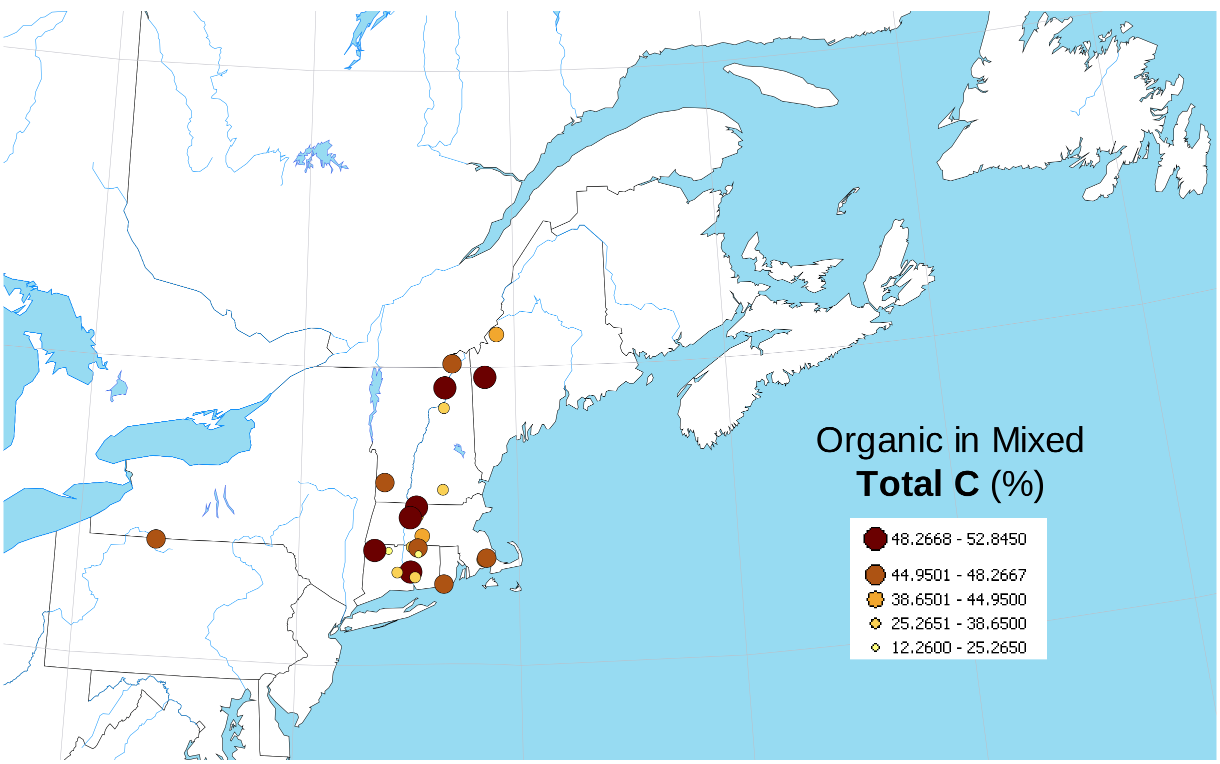
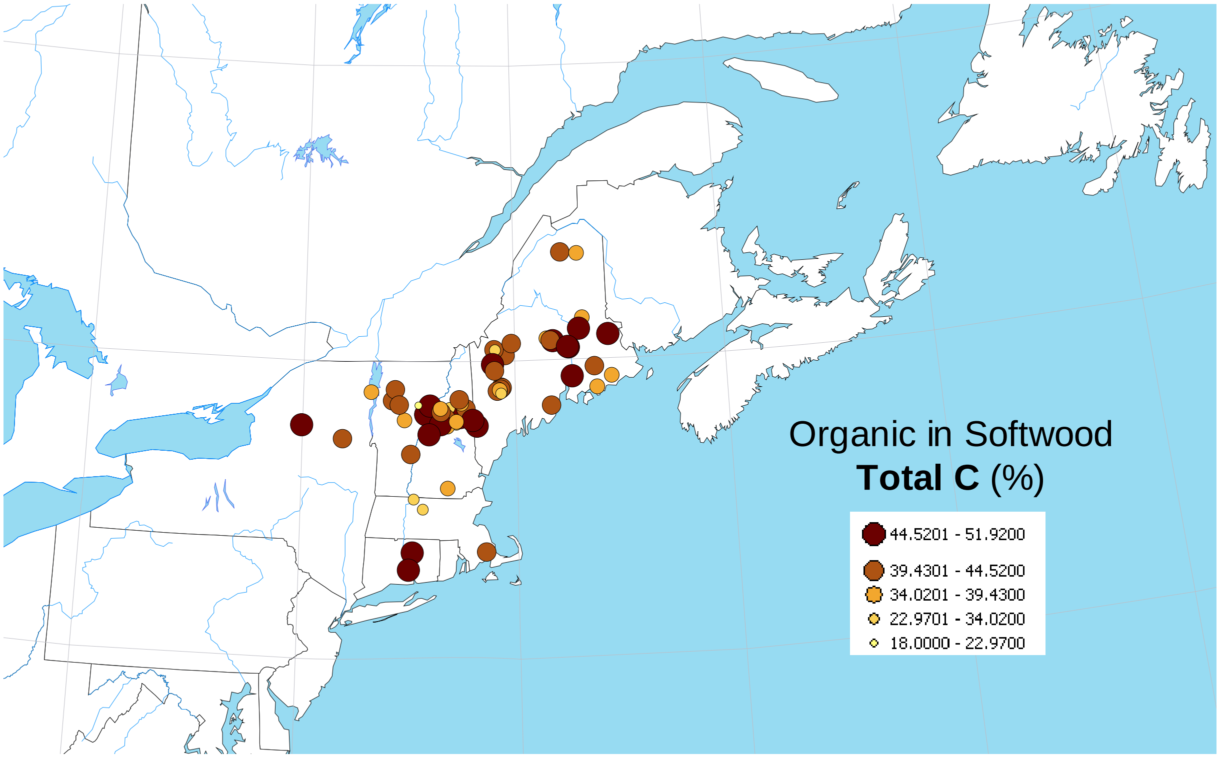
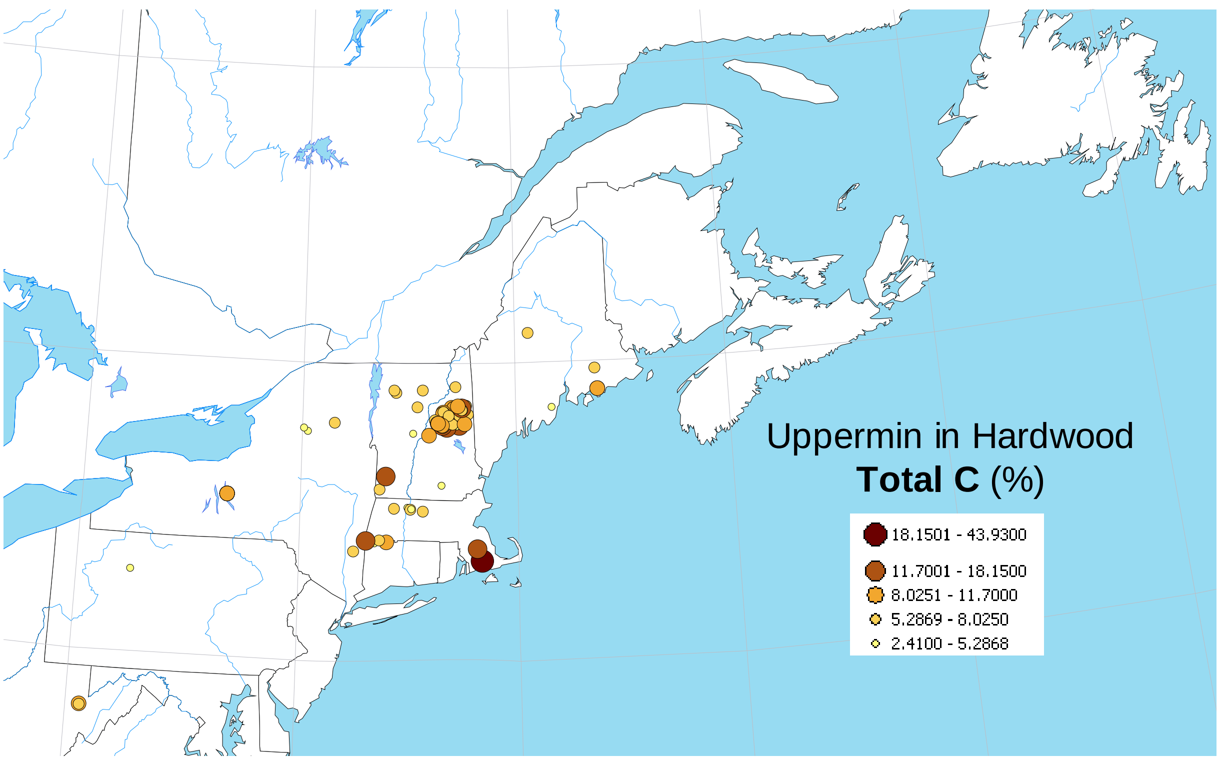

Lowermin in Softwood
pH (in CaCl2)
4.8501 - 5.0333
4.7168 - 4.8500
4.5668 - 4.7167
4.4668 - 4.5667
4.4667

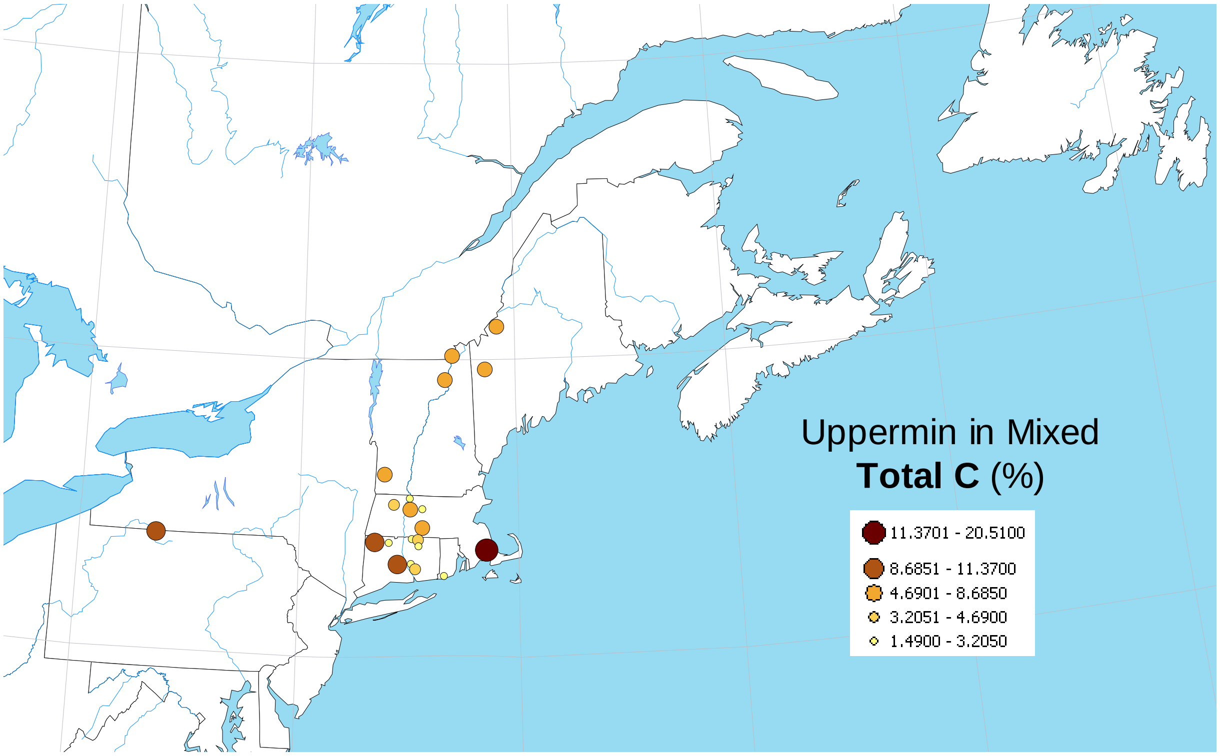
Figure 19. Maps for soil carbon. (figure spans multiple pages)

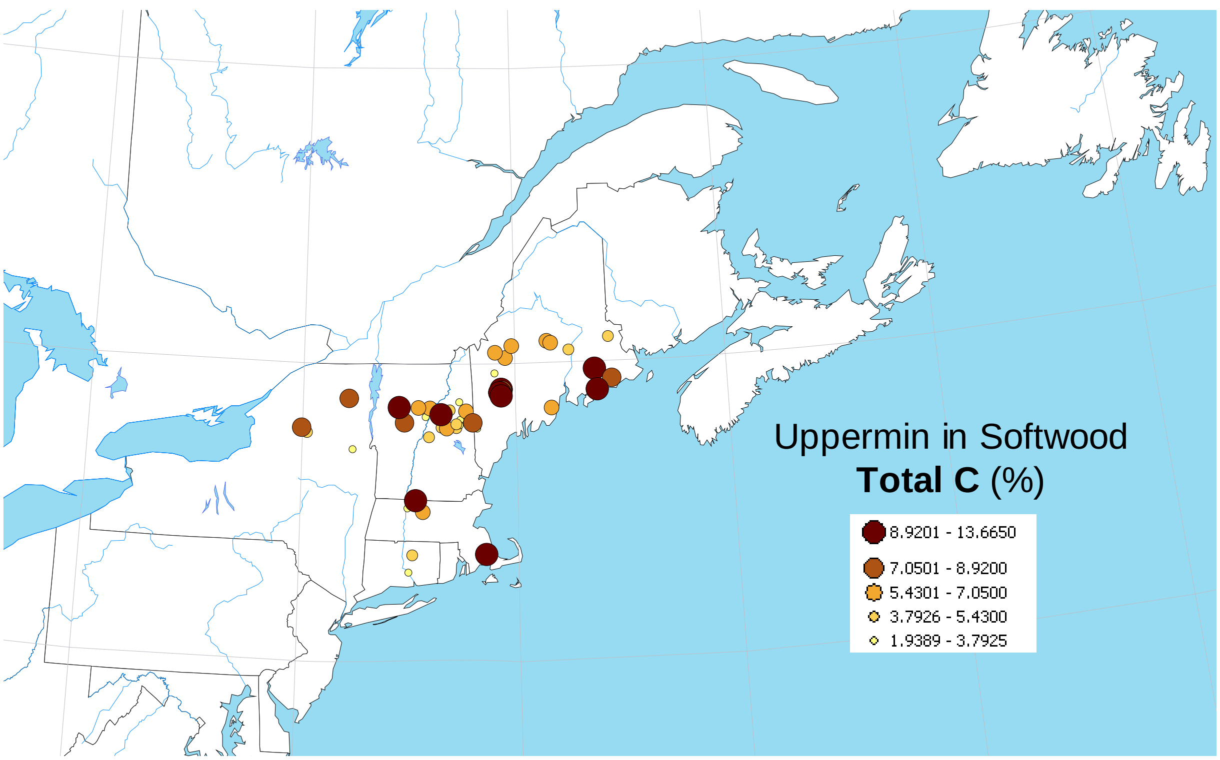


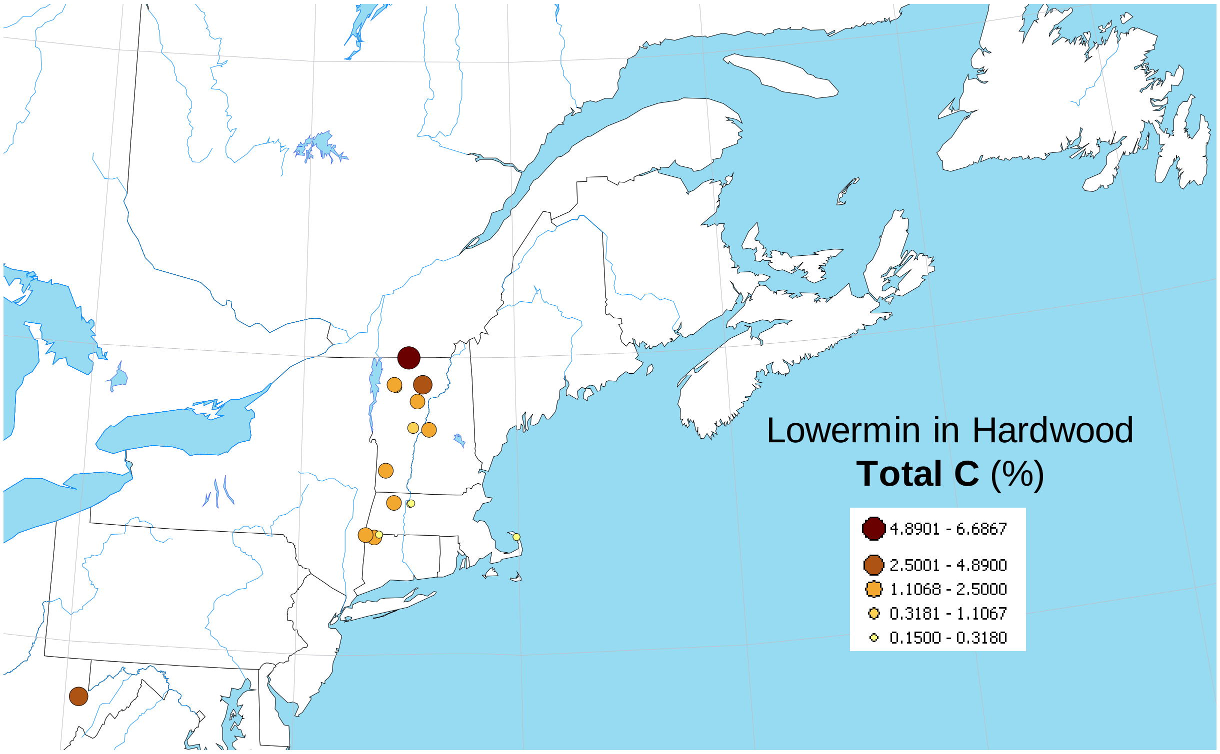


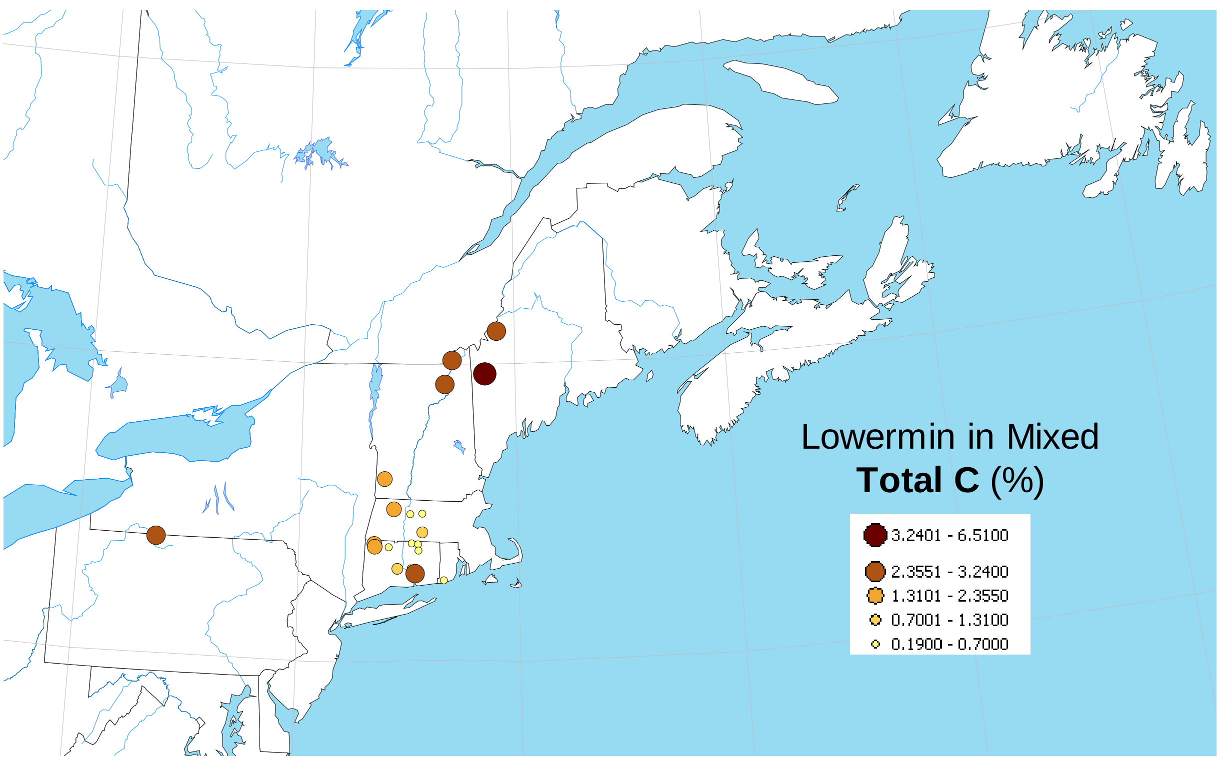

Organic in Softwood
Total C (%)
44.5201 - 51.9200
39.4301 - 44.5200
34.0201 - 39.4300
22.9701 - 34.0200
18.0000 - 22.9700


Uppermin in Hardwood
Total C (%)
18.1501 - 43.9300
11.7001 - 18.1500
8.0251 - 11.7000
5.2869 - 8.0250
2.4100 - 5.2868


Uppermin in Mixed
Total C (%)
11.3701 - 20.5100
8.6851 - 11.3700
4.6901 - 8.6850
3.2051 - 4.6900
1.4900 - 3.2050


Uppermin in Softwood
Total C (%)
8.9201 - 13.6650
7.0501 - 8.9200
5.4301 - 7.0500
3.7926 - 5.4300
1.9389 - 3.7925


Lowermin in Hardwood
Total C (%)
4.8901 - 6.6867
2.5001 - 4.8900
1.1068 - 2.5000
0.3181 - 1.1067
0.1500 - 0.3180


Lowermin in Mixed
Total C (%)
3.2401 - 6.5100
2.3551 - 3.2400
1.3101 - 2.3550
0.7001 - 1.3100
0.1900 - 0.7000

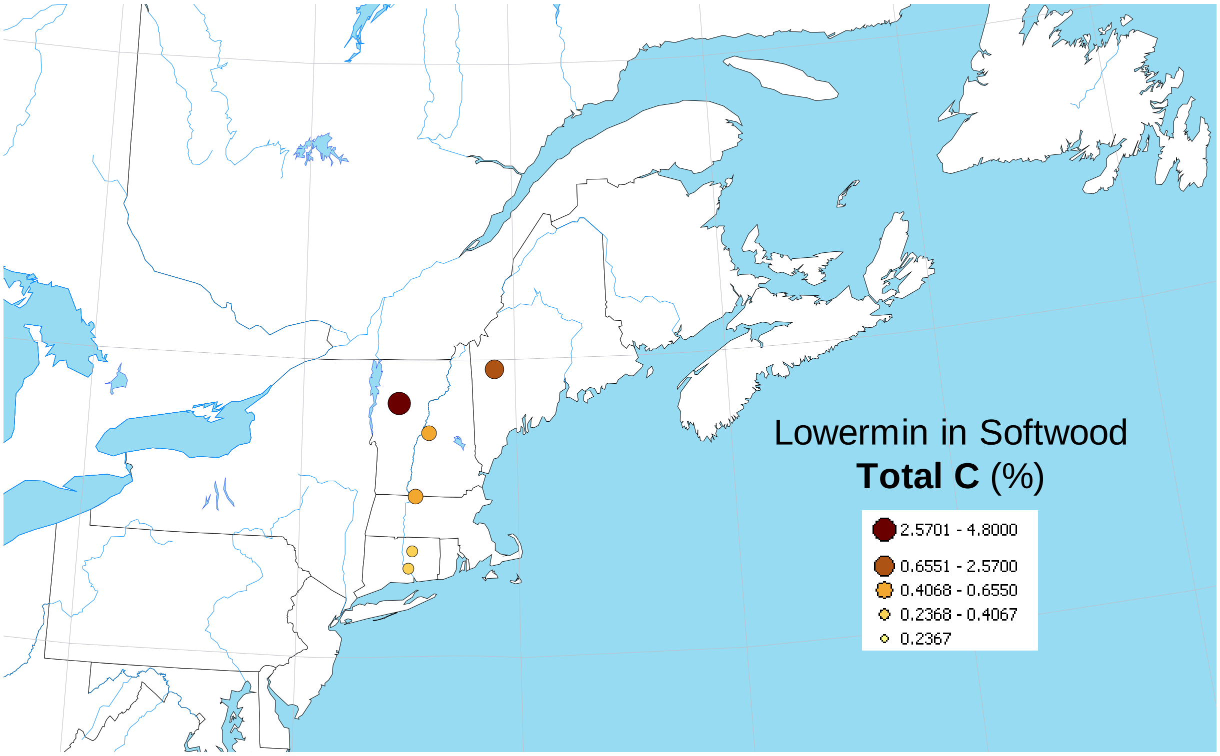
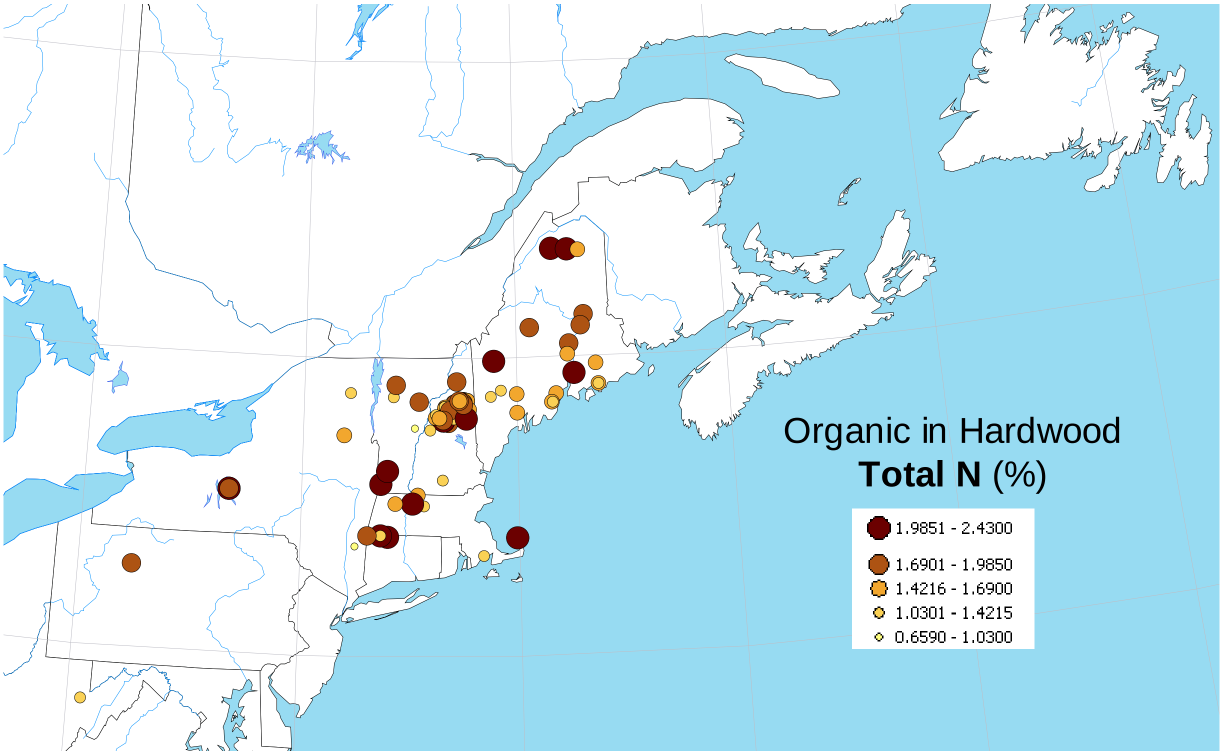
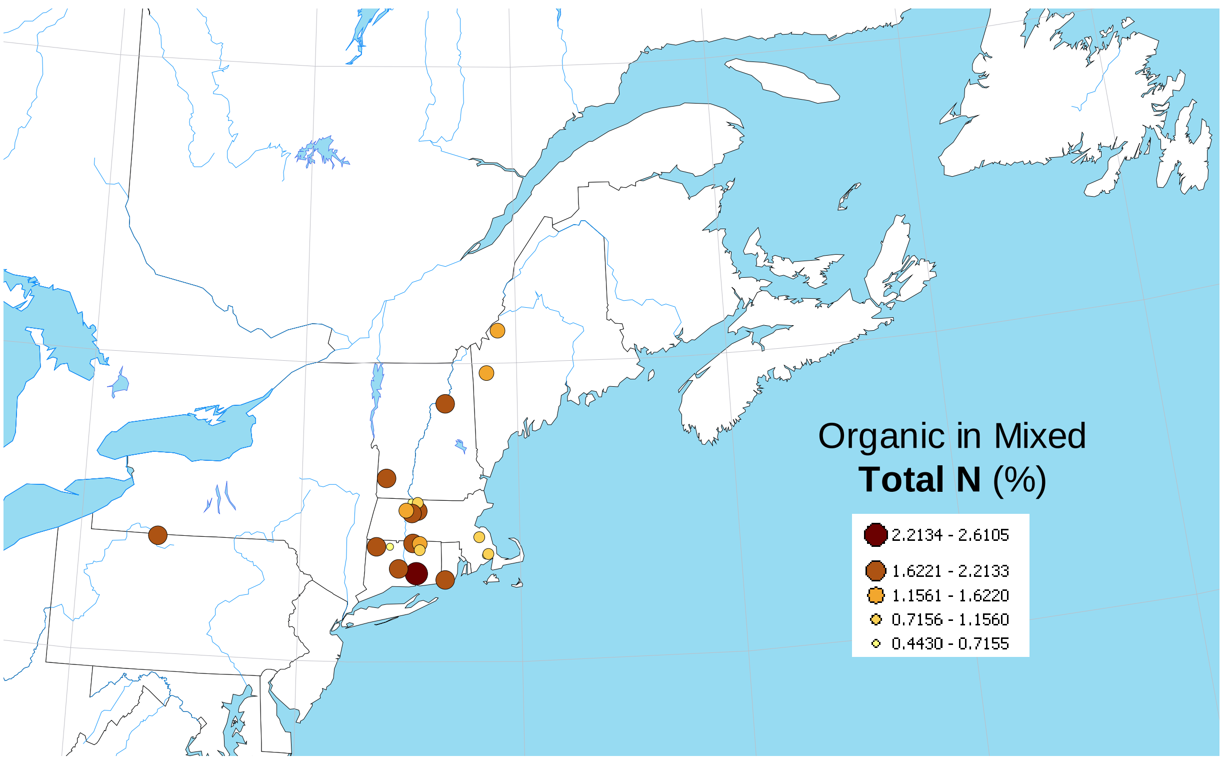
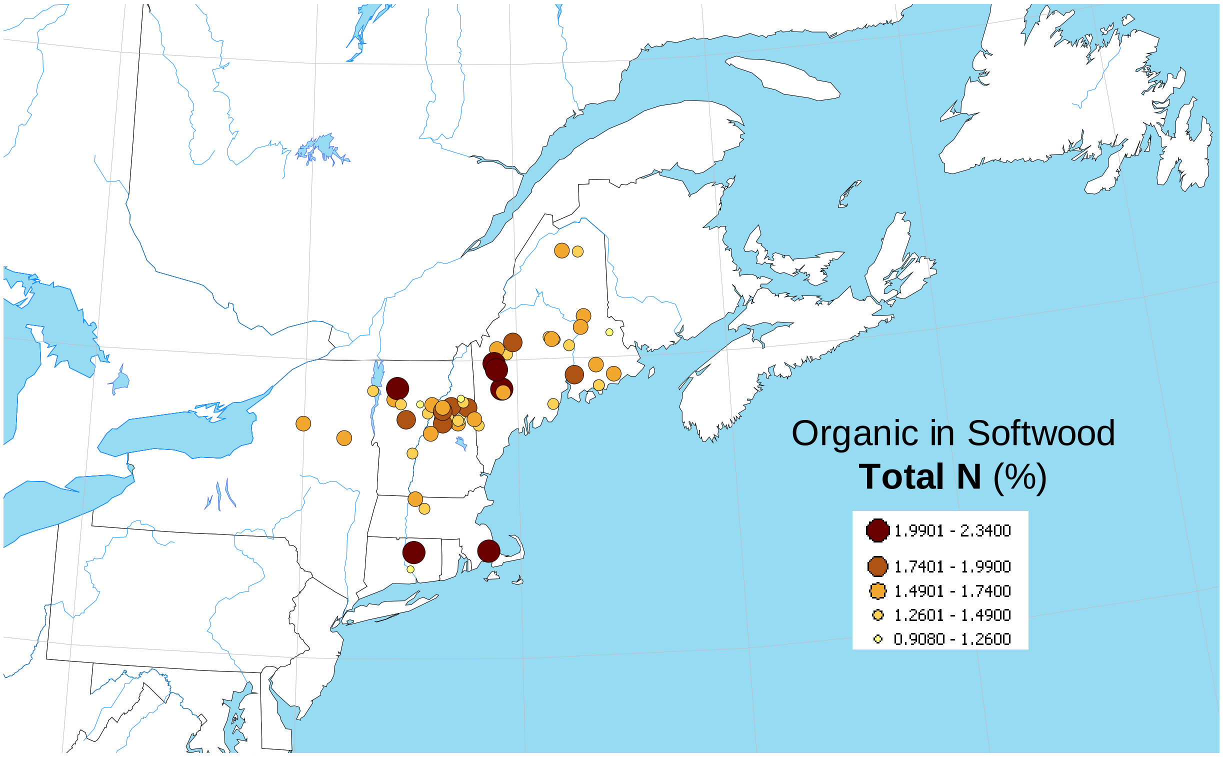
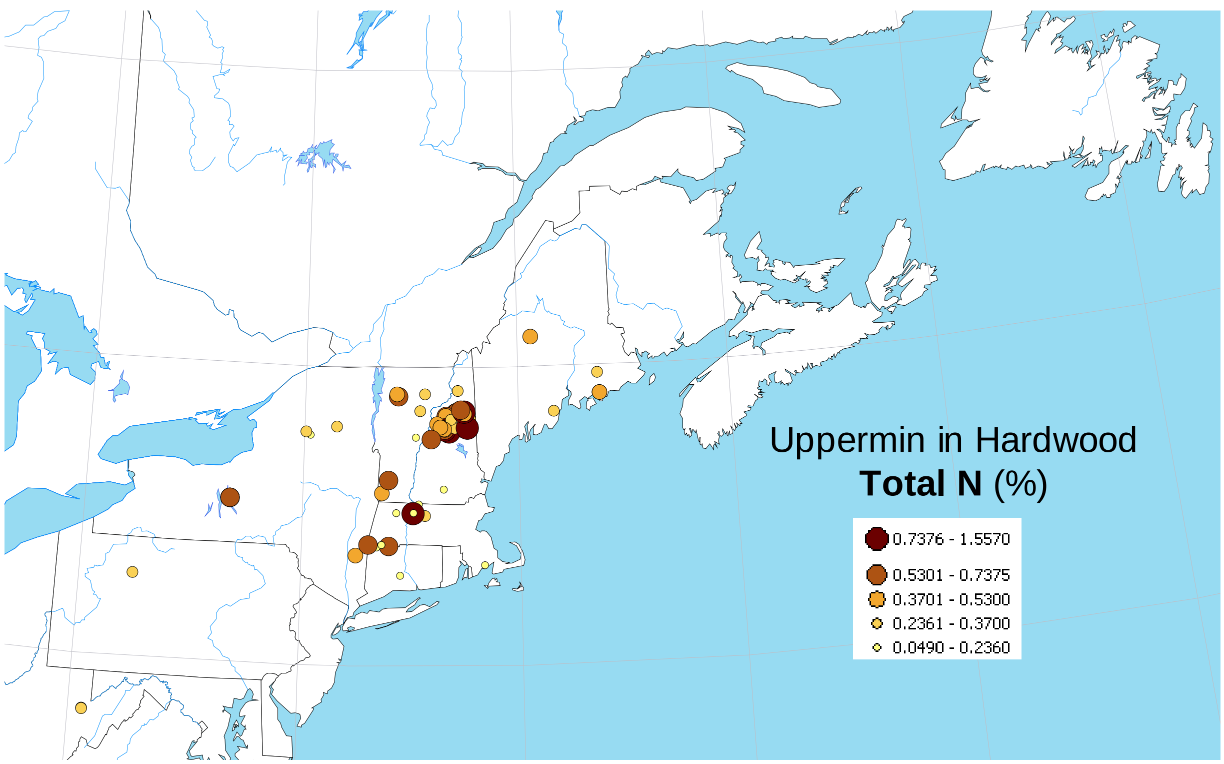

Lowermin in Softwood
Total C (%)
2.5701 - 4.8000
0.6551 - 2.5700
0.4068 - 0.6550
0.2368 - 0.4067
0.2367

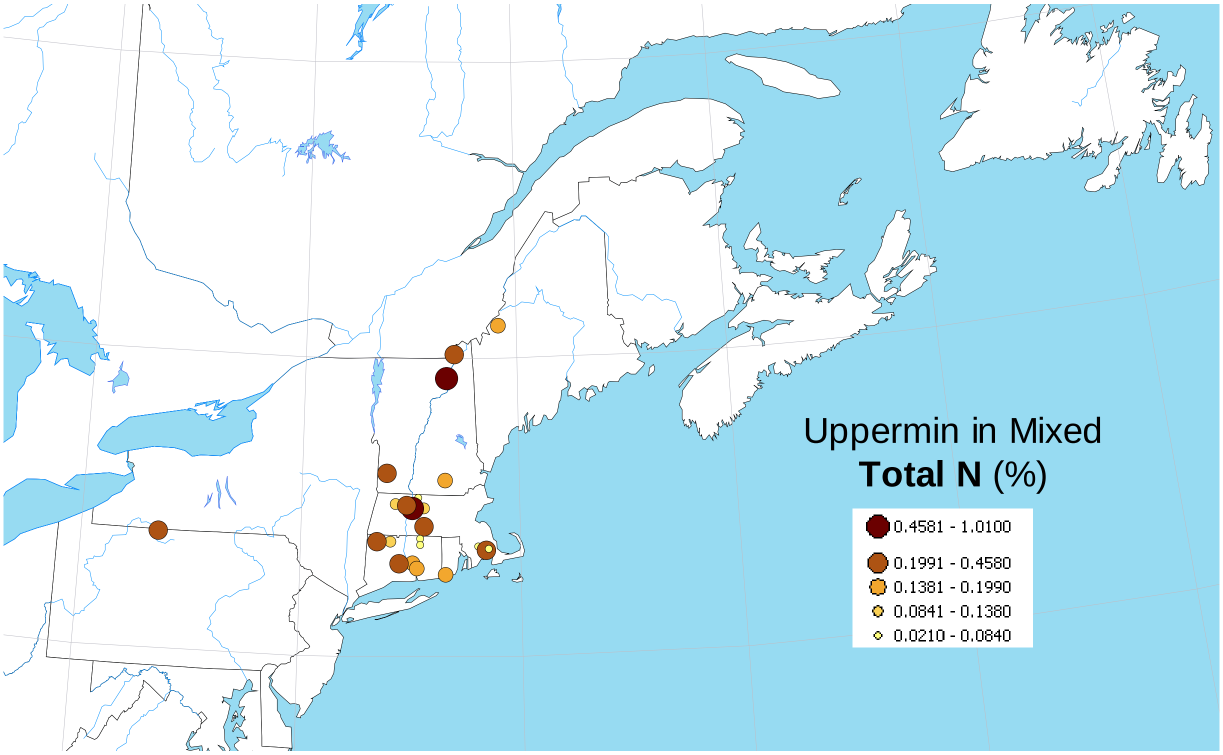
Figure 20. Maps for soil nitrogen. (figure spans multiple pages)

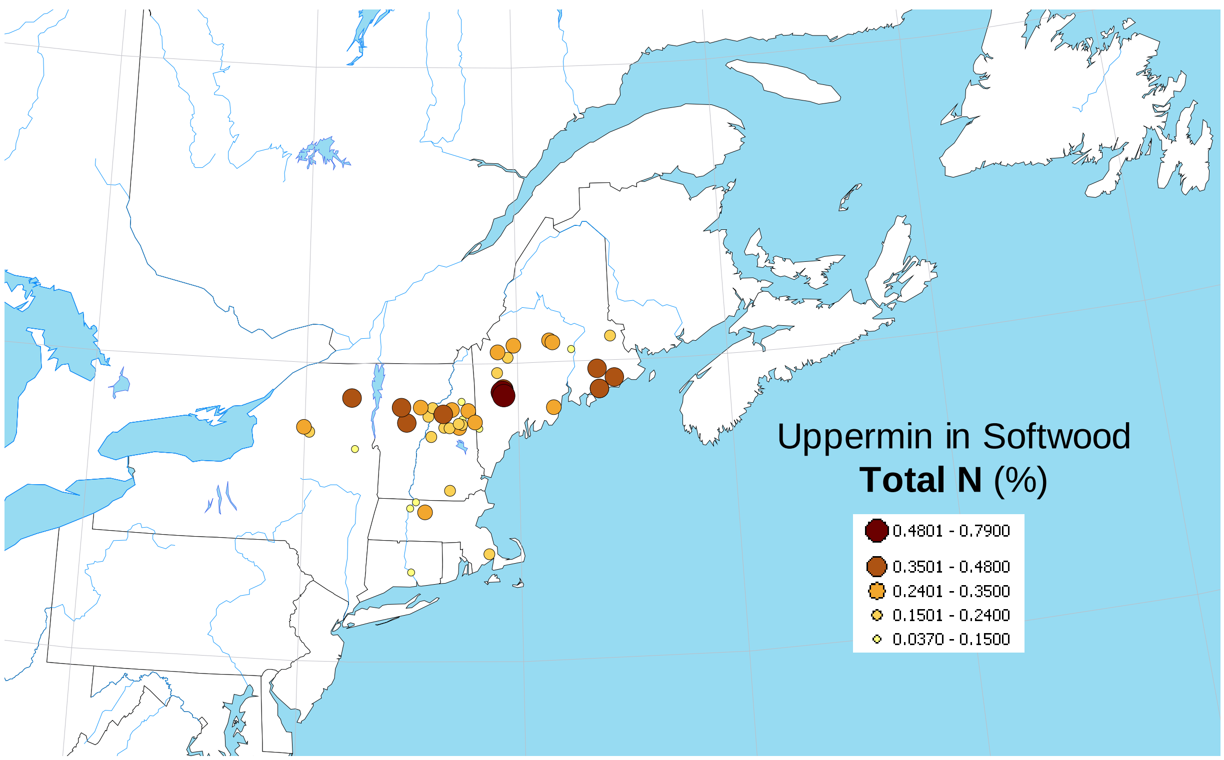


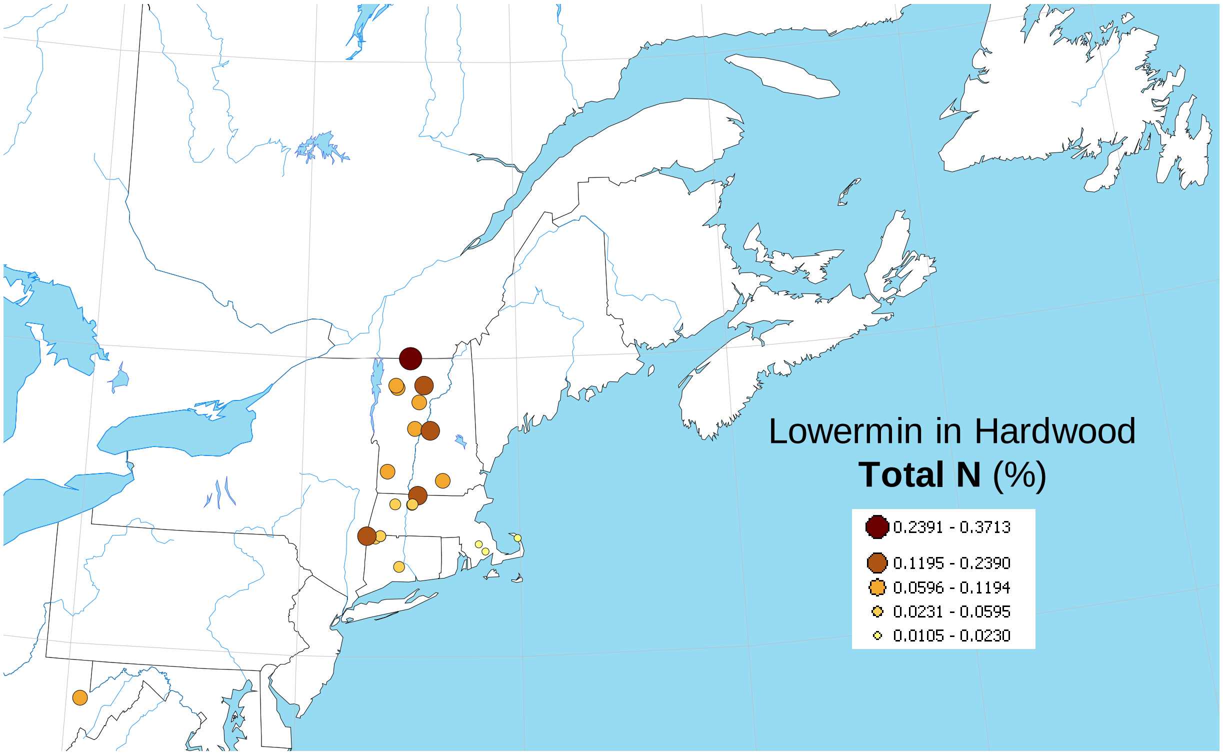


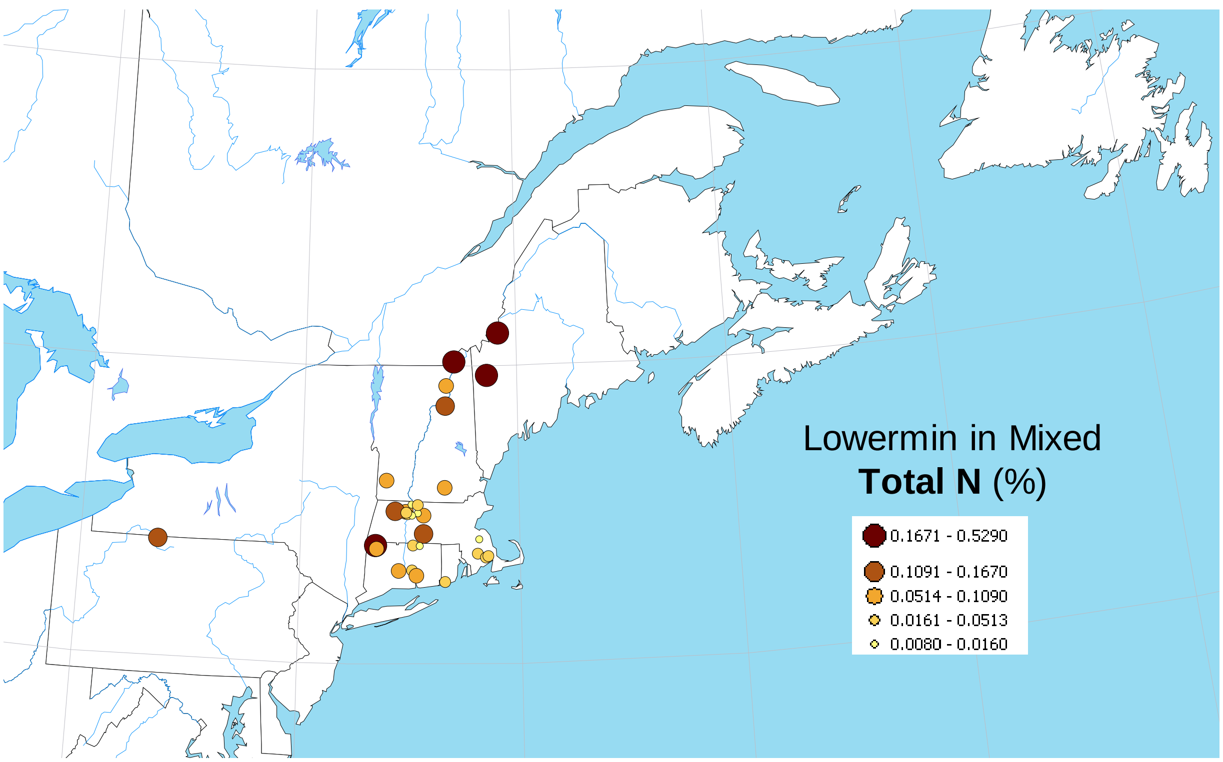

Organic in Softwood
Total N (%)
1.9901 - 2.3400
1.7401 - 1.9900
1.4901 - 1.7400
1.2601 - 1.4900
0.9080 - 1.2600


Uppermin in Hardwood
Total N (%)
0.7376 - 1.5570
0.5301 - 0.7375
0.3701 - 0.5300
0.2361 - 0.3700
0.0490 - 0.2360


Uppermin in Mixed
Total N (%)
0.4581 - 1.0100
0.1991 - 0.4580
0.1381 - 0.1990
0.0841 - 0.1380
0.0210 - 0.0840


Uppermin in Softwood
Total N (%)
0.4801 - 0.7900
0.3501 - 0.4800
0.2401 - 0.3500
0.1501 - 0.2400
0.0370 - 0.1500


Lowermin in Hardwood
Total N (%)
0.2391 - 0.3713
0.1195 - 0.2390
0.0596 - 0.1194
0.0231 - 0.0595
0.0105 - 0.0230


Lowermin in Mixed
Total N (%)
0.1671 - 0.5290
0.1091 - 0.1670
0.0514 - 0.1090
0.0161 - 0.0513
0.0080 - 0.0160

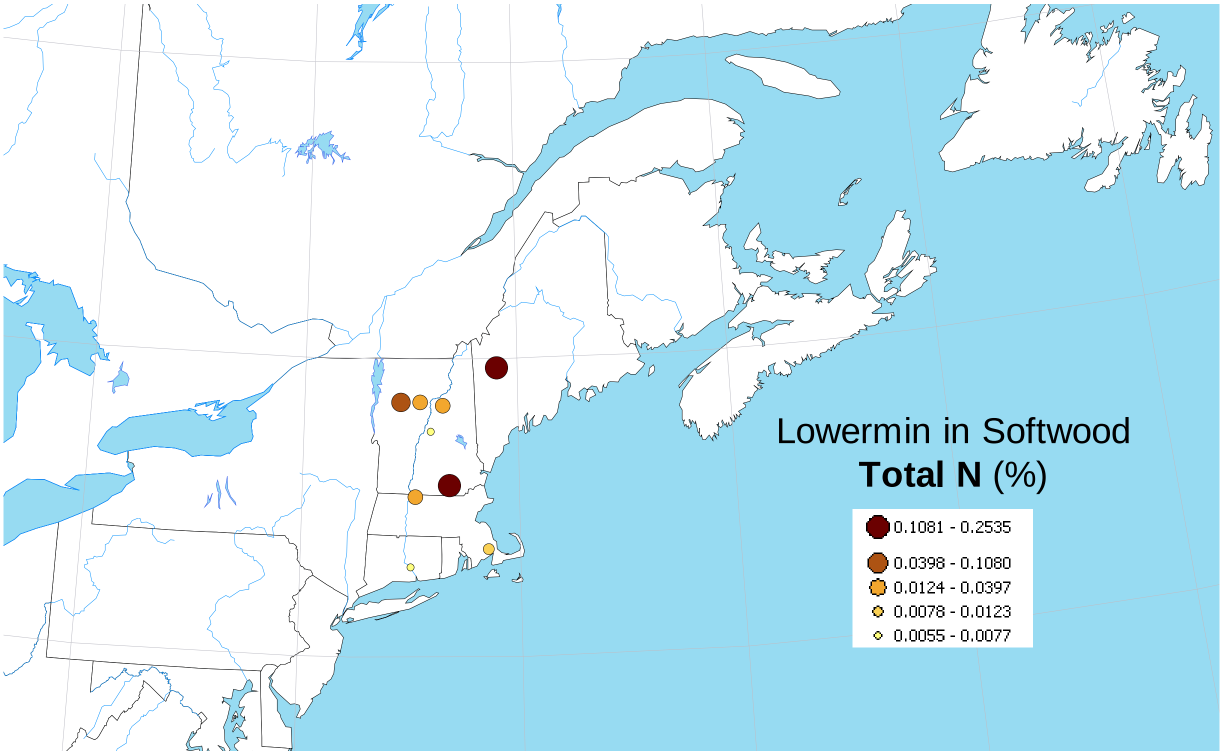
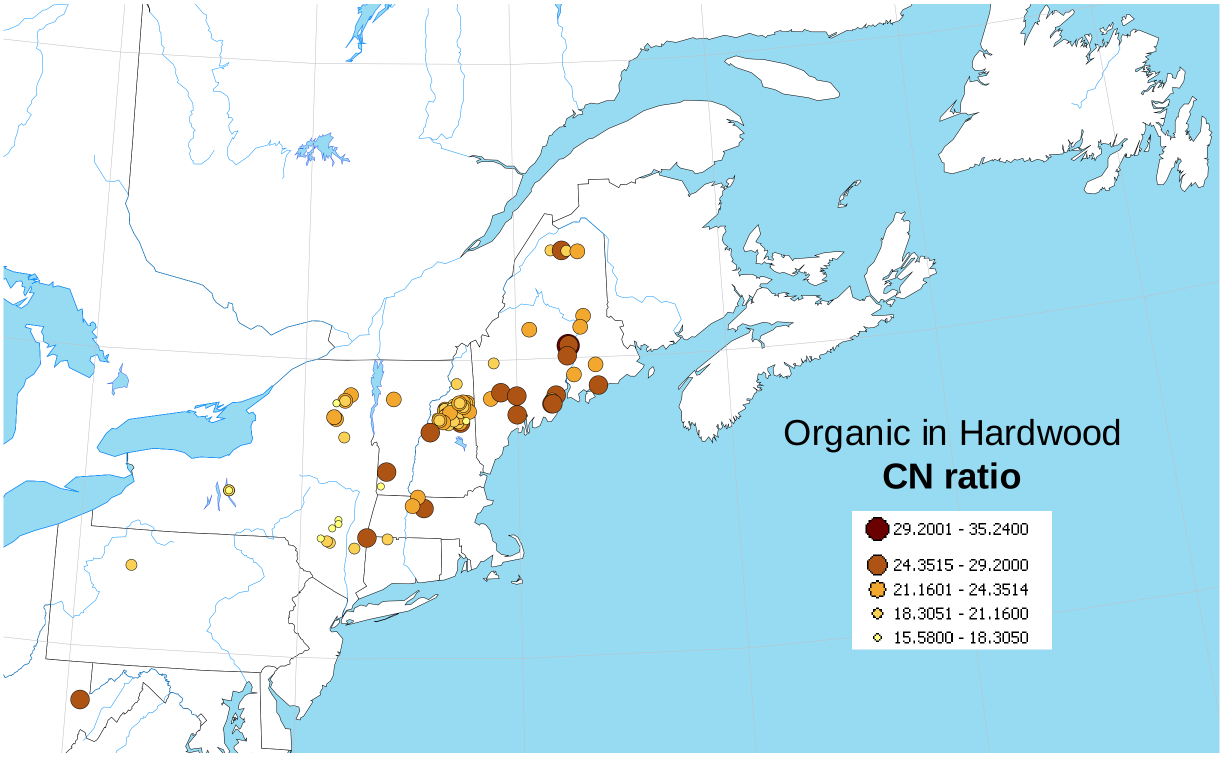
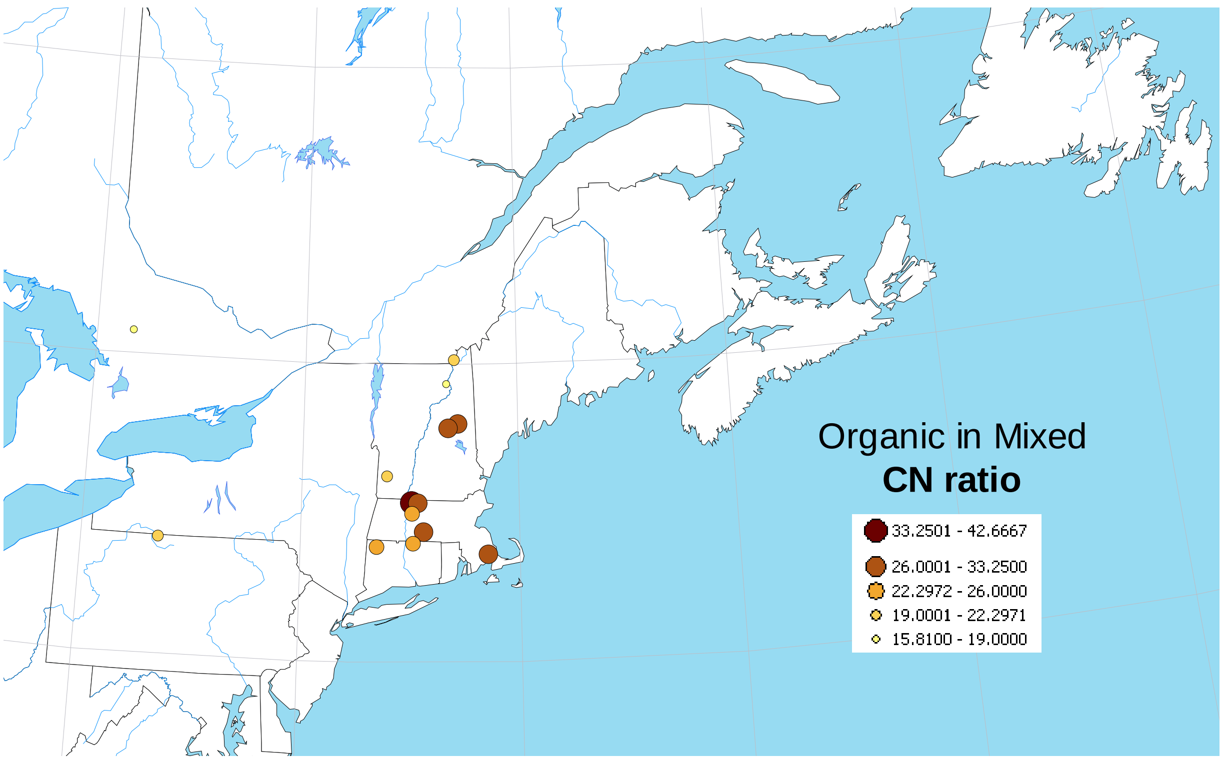
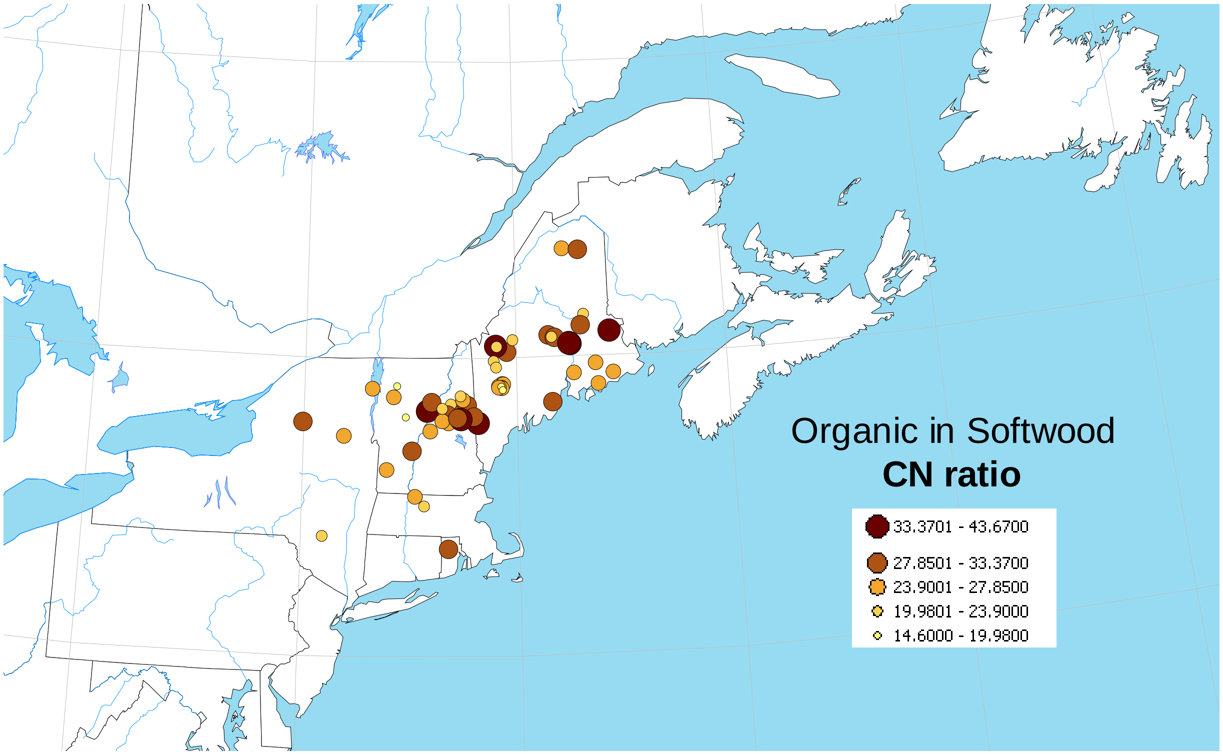
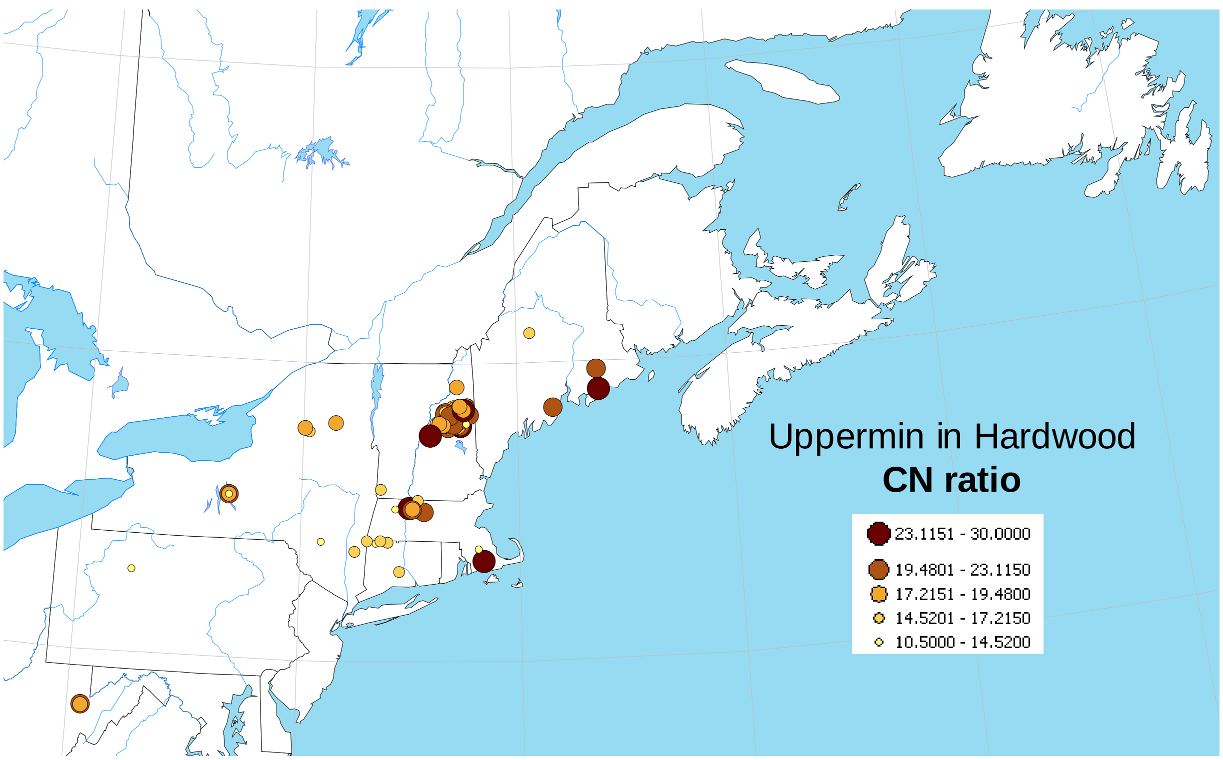

Lowermin in Softwood
Total N (%)
0.1081 - 0.2535
0.0398 - 0.1080
0.0124 - 0.0397
0.0078 - 0.0123
0.0055 - 0.0077

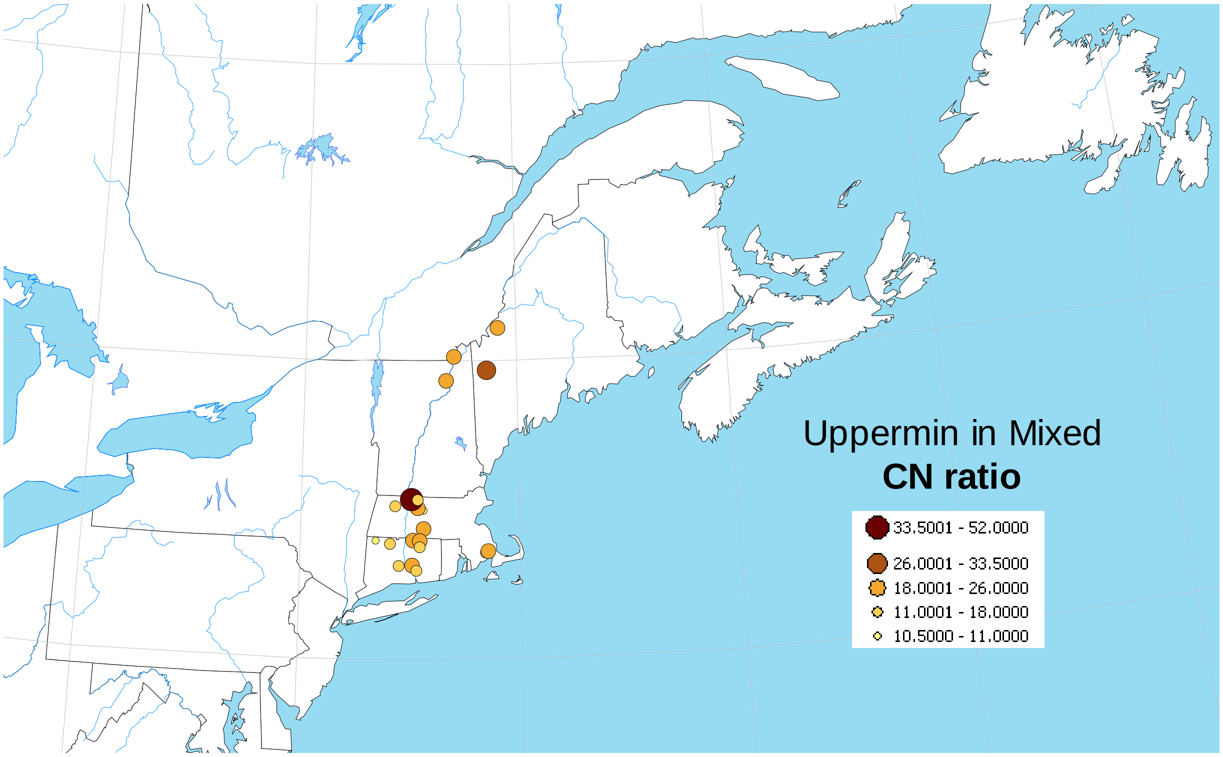
Figure 21. Maps for soil CN ratio. (figure spans multiple pages)

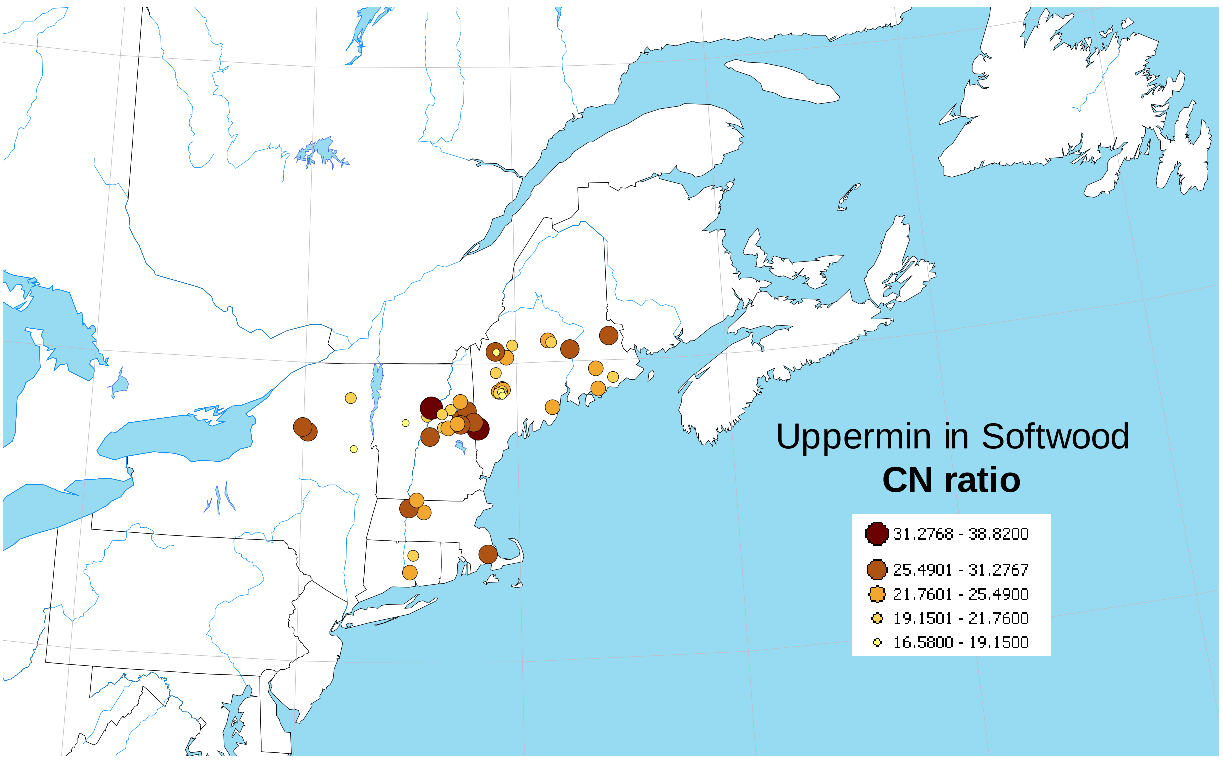


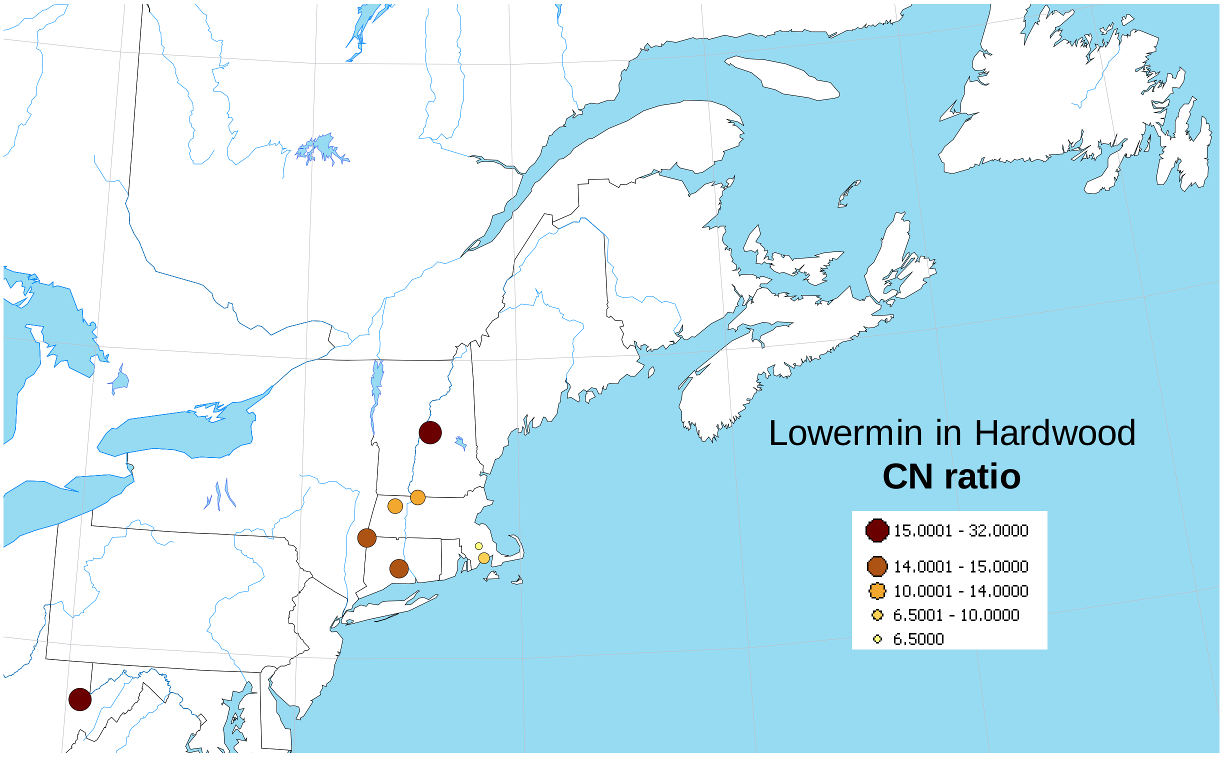


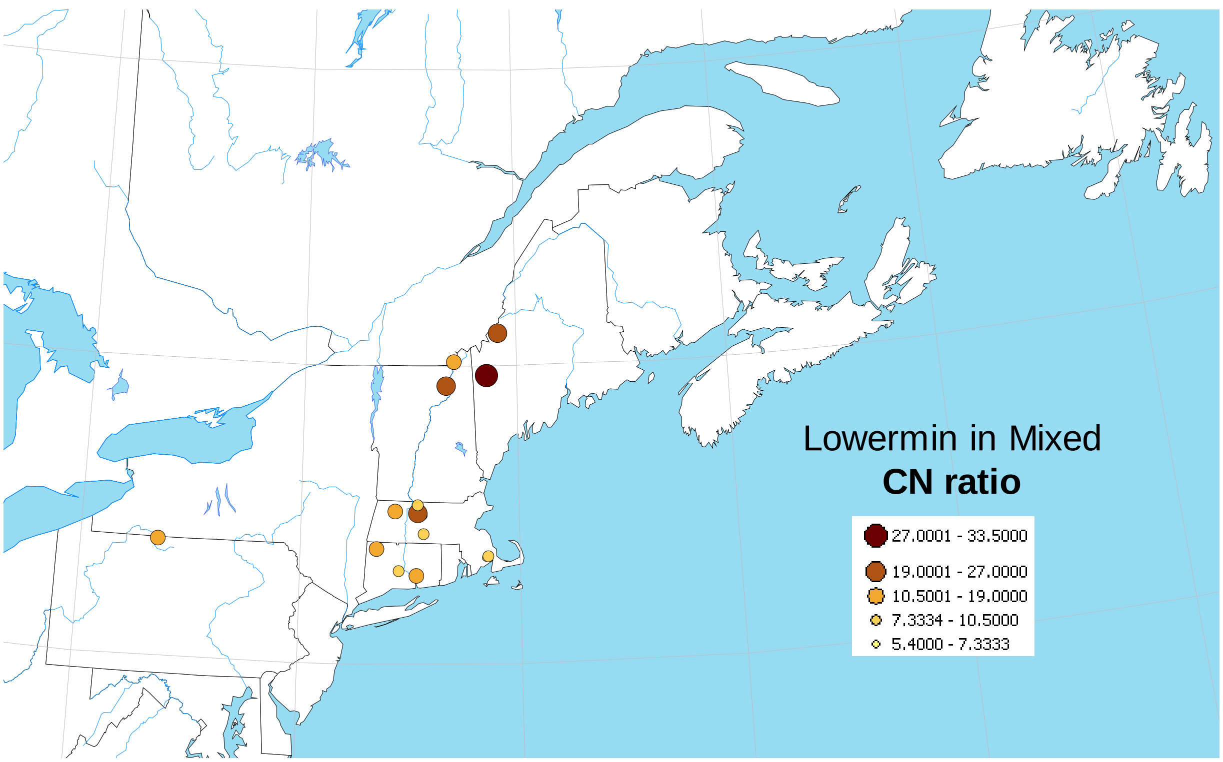

Organic in Softwood
CN ratio
33.3701 - 43.6700
27.8501 - 33.3700
23.9001 - 27.8500
19.9801 - 23.9000
14.6000 - 19.9800


Uppermin in Hardwood
CN ratio
23.1151 - 30.0000
19.4801 - 23.1150
17.2151 - 19.4800
14.5201 - 17.2150
10.5000 - 14.5200


Uppermin in Mixed
CN ratio
33.5001 - 52.0000
26.0001 - 33.5000
18.0001 - 26.0000
11.0001 - 18.0000
10.5000 - 11.0000


Uppermin in Softwood
CN ratio
31.2768 - 38.8200
25.4901 - 31.2767
21.7601 - 25.4900
19.1501 - 21.7600
16.5800 - 19.1500


Lowermin in Hardwood
CN ratio
15.0001 - 32.0000
14.0001 - 15.0000
10.0001 - 14.0000
6.5001 - 10.0000
6.5000


Lowermin in Mixed
CN ratio
27.0001 - 33.5000
19.0001 - 27.0000
10.5001 - 19.0000
7.3334 - 10.5000
5.4000 - 7.3333

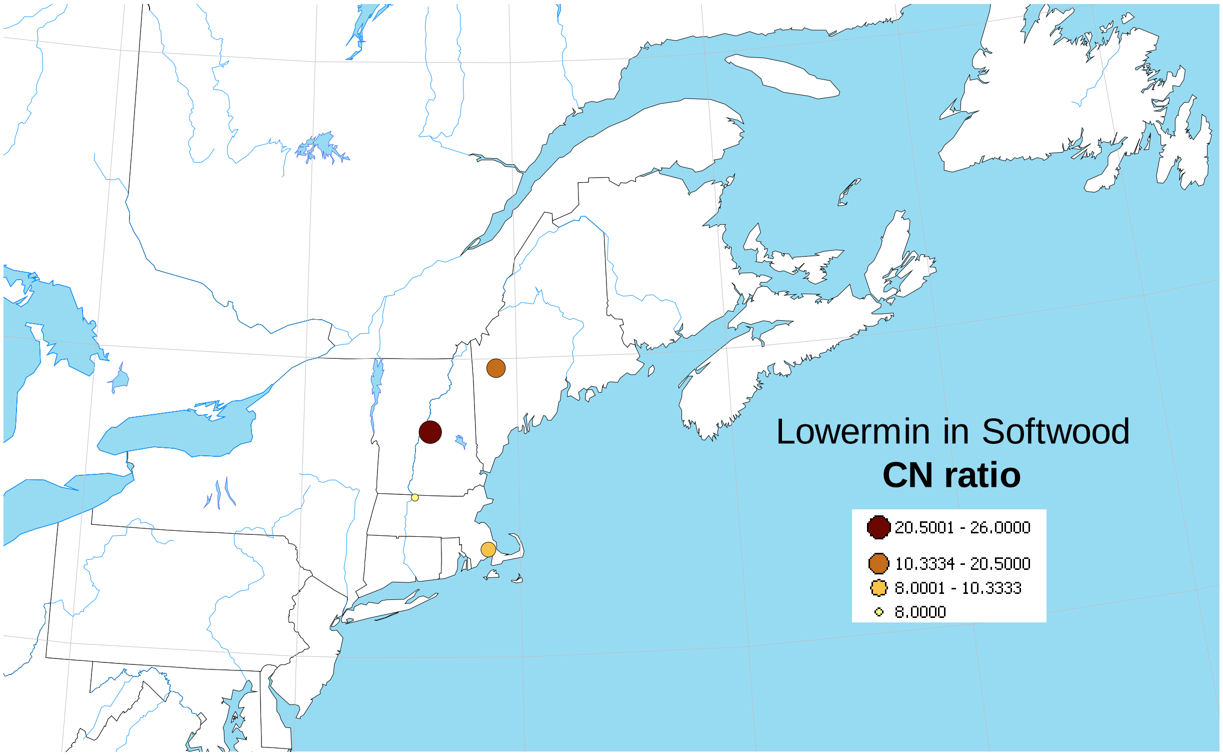
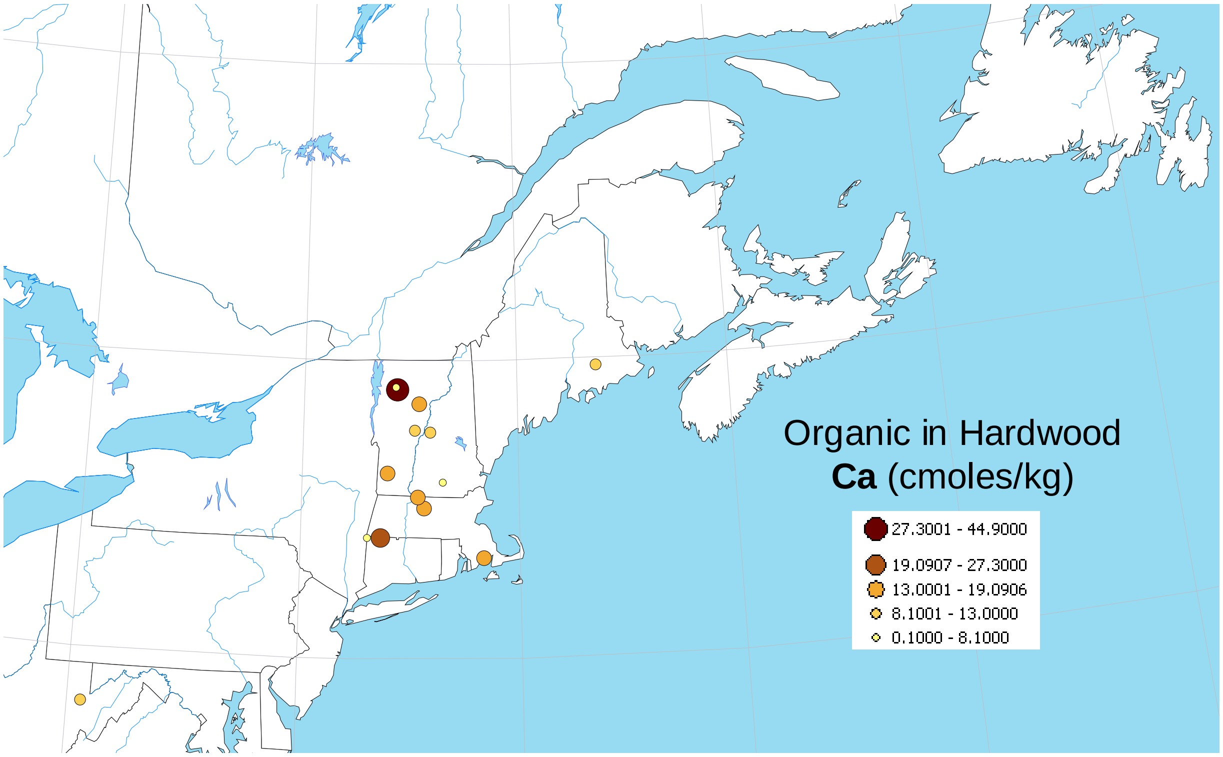
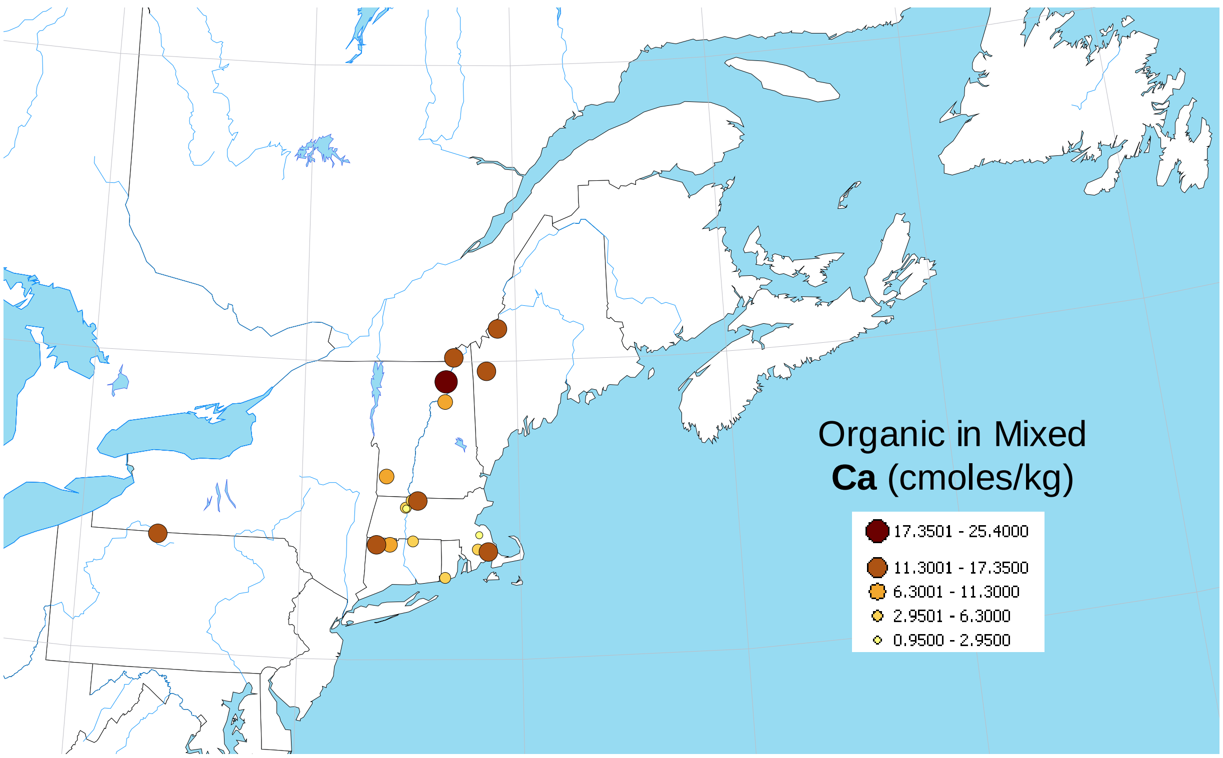
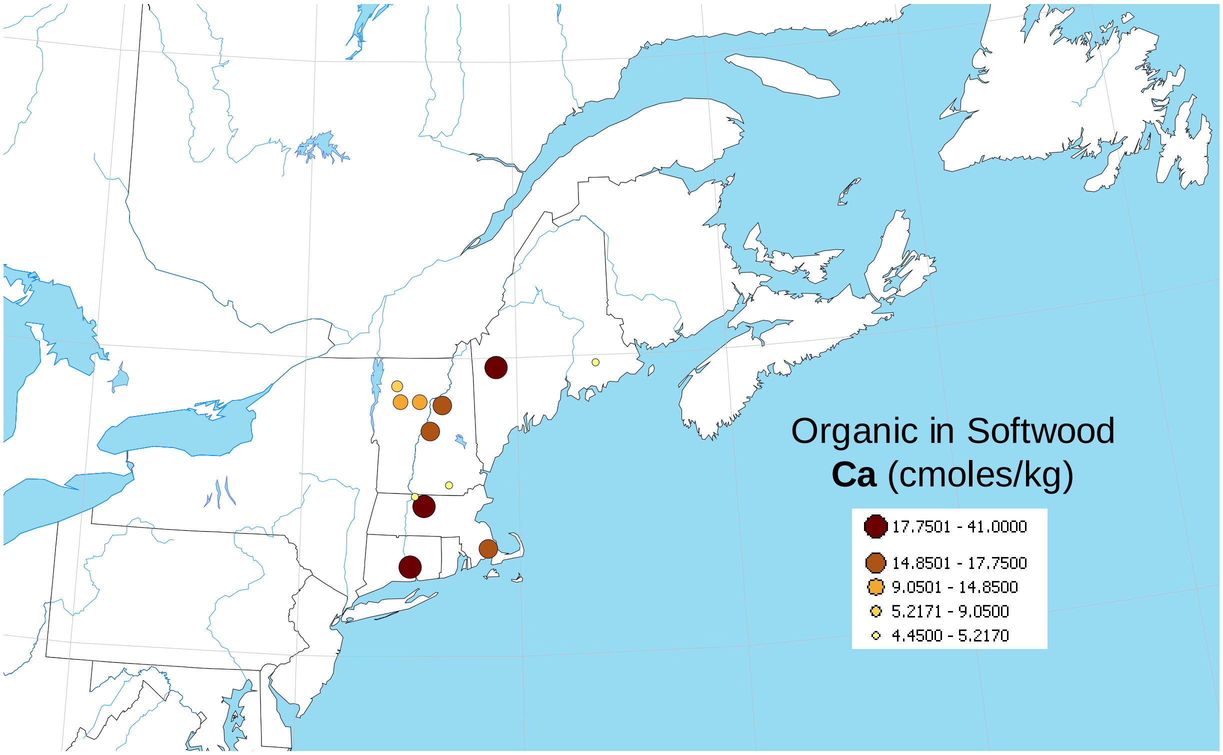
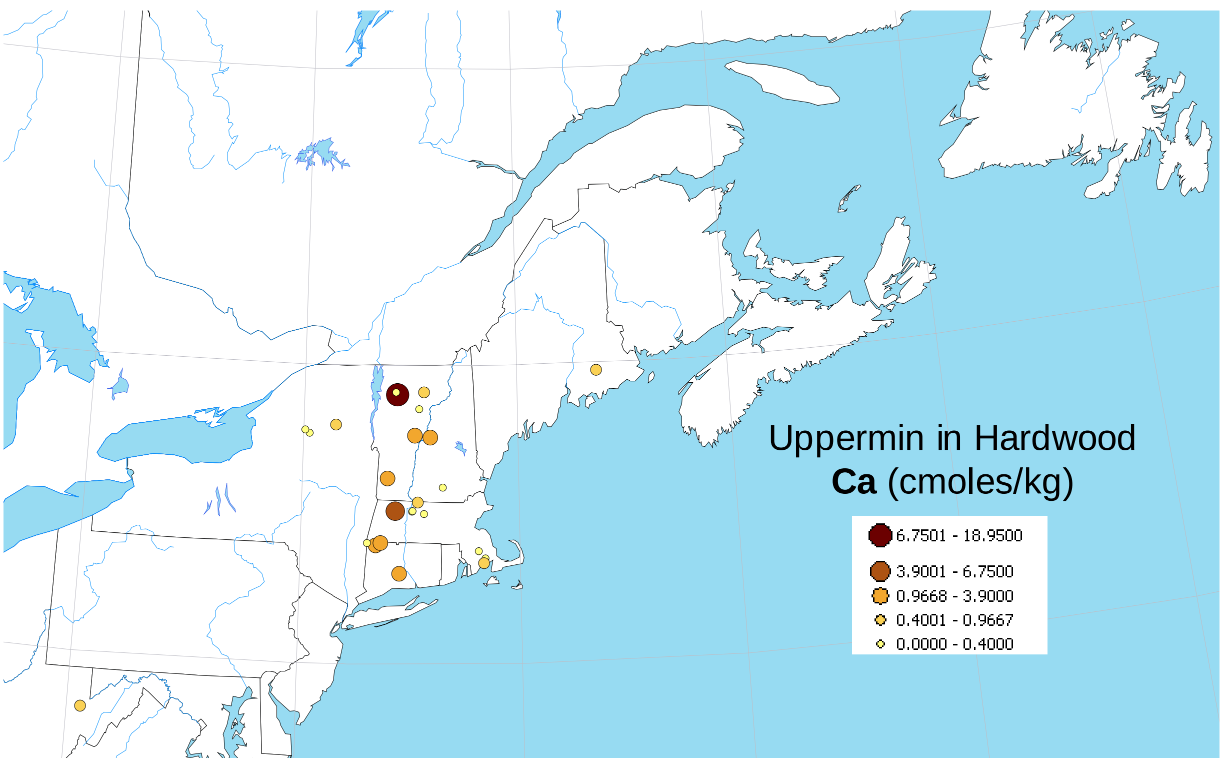

Lowermin in Softwood
CN ratio
20.5001 - 26.0000
10.3334 - 20.5000
8.0001 - 10.3333
8.0000

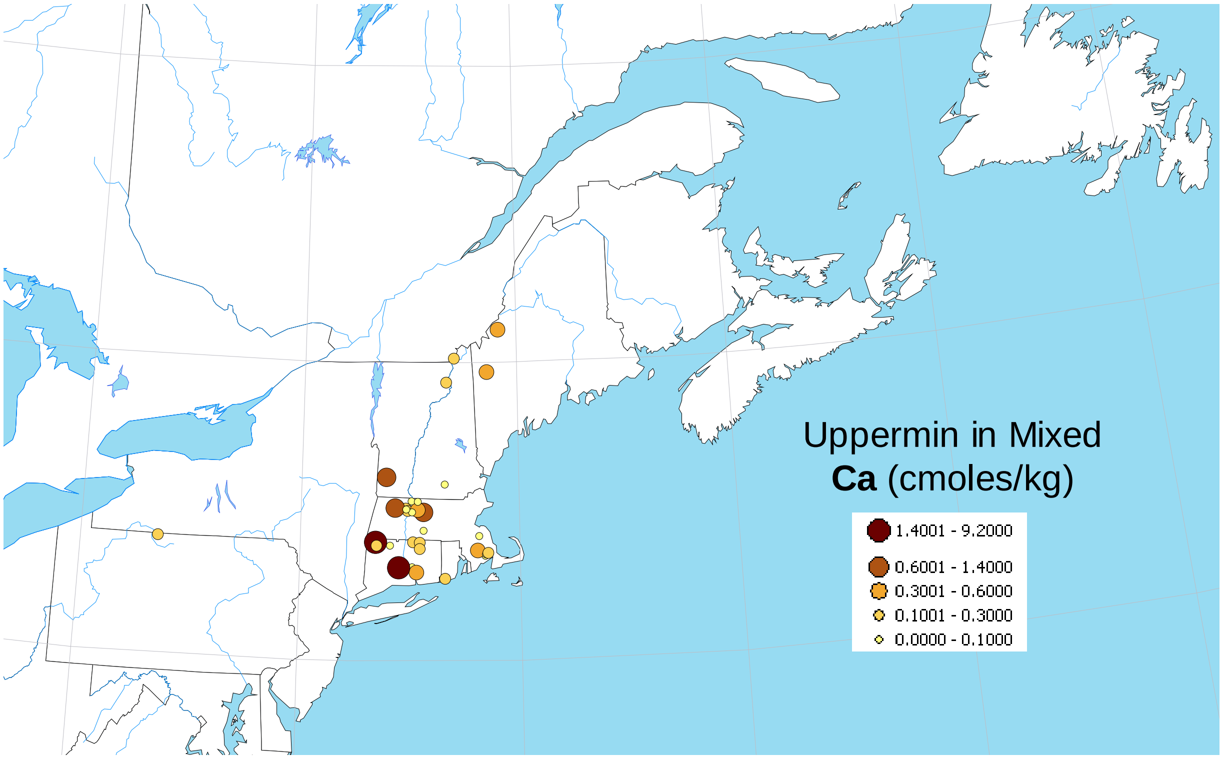
Figure 22. Maps for soil calcium. (figure spans multiple pages)

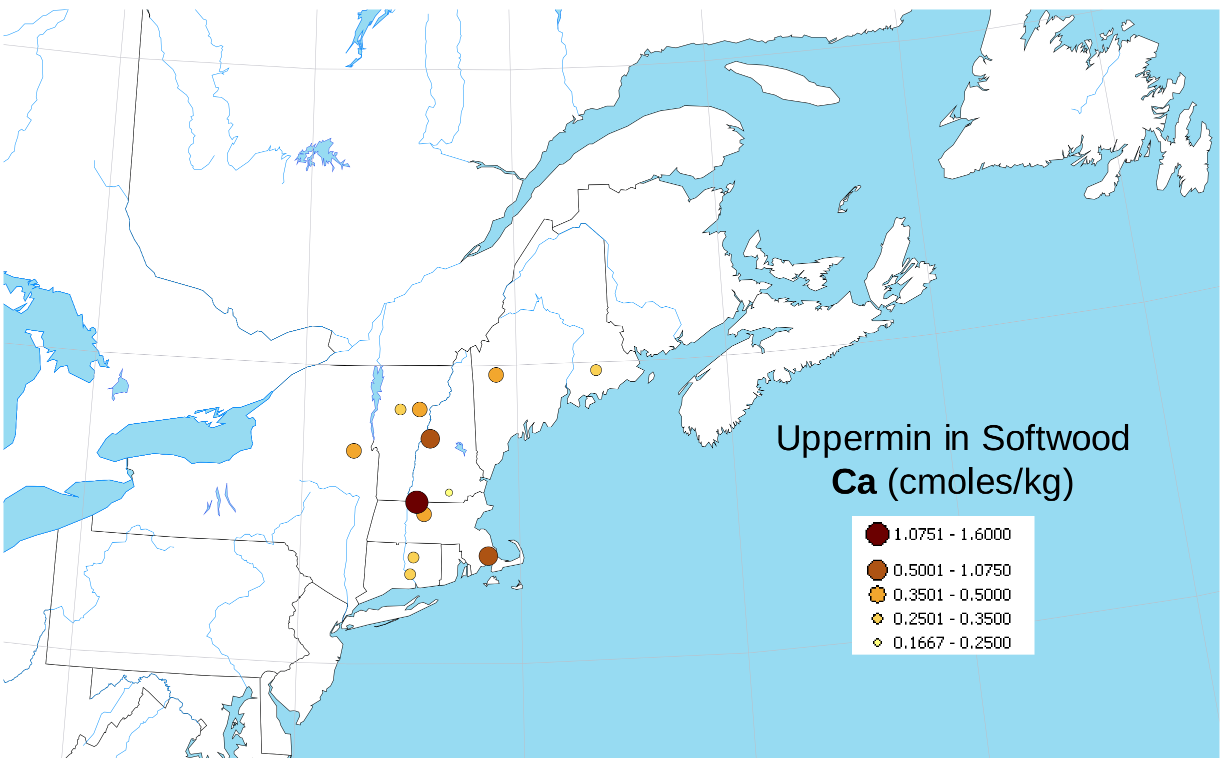


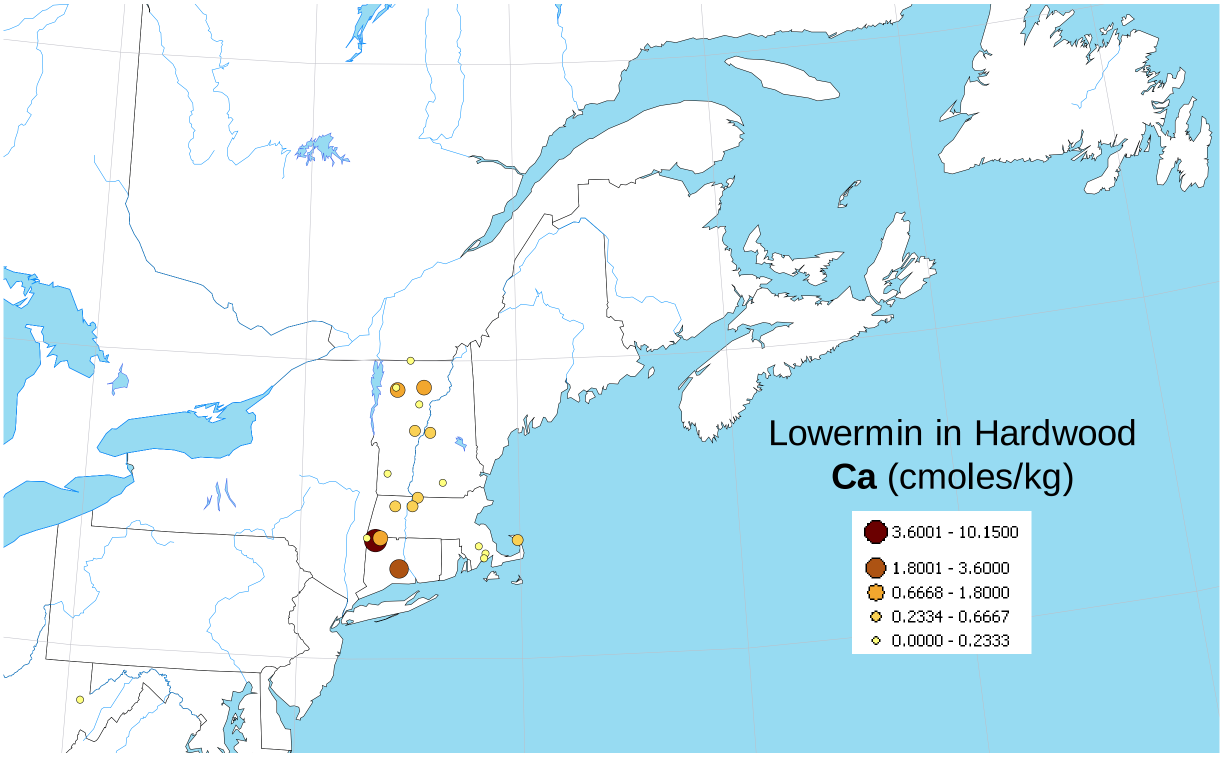


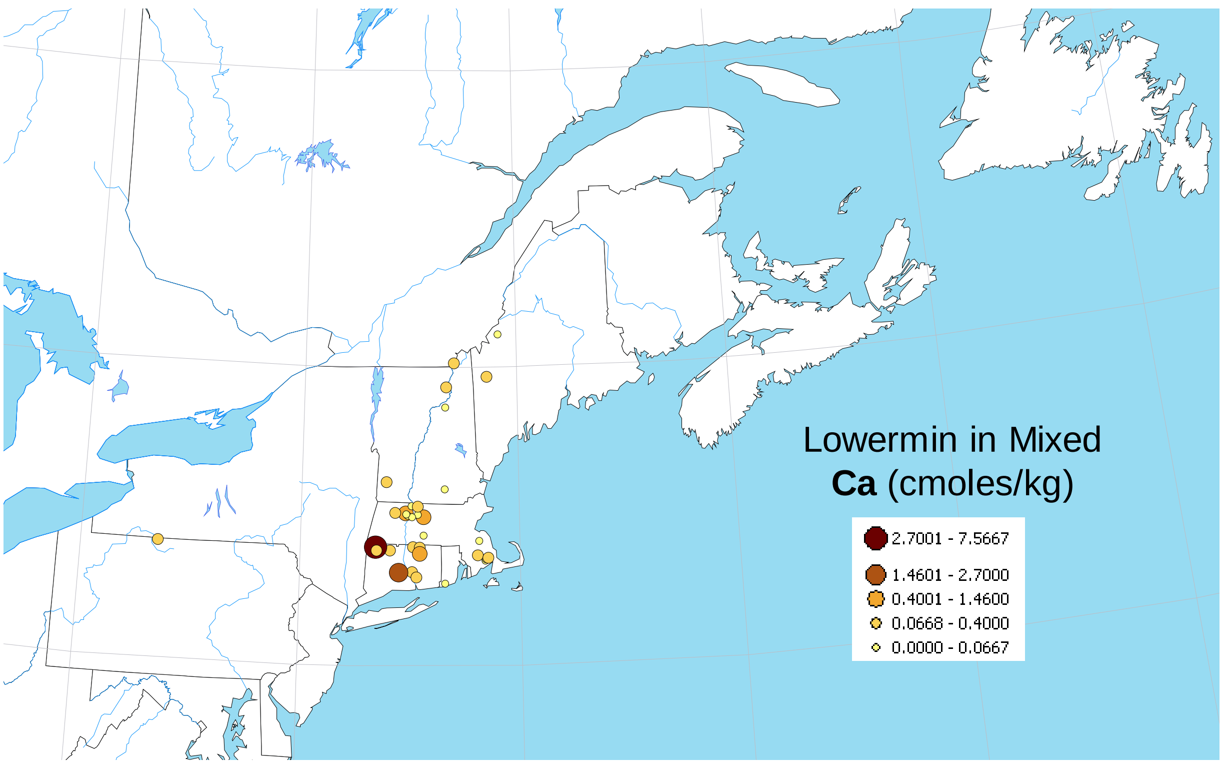

Organic in Softwood
Ca (cmoles/kg)
17.7501 - 41.0000
14.8501 - 17.7500
9.0501 - 14.8500
5.2171 - 9.0500
4.4500 - 5.2170


Uppermin in Hardwood
Ca (cmoles/kg)
6.7501 - 18.9500
3.9001 - 6.7500
0.9668 - 3.9000
0.4001 - 0.9667
0.0000 - 0.4000


Uppermin in Mixed
Ca (cmoles/kg)
1.4001 - 9.2000
0.6001 - 1.4000
0.3001 - 0.6000
0.1001 - 0.3000
0.0000 - 0.1000


Uppermin in Softwood
Ca (cmoles/kg)
1.0751 - 1.6000
0.5001 - 1.0750
0.3501 - 0.5000
0.2501 - 0.3500
0.1667 - 0.2500


Lowermin in Hardwood
Ca (cmoles/kg)
3.6001 - 10.1500
1.8001 - 3.6000
0.6668 - 1.8000
0.2334 - 0.6667
0.0000 - 0.2333


Lowermin in Mixed
Ca (cmoles/kg)
2.7001 - 7.5667
1.4601 - 2.7000
0.4001 - 1.4600
0.0668 - 0.4000
0.0000 - 0.0667

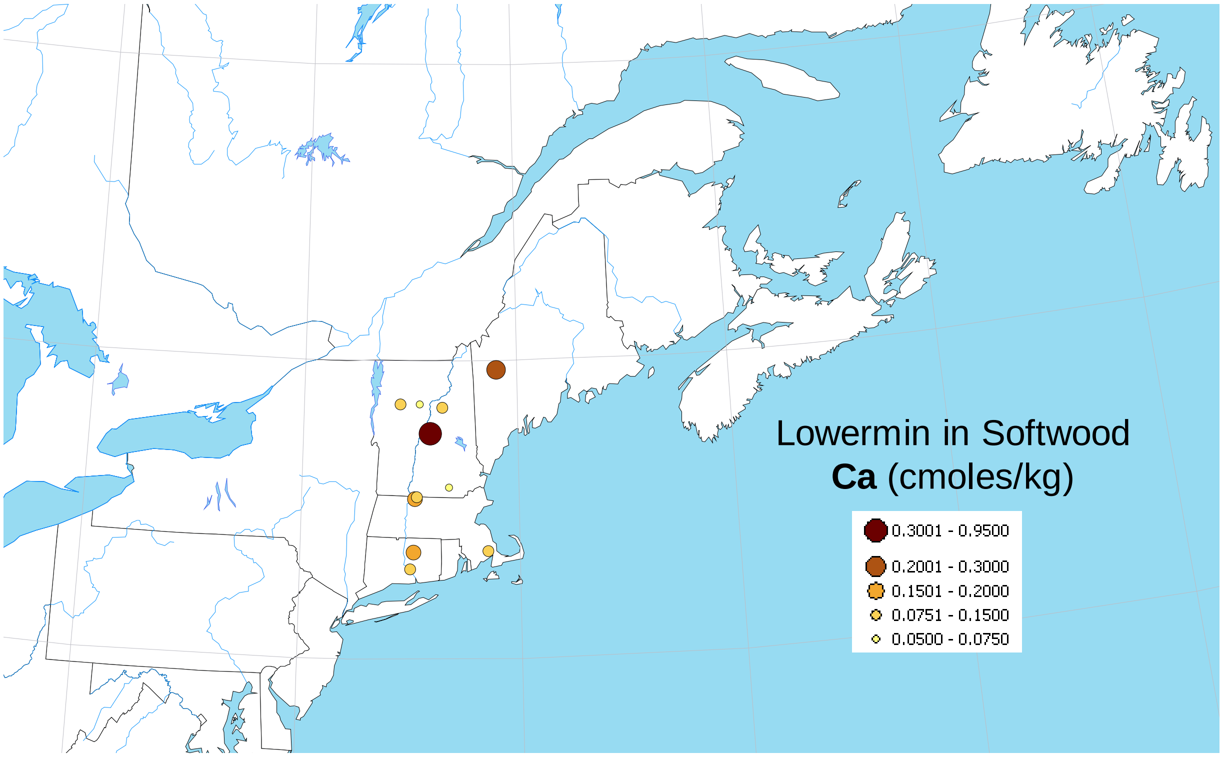
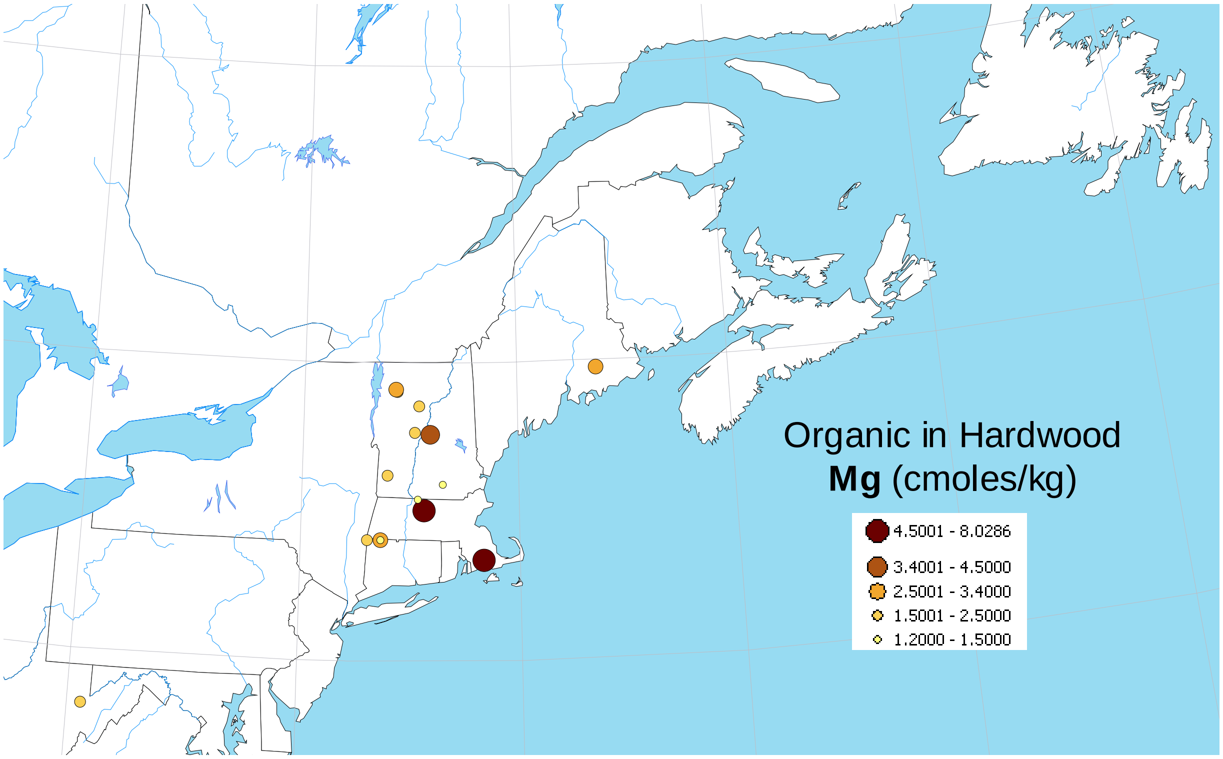
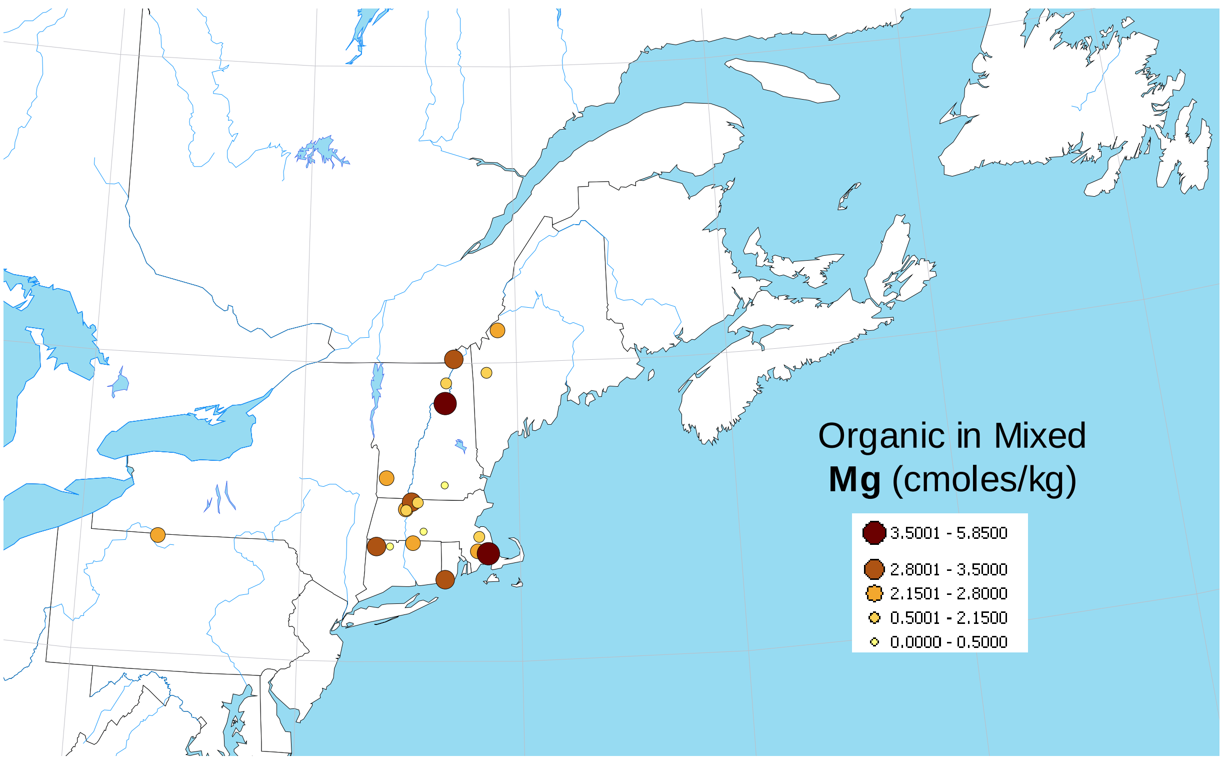
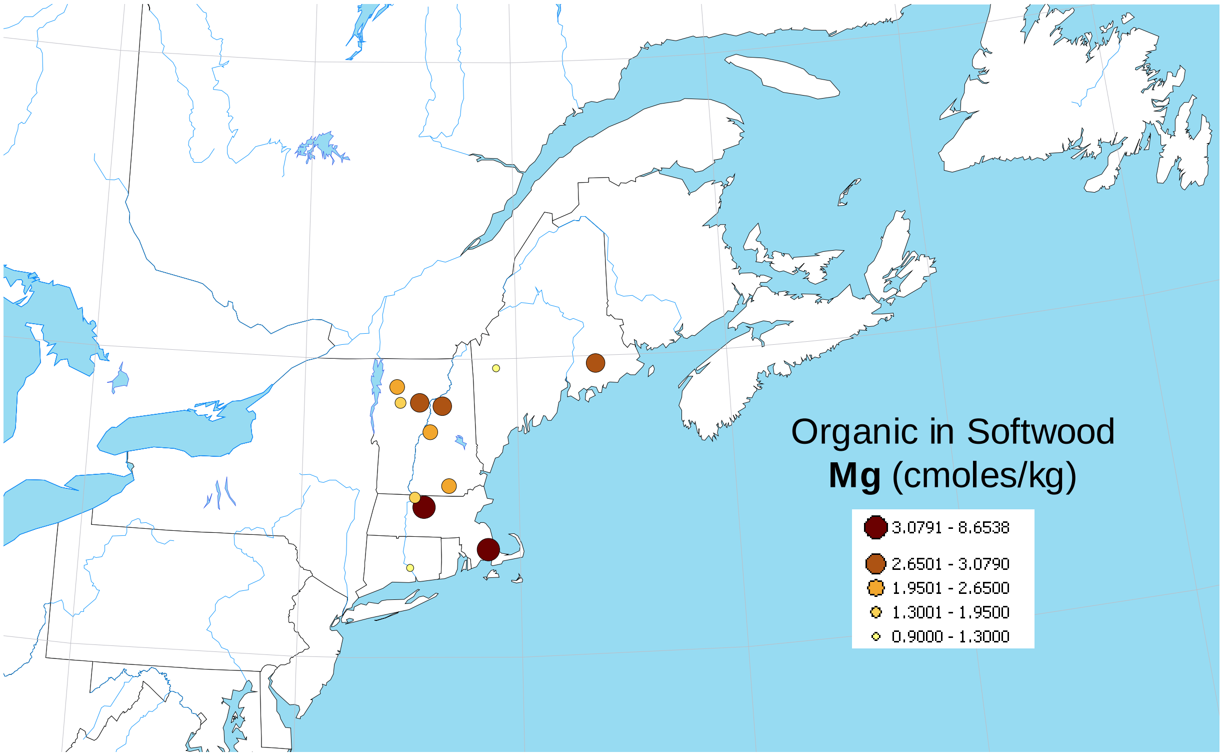
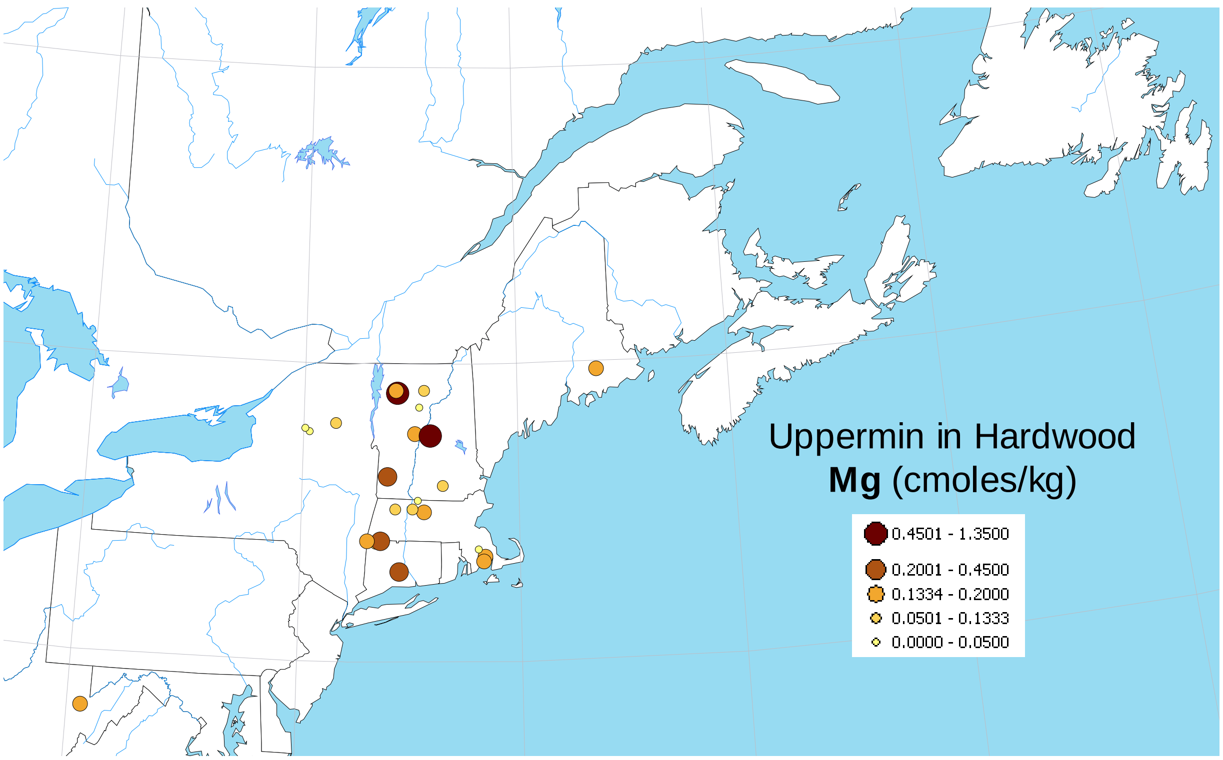

Lowermin in Softwood
Ca (cmoles/kg)
0.3001 - 0.9500
0.2001 - 0.3000
0.1501 - 0.2000
0.0751 - 0.1500
0.0500 - 0.0750

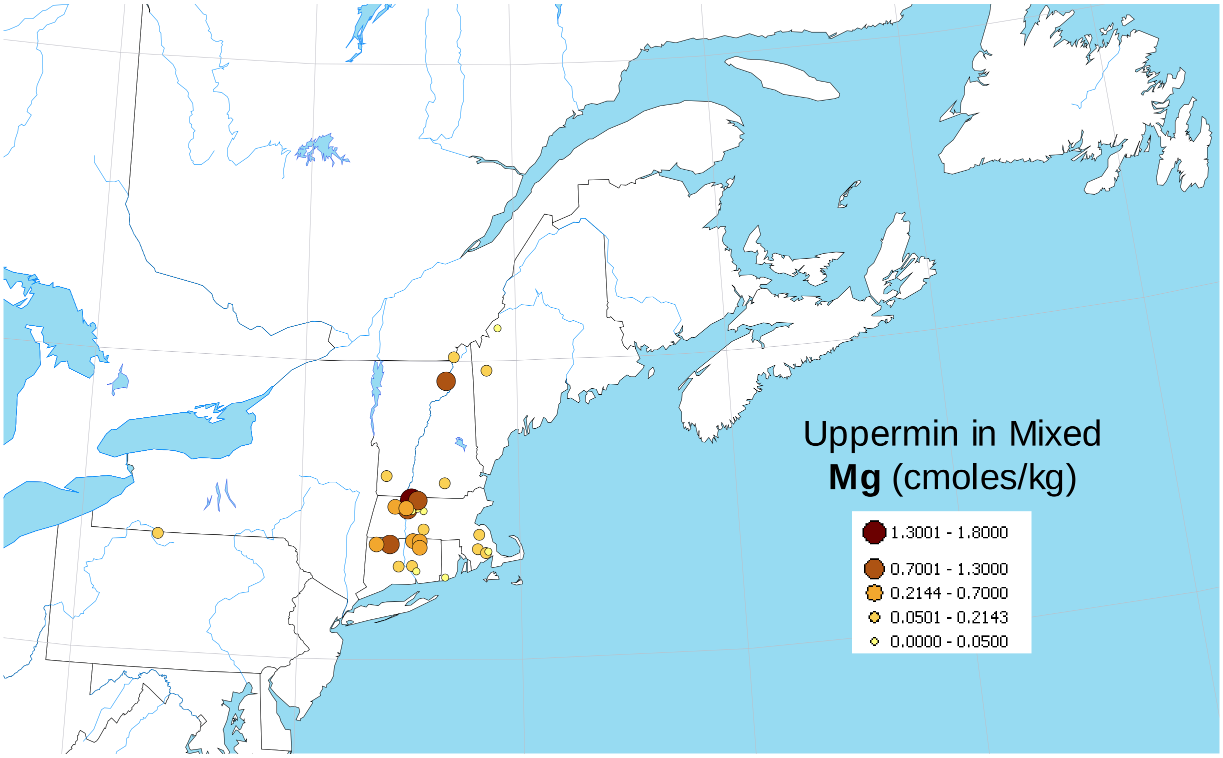
Figure 23. Maps for soil magnesium. (figure spans multiple pages)

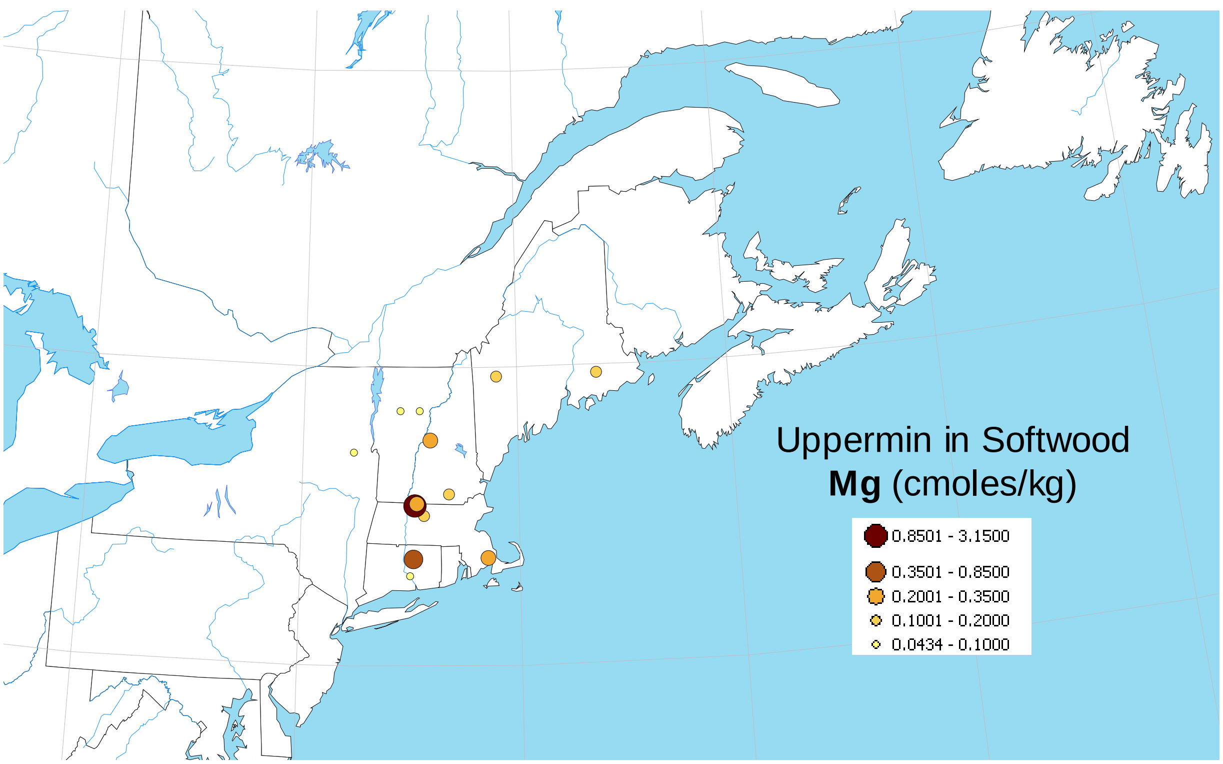


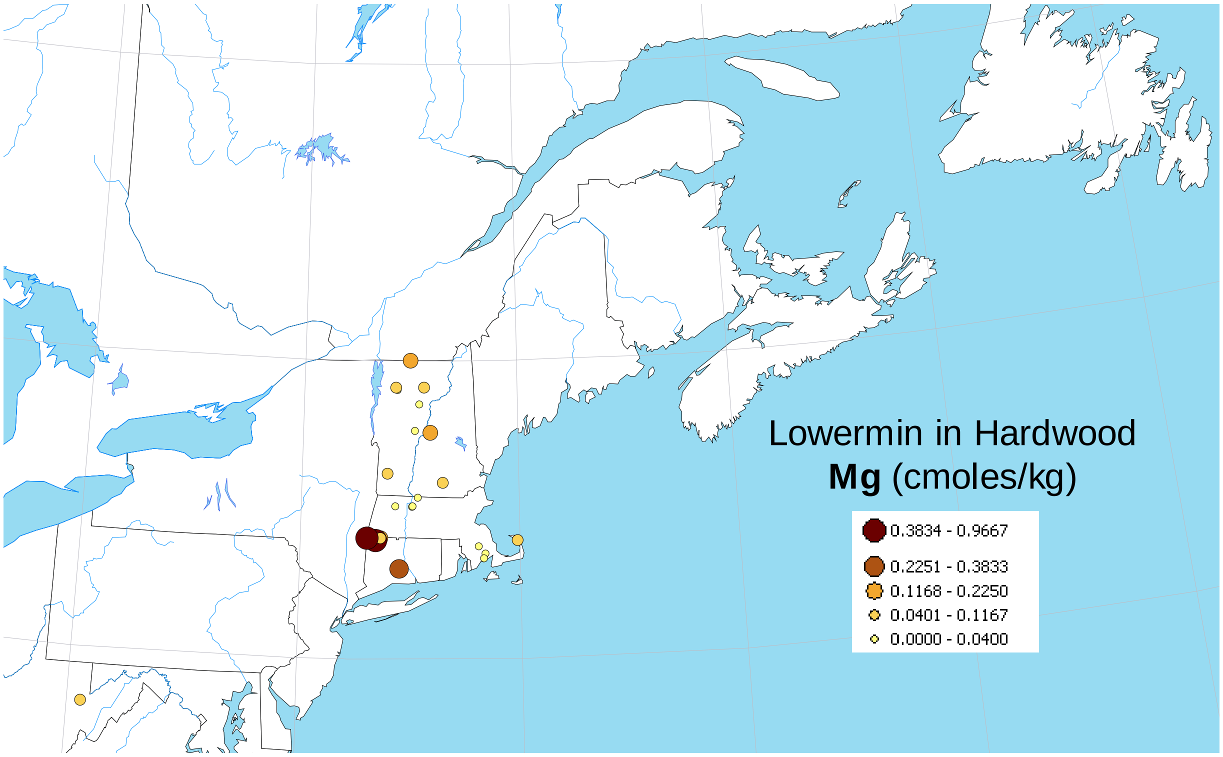


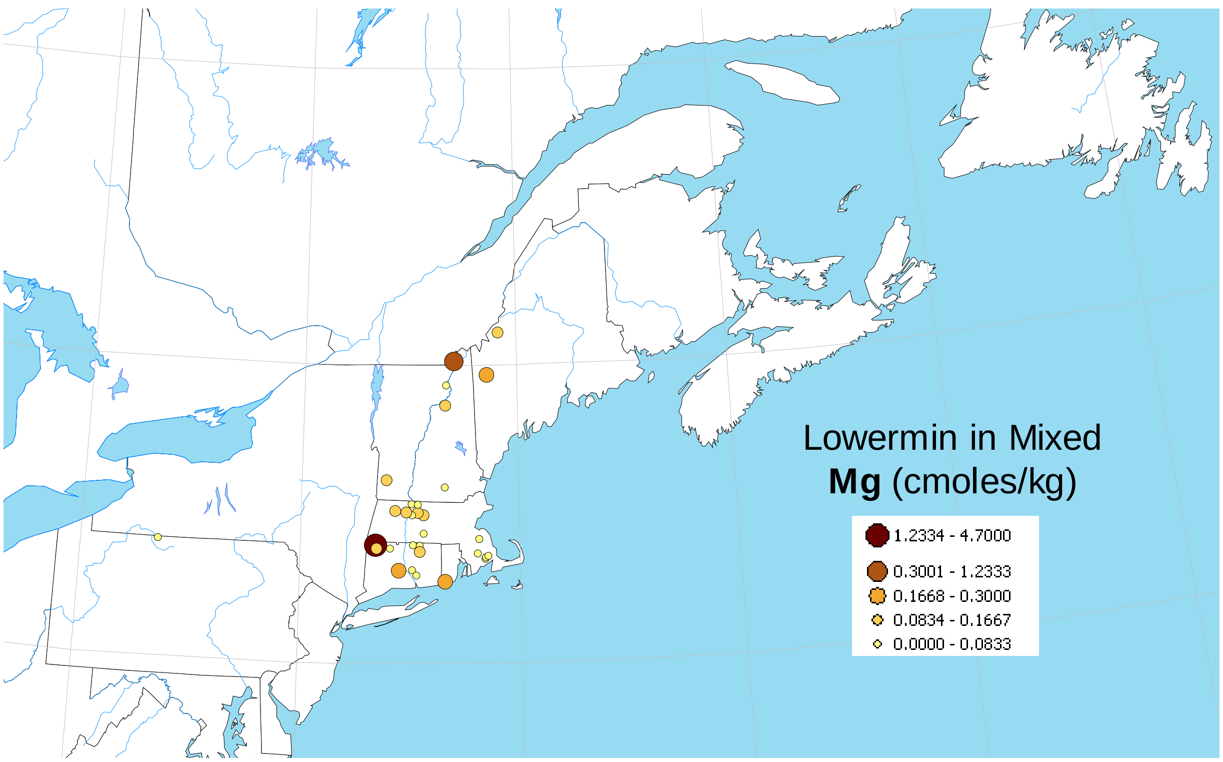

Organic in Softwood
Mg (cmoles/kg)
3.0791 - 8.6538
2.6501 - 3.0790
1.9501 - 2.6500
1.3001 - 1.9500
0.9000 - 1.3000


Uppermin in Hardwood
Mg (cmoles/kg)
0.4501 - 1.3500
0.2001 - 0.4500
0.1334 - 0.2000
0.0501 - 0.1333
0.0000 - 0.0500


Uppermin in Mixed
Mg (cmoles/kg)
1.3001 - 1.8000
0.7001 - 1.3000
0.2144 - 0.7000
0.0501 - 0.2143
0.0000 - 0.0500


Uppermin in Softwood
Mg (cmoles/kg)
0.8501 - 3.1500
0.3501 - 0.8500
0.2001 - 0.3500
0.1001 - 0.2000
0.0434 - 0.1000


Lowermin in Hardwood
Mg (cmoles/kg)
0.3834 - 0.9667
0.2251 - 0.3833
0.1168 - 0.2250
0.0401 - 0.1167
0.0000 - 0.0400


Lowermin in Mixed
Mg (cmoles/kg)
1.2334 - 4.7000
0.3001 - 1.2333
0.1668 - 0.3000
0.0834 - 0.1667
0.0000 - 0.0833

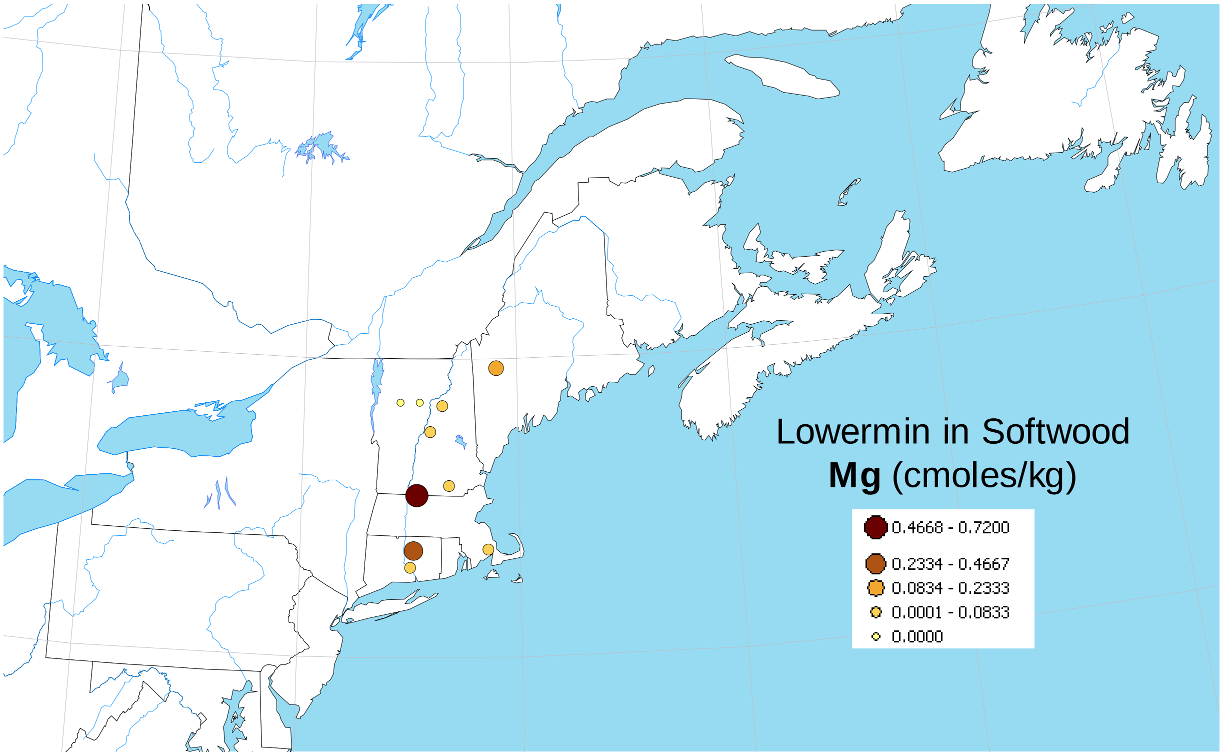
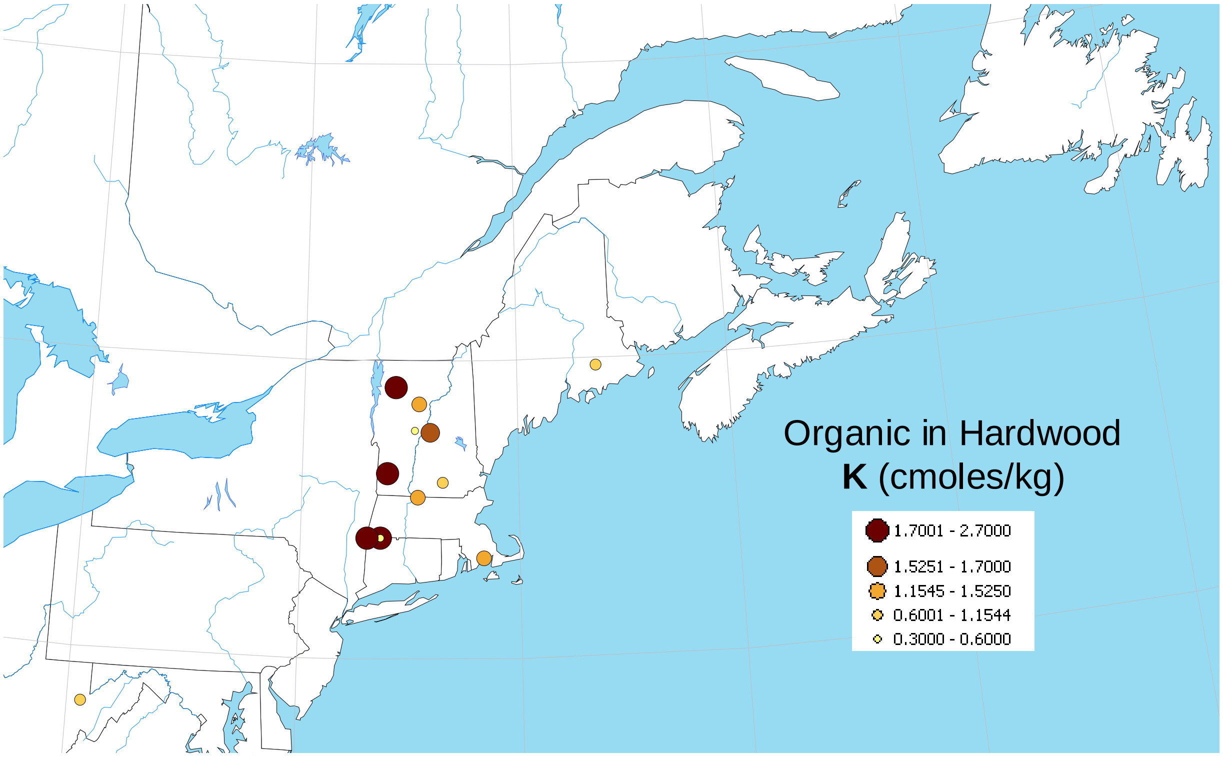
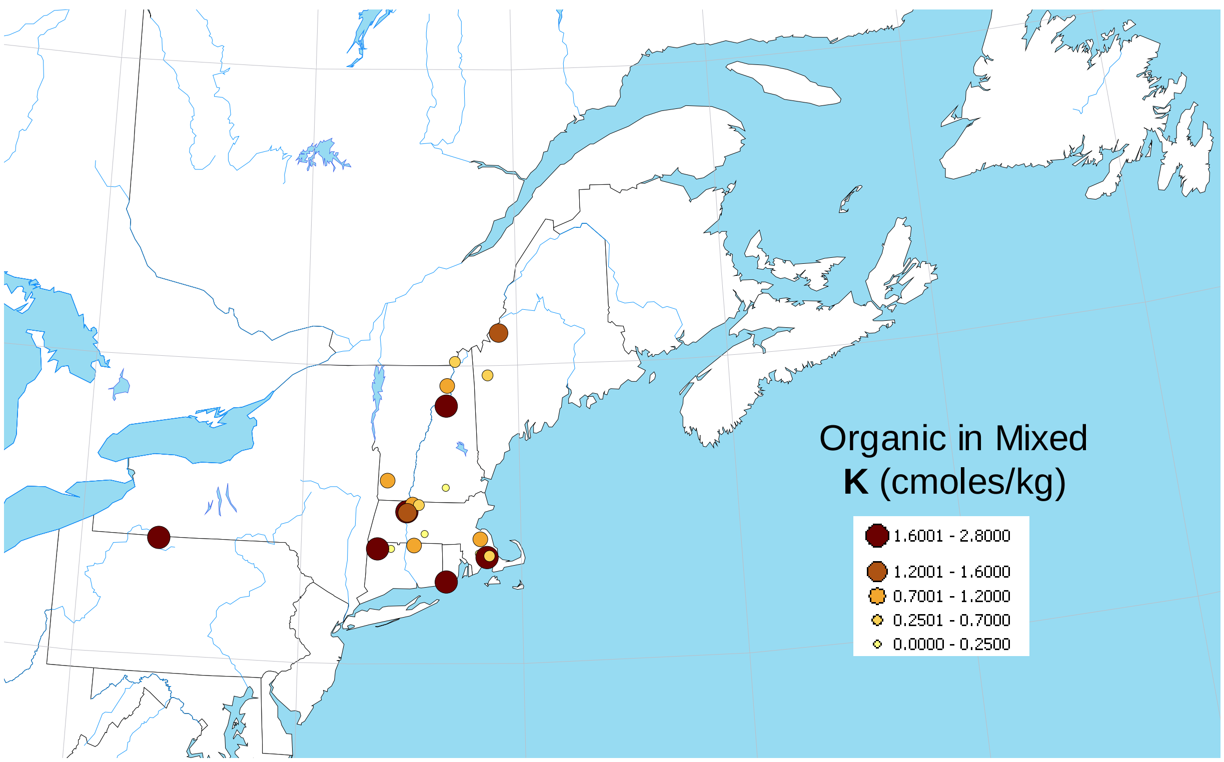
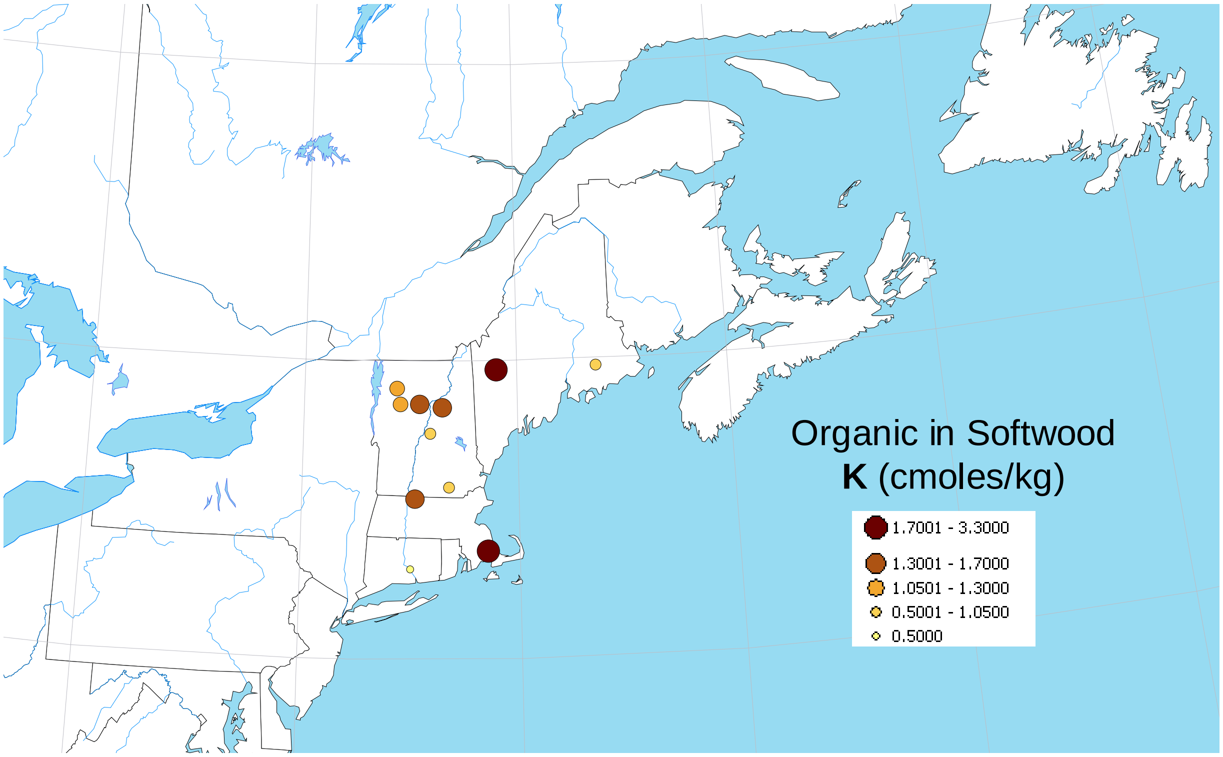
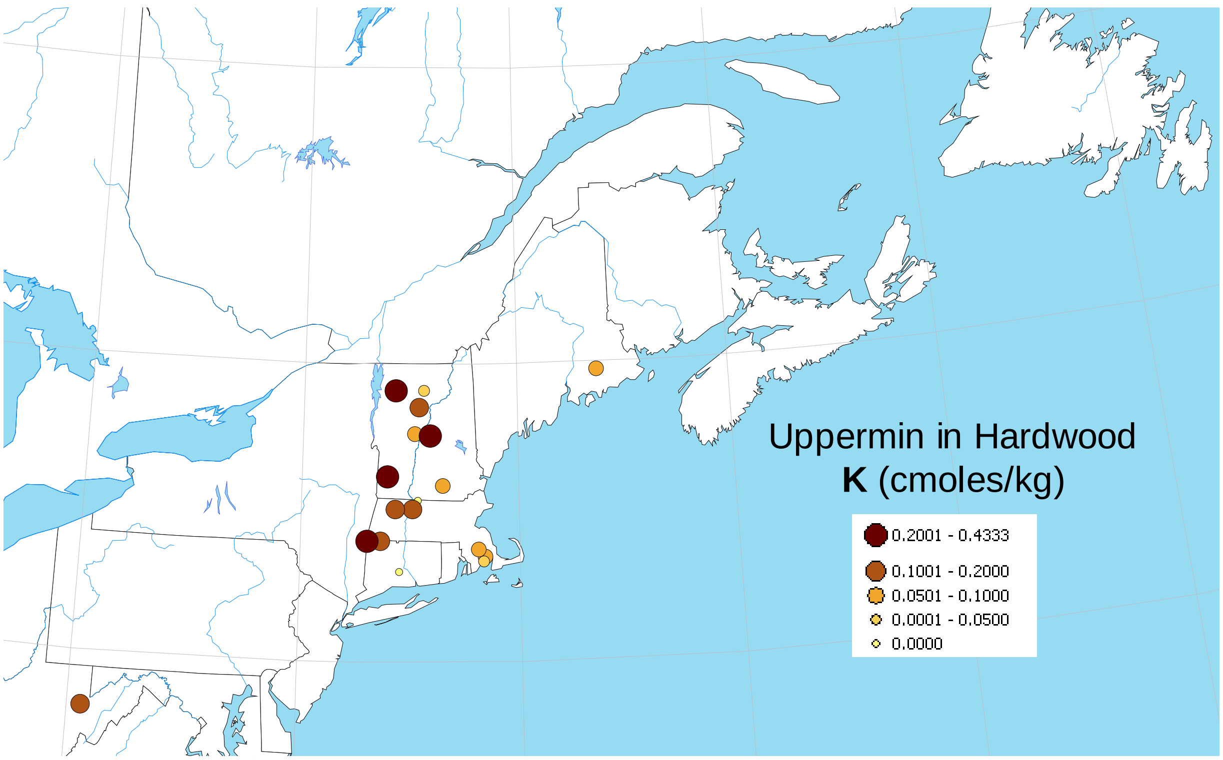

Lowermin in Softwood
Mg (cmoles/kg)
0.4668 - 0.7200
0.2334 - 0.4667
0.0834 - 0.2333
0.0001 - 0.0833
0.0000

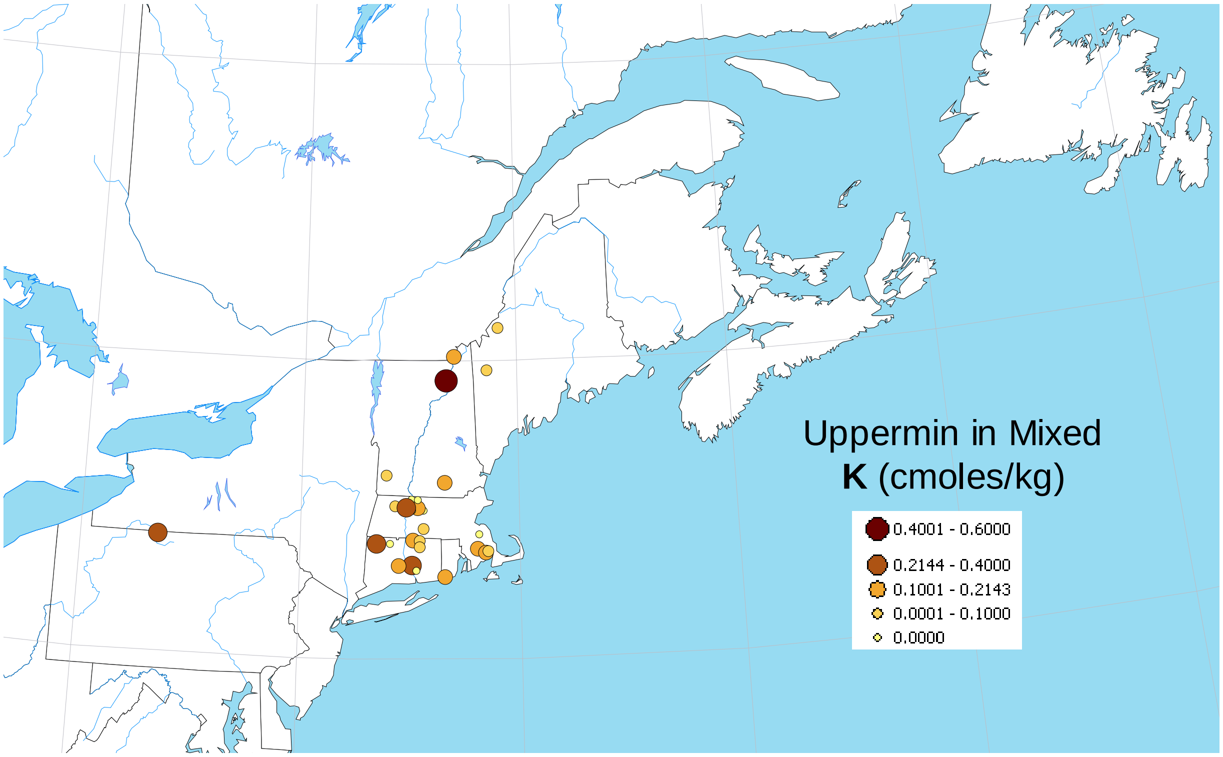
Figure 24. Maps for soil potassium. (figure spans multiple pages)

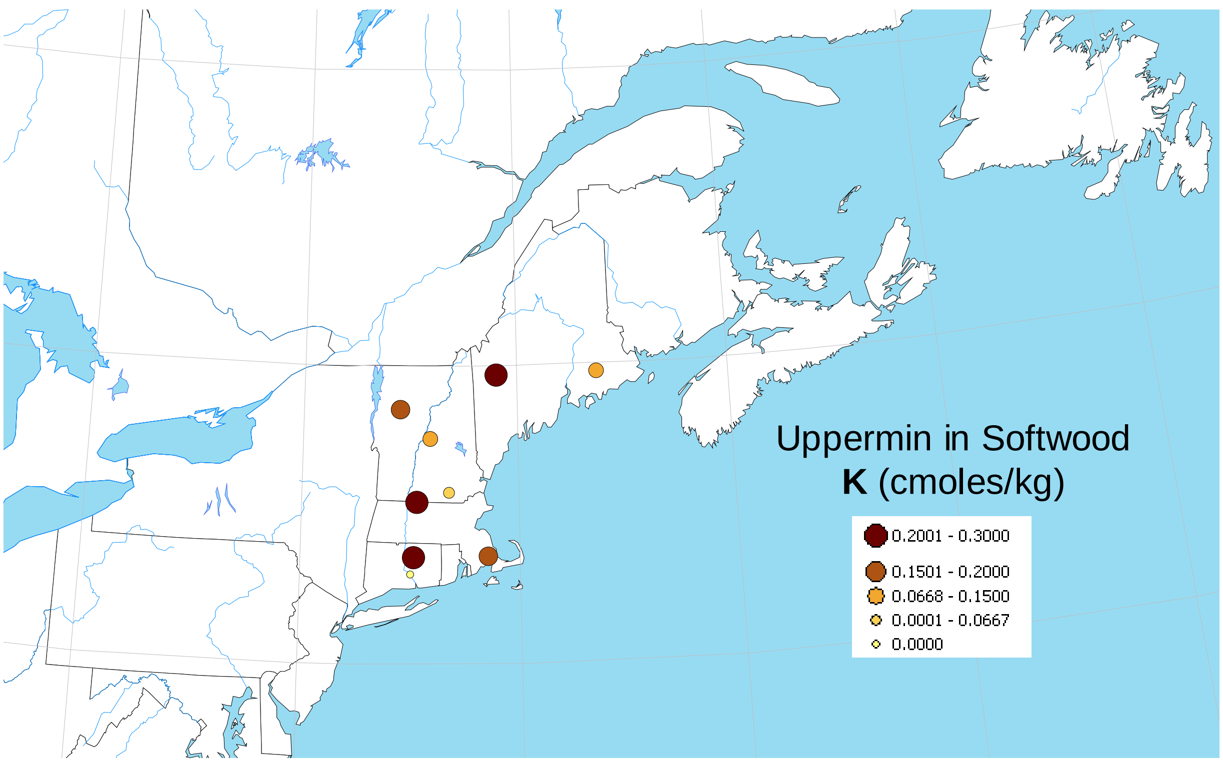


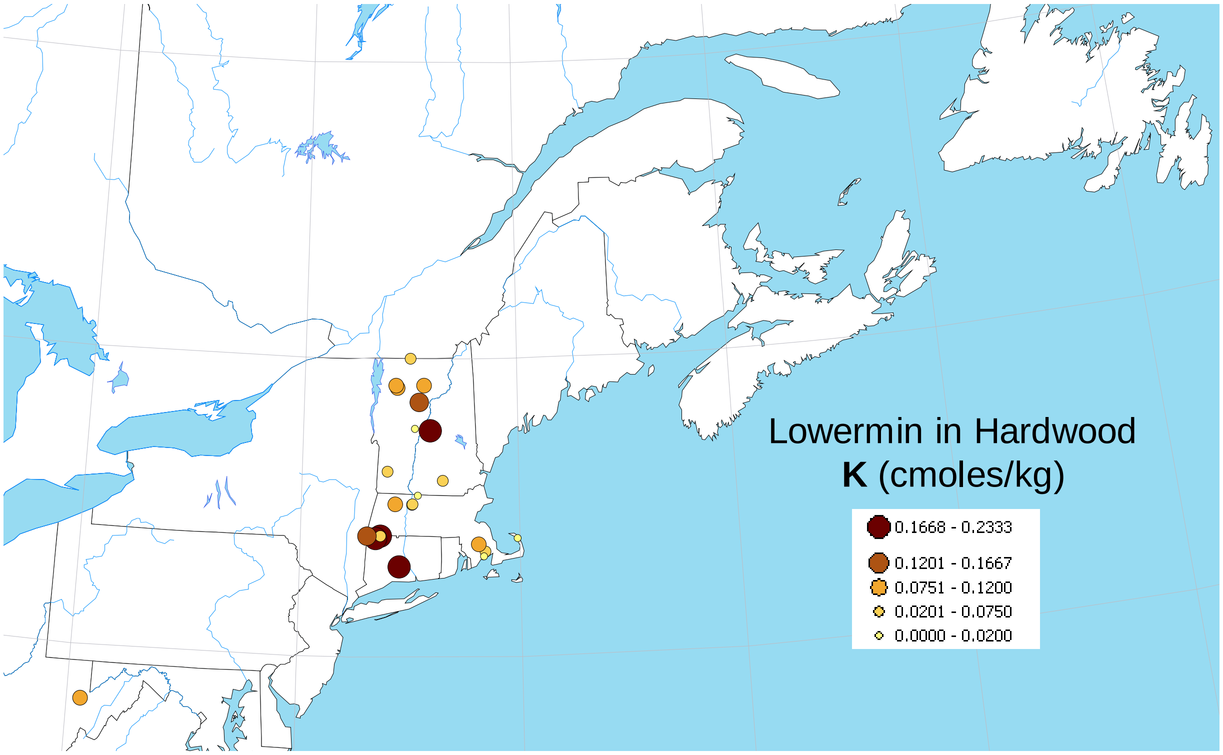


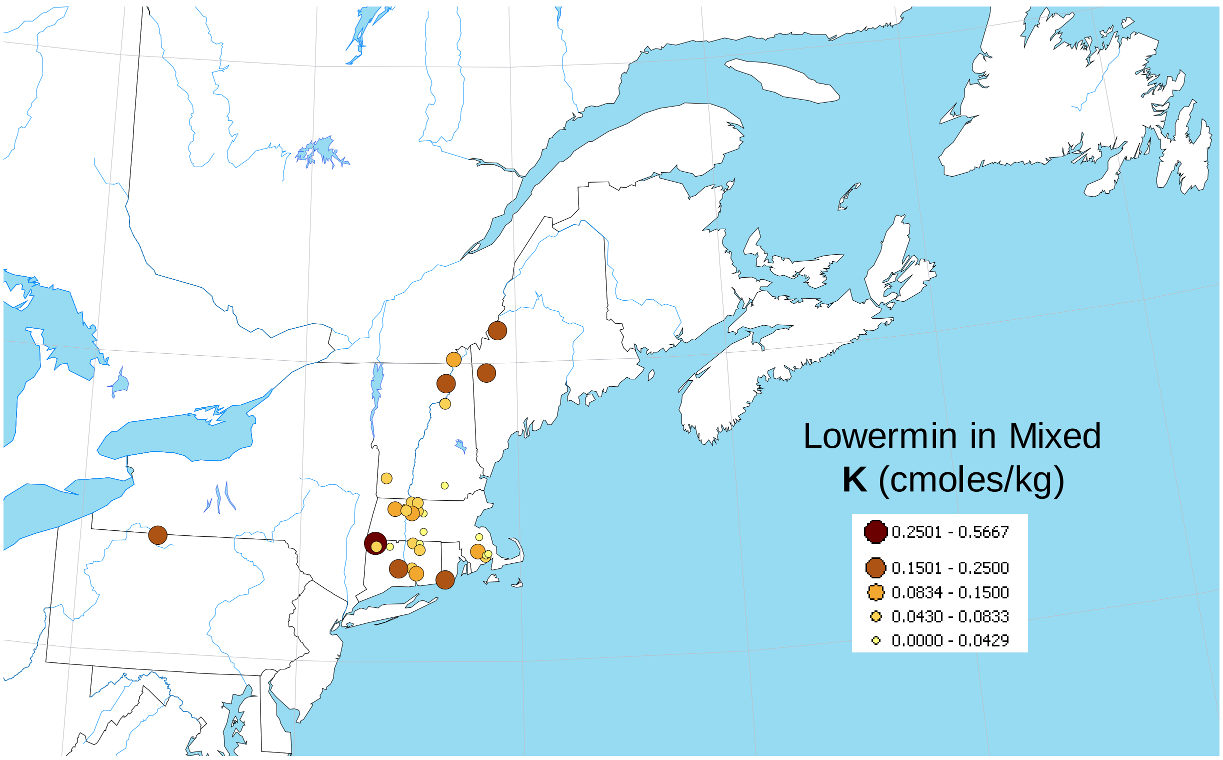

Organic in Softwood
K (cmoles/kg)
1.7001 - 3.3000
1.3001 - 1.7000
1.0501 - 1.3000
0.5001 - 1.0500
0.5000


Uppermin in Hardwood
K (cmoles/kg)
0.2001 - 0.4333
0.1001 - 0.2000
0.0501 - 0.1000
0.0001 - 0.0500
0.0000


Uppermin in Mixed
K (cmoles/kg)
0.4001 - 0.6000
0.2144 - 0.4000
0.1001 - 0.2143
0.0001 - 0.1000
0.0000


Uppermin in Softwood
K (cmoles/kg)
0.2001 - 0.3000
0.1501 - 0.2000
0.0668 - 0.1500
0.0001 - 0.0667
0.0000


Lowermin in Hardwood
K (cmoles/kg)
0.1668 - 0.2333
0.1201 - 0.1667
0.0751 - 0.1200
0.0201 - 0.0750
0.0000 - 0.0200


Lowermin in Mixed
K (cmoles/kg)
0.2501 - 0.5667
0.1501 - 0.2500
0.0834 - 0.1500
0.0430 - 0.0833
0.0000 - 0.0429

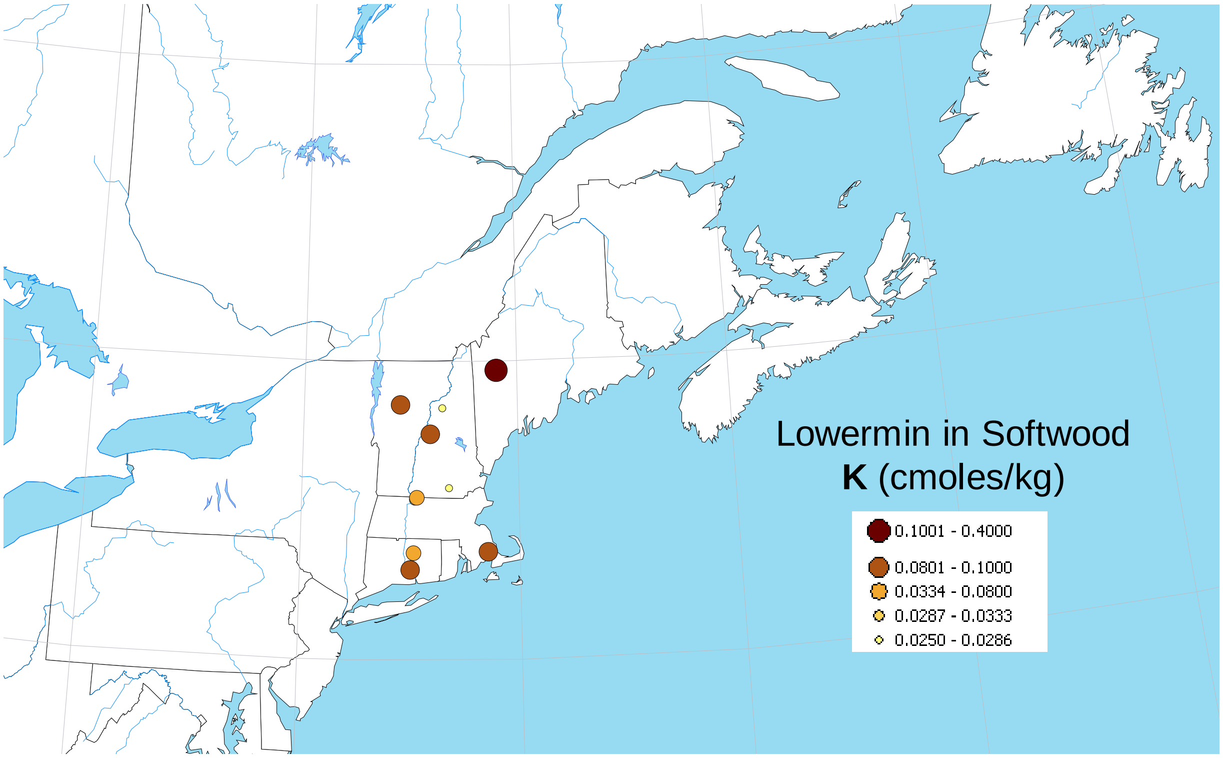
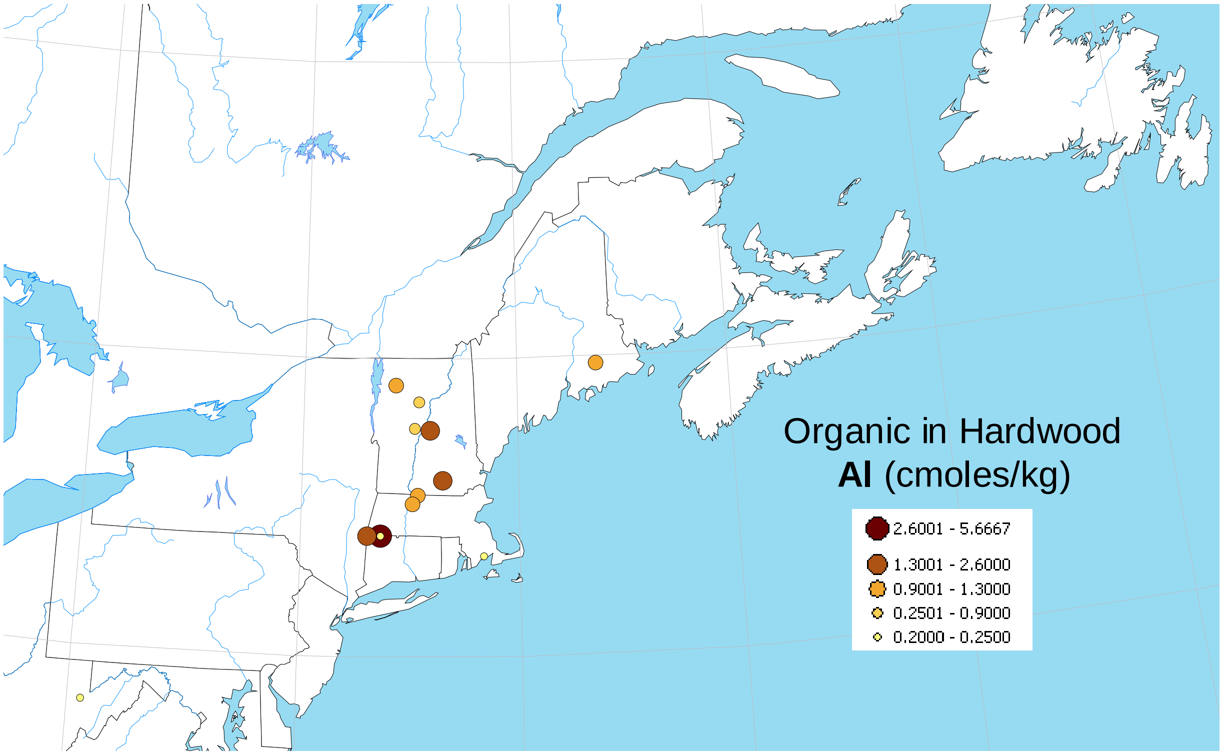
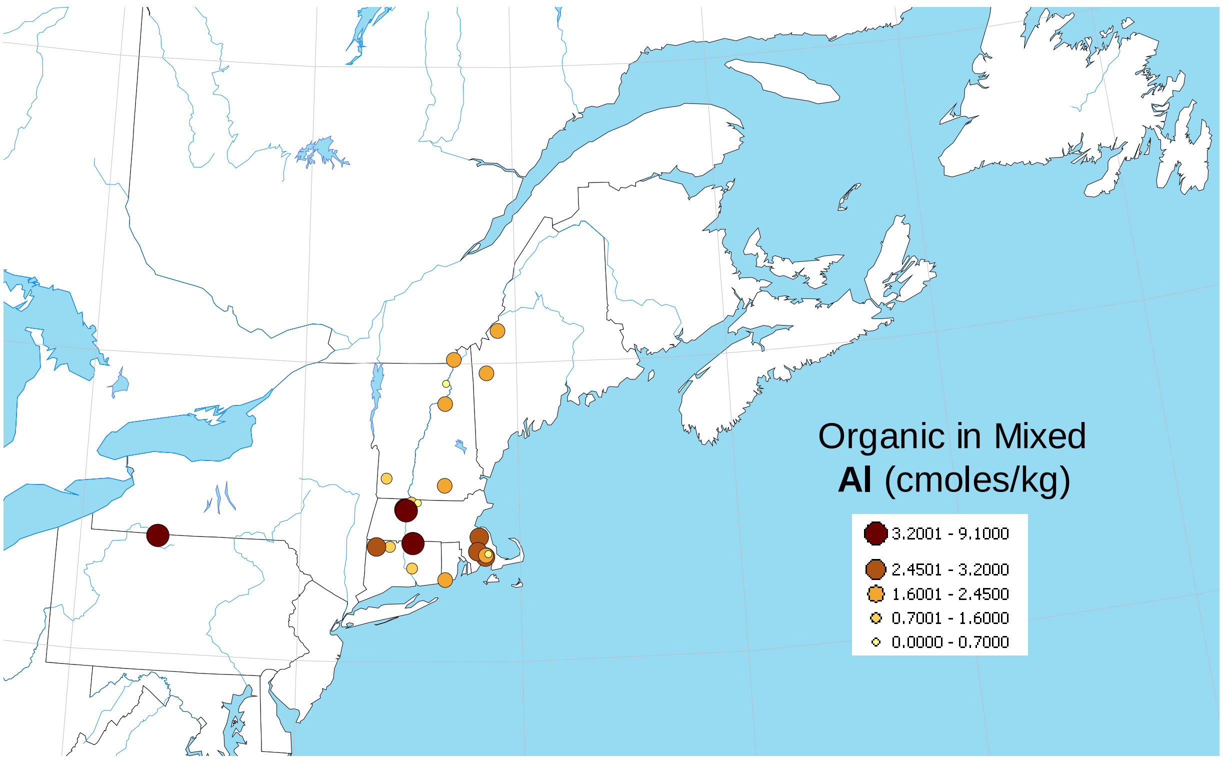
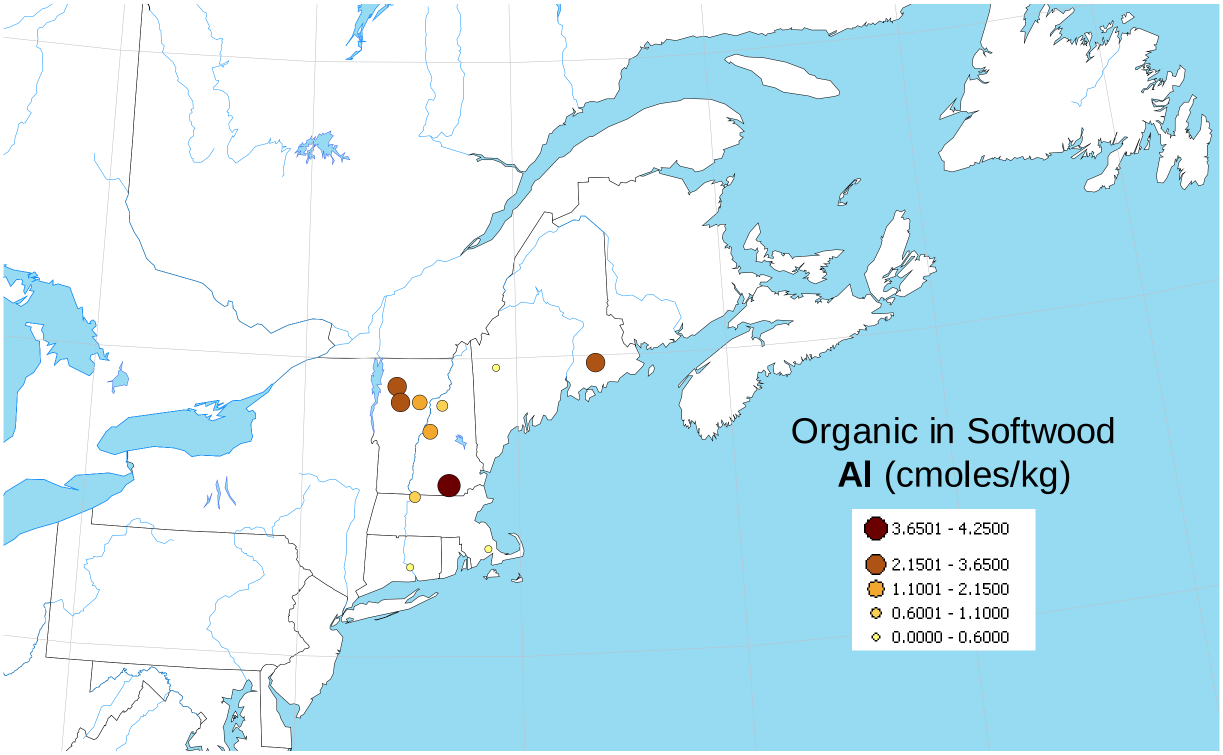
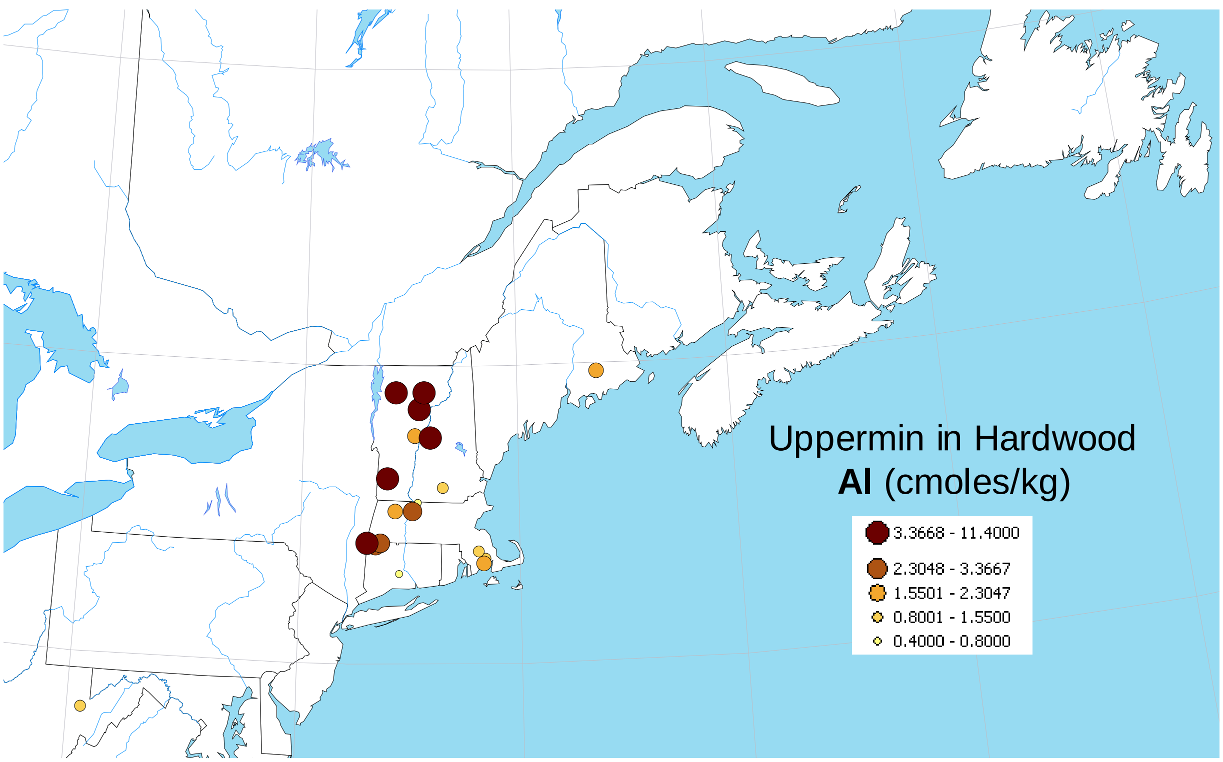

Lowermin in Softwood
K (cmoles/kg)
0.1001 - 0.4000
0.0801 - 0.1000
0.0334 - 0.0800
0.0287 - 0.0333
0.0250 - 0.0286

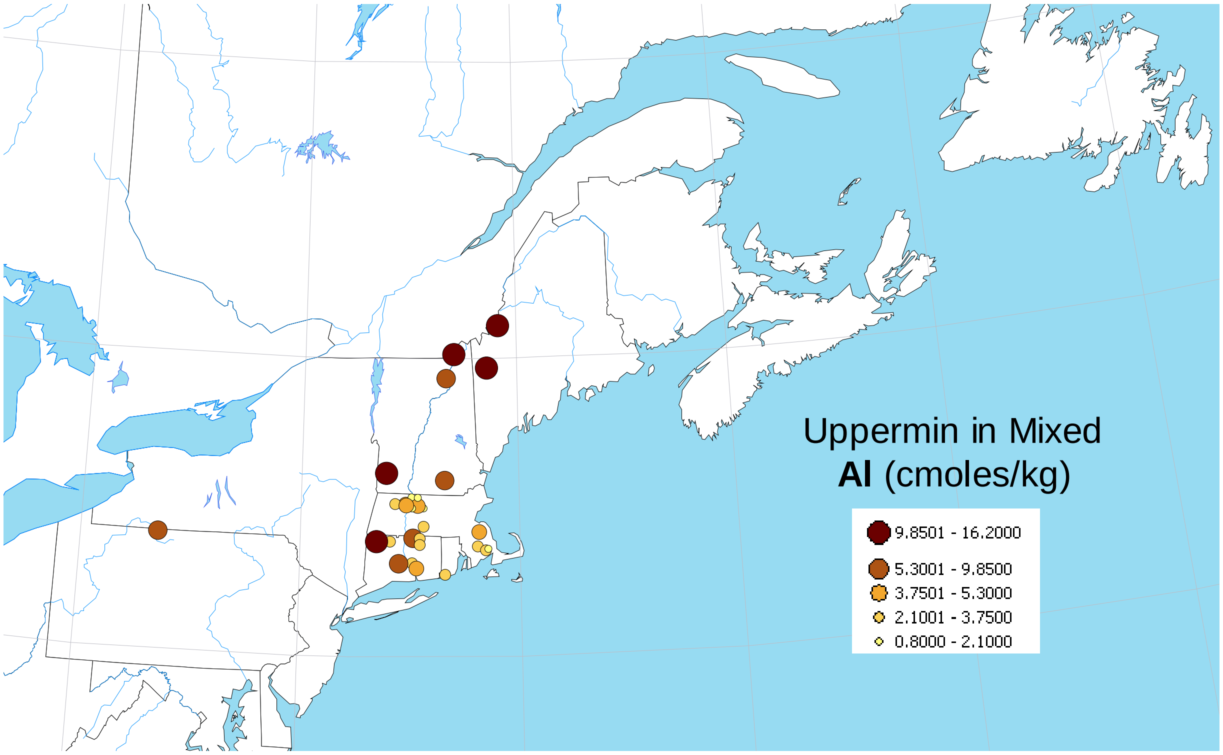
Figure 25. Maps for soil aluminum. (figure spans multiple pages)

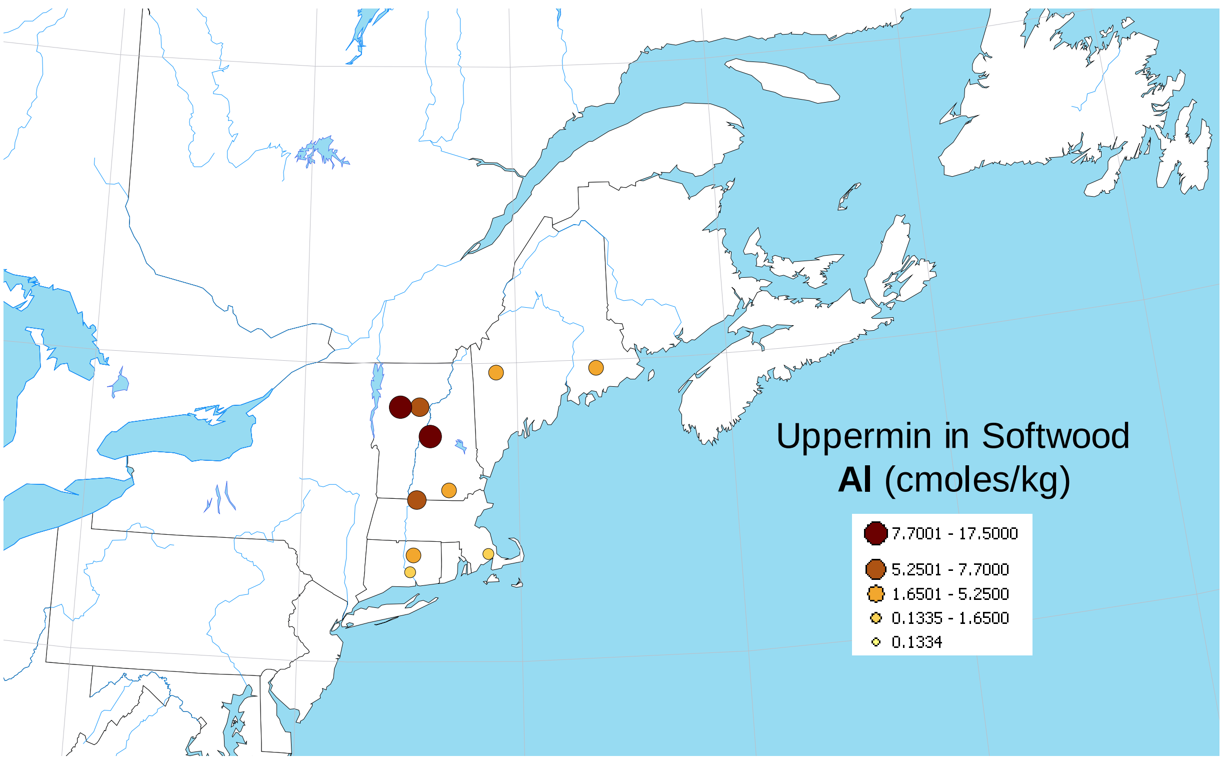


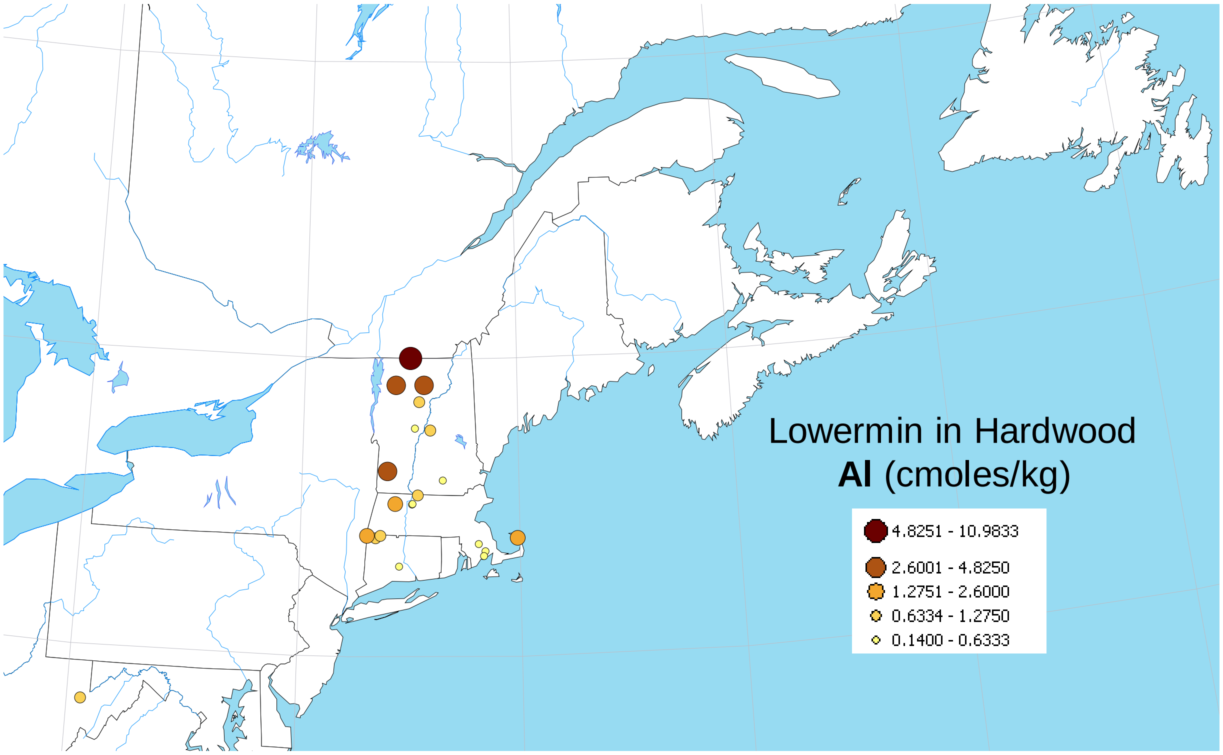


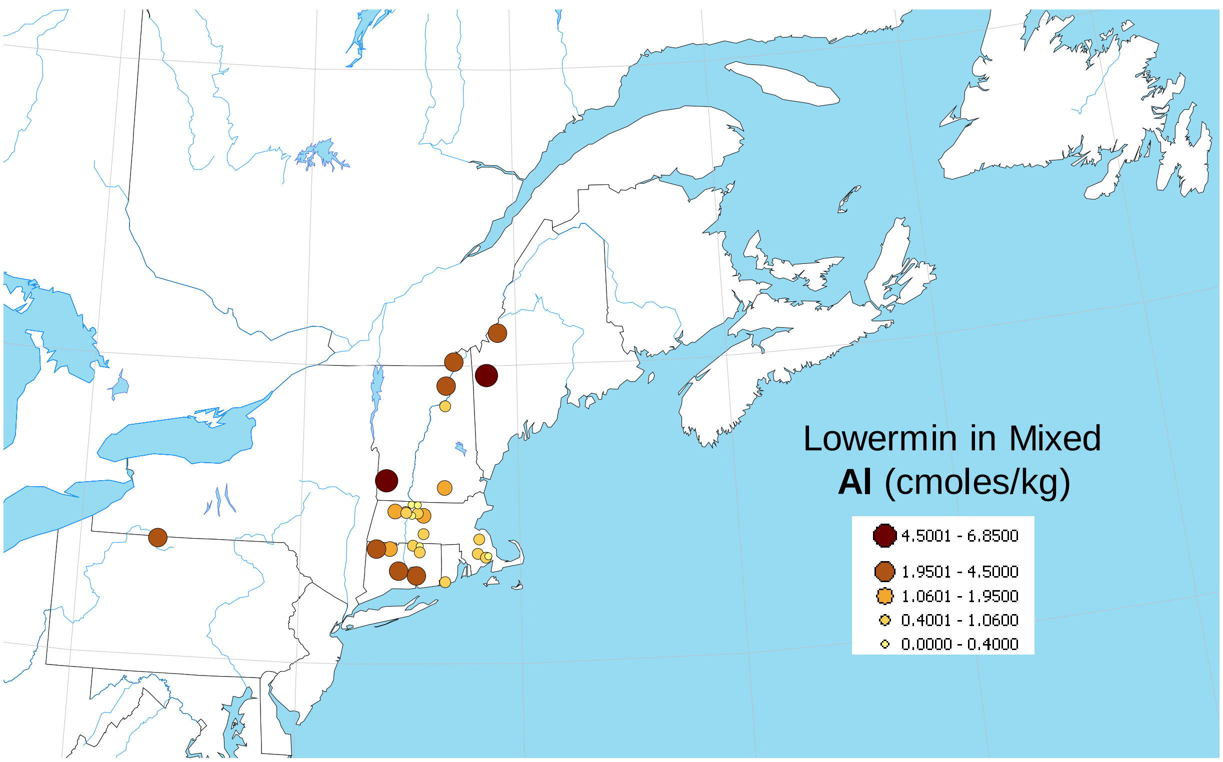

Organic in Softwood
Al (cmoles/kg)
3.6501 - 4.2500
2.1501 - 3.6500
1.1001 - 2.1500
0.6001 - 1.1000
0.0000 - 0.6000


Uppermin in Hardwood
Al (cmoles/kg)
3.3668 - 11.4000
2.3048 - 3.3667
1.5501 - 2.3047
0.8001 - 1.5500
0.4000 - 0.8000


Uppermin in Mixed
Al (cmoles/kg)
9.8501 - 16.2000
5.3001 - 9.8500
3.7501 - 5.3000
2.1001 - 3.7500
0.8000 - 2.1000


Uppermin in Softwood
Al (cmoles/kg)
7.7001 - 17.5000
5.2501 - 7.7000
1.6501 - 5.2500
0.1335 - 1.6500
0.1334


Lowermin in Hardwood
Al (cmoles/kg)
4.8251 - 10.9833
2.6001 - 4.8250
1.2751 - 2.6000
0.6334 - 1.2750
0.1400 - 0.6333


Lowermin in Mixed
Al (cmoles/kg)
4.5001 - 6.8500
1.9501 - 4.5000
1.0601 - 1.9500
0.4001 - 1.0600
0.0000 - 0.4000

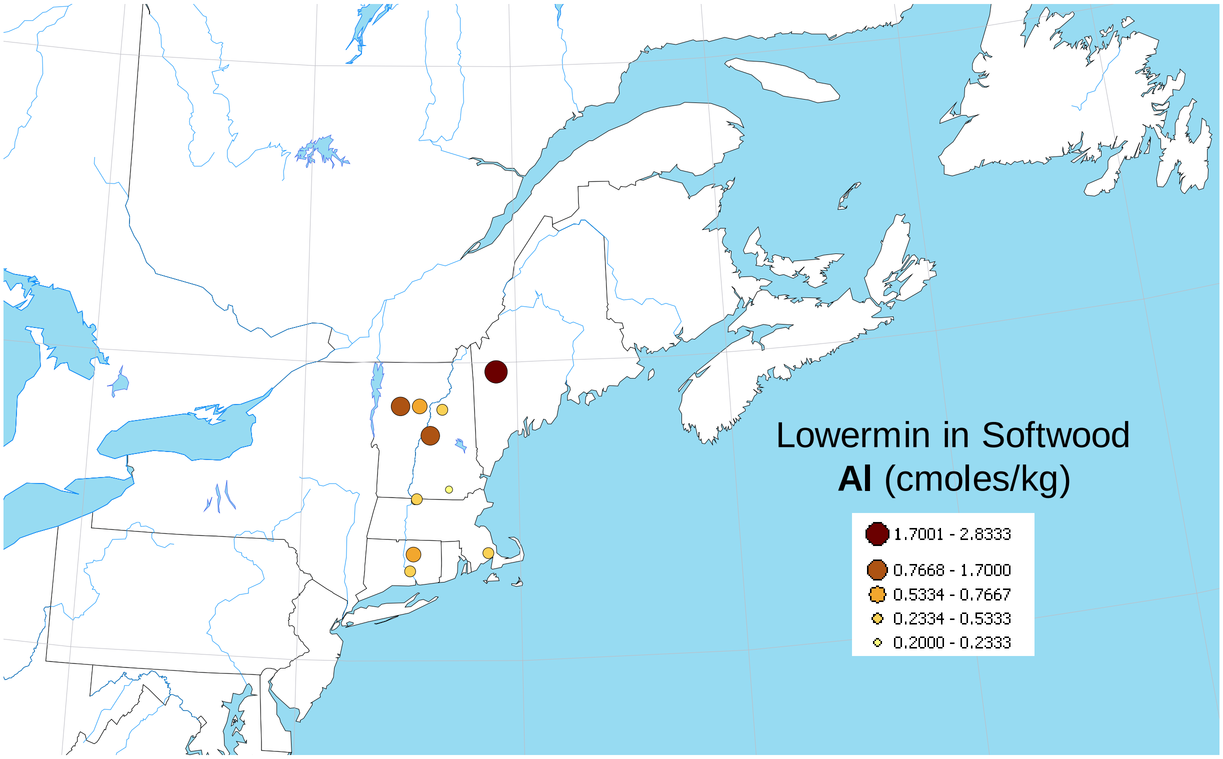
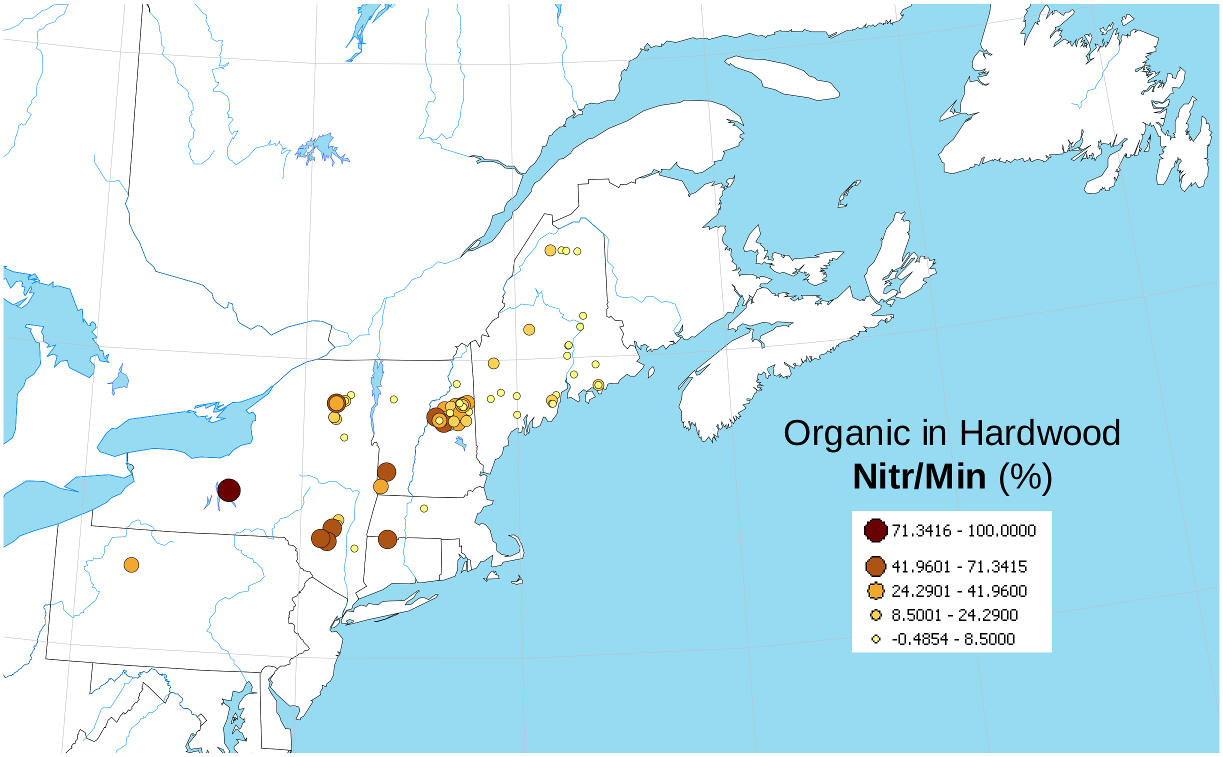
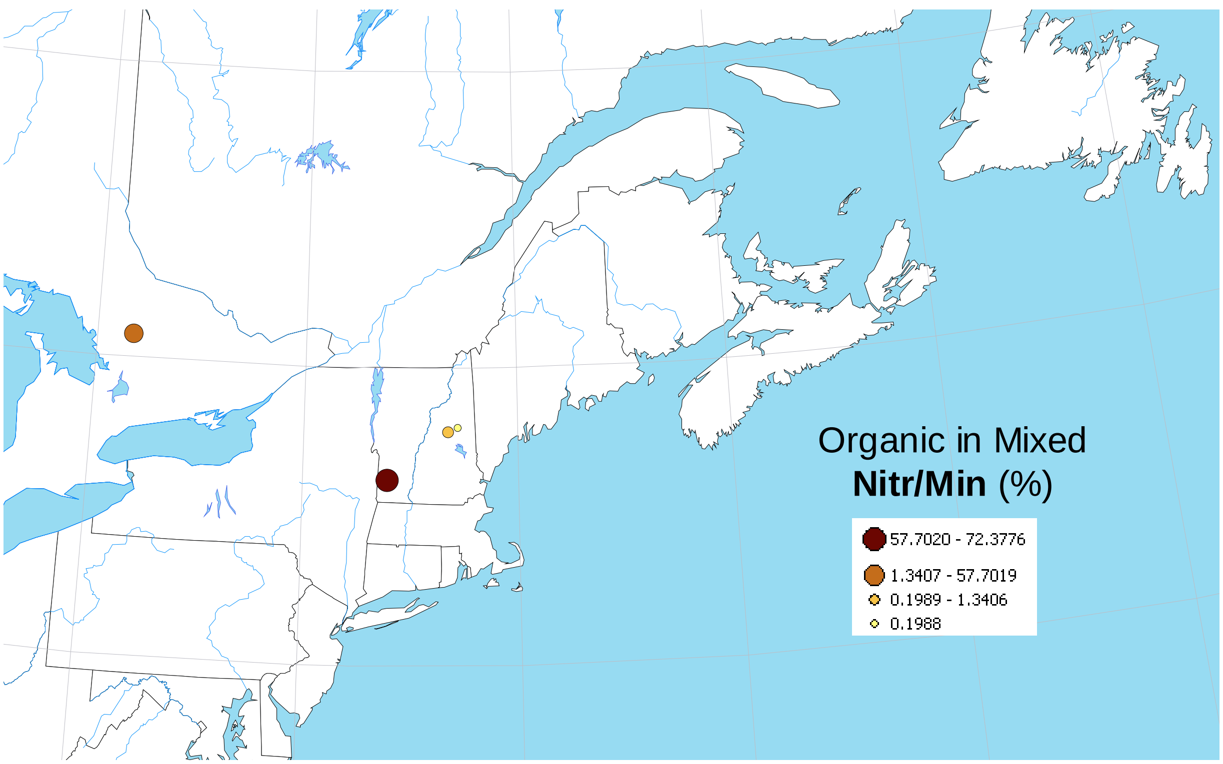
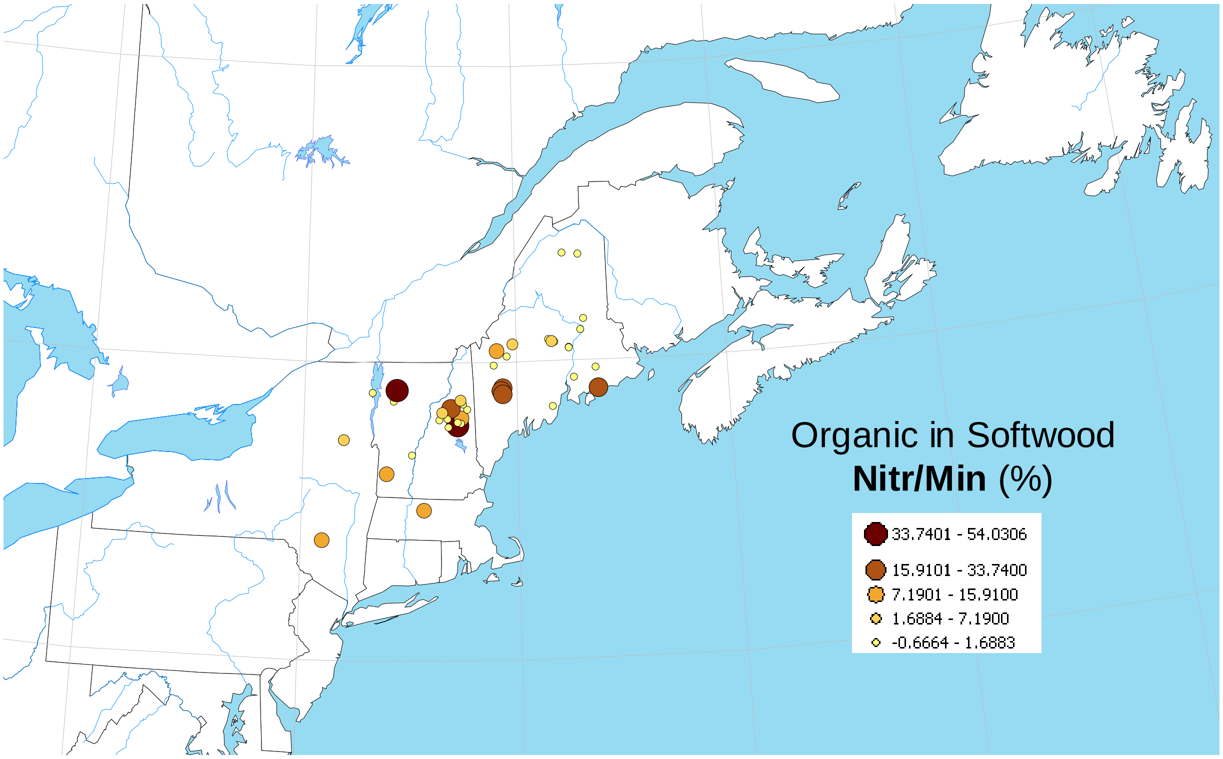
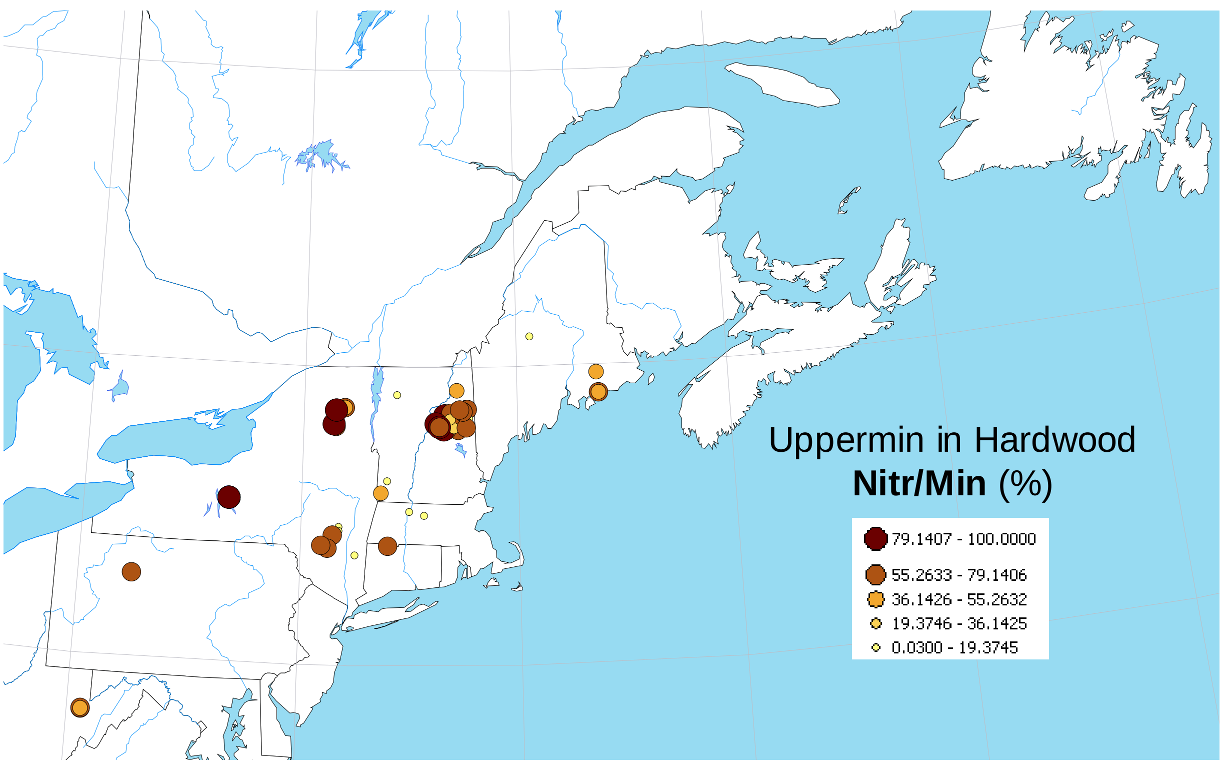

Lowermin in Softwood
Al (cmoles/kg)
1.7001 - 2.8333
0.7668 - 1.7000
0.5334 - 0.7667
0.2334 - 0.5333
0.2000 - 0.2333

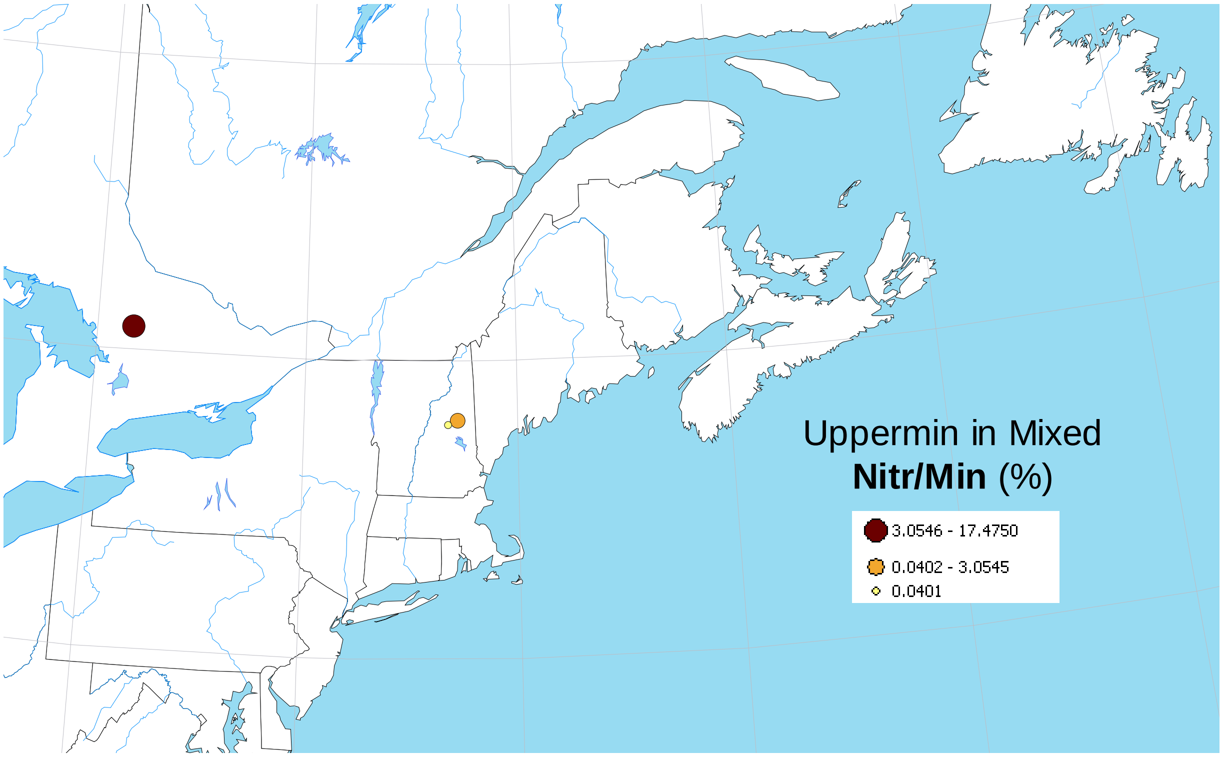
Figure 26. Maps for soil nitrification/mineralization. (figure spans multiple pages)

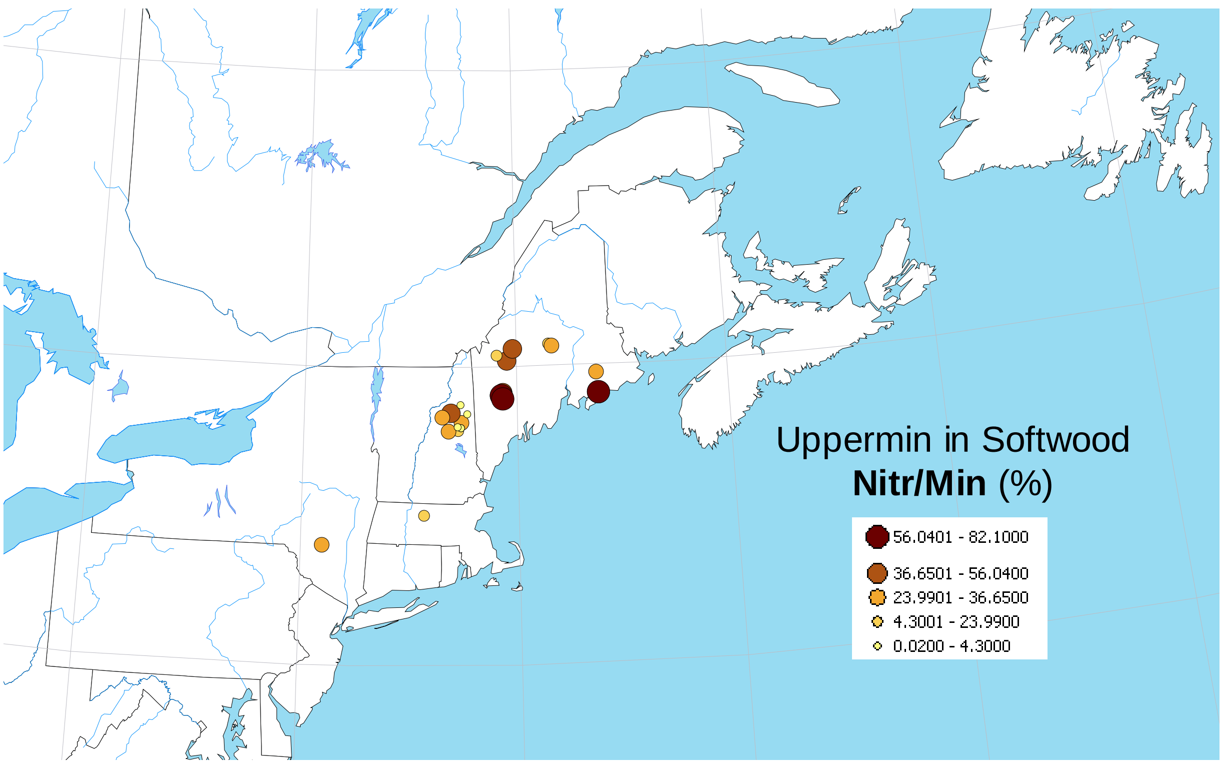





Organic in Softwood
Nitr/Min (%)
33.7401 - 54.0306
15.9101 - 33.7400
7.1901 - 15.9100
1.6884 - 7.1900
-0.6664 - 1.6883


Uppermin in Hardwood
Nitr/Min (%)
79.1407 - 100.0000
55.2633 - 79.1406
36.1426 - 55.2632
19.3746 - 36.1425
0.0300 - 19.3745


Uppermin in Mixed
Nitr/Min (%)
3.0546 - 17.4750
0.0402 - 3.0545
0.0401


Uppermin in Softwood
Nitr/Min (%)
56.0401 - 82.1000
36.6501 - 56.0400
23.9901 - 36.6500
4.3001 - 23.9900
0.0200 - 4.3000

Appendix C-4: Soil Chemistry Linear Regressions with Latitude, Longitude and Elevation

Table 2. Results of linear regression of each parameter against latitude, longitude and elevation. Trend indicates positive or negative correlation and R^2 coefficients for the relationship are given below. (table spans multiple pages)

Latitude

		Organic layer			Upper mineral layer			Lower mineral layer		
		Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood
Trend	pH	0	0	0	---	0	0	---	0	NA
	Total C	0	0	0	0	0	0	0	+++	NA
	Total N	0	0	0	0	+++	+++	+++	+++	NA
	CN ratio	+++	NA	0	0	0	0	NA	NA	NA
	Ca	NA	+++	NA	0	0	NA	0	0	NA
	Mg	NA	0	NA	0	0	NA	0	0	NA
	K	NA	0	NA	0	0	NA	0	0	NA
	Al	NA	0	NA	+++	+++	NA	+++	+++	NA
	Nitr/Min	---	NA	0	0	NA	0	NA	NA	NA
R^2	pH	0.0117	0.0001	0.0146	0.1127	0.0657	0.0069	0.1803	0.0406	NA
	Total C	0.0027	0.0433	0.0293	0.0214	0.0173	0.0104	0.0716	0.3743	NA
	Total N	0.0005	0.0010	0.0650	0.0127	0.1202	0.1256	0.3110	0.3482	NA
	CN ratio	0.1269	NA	0.0125	0.0429	0.0755	0.0063	NA	NA	NA
	Ca	NA	0.3113	NA	0.0254	0.0194	NA	0.0128	0.0265	NA
	Mg	NA	0.0083	NA	0.0199	0.0169	NA	0.0339	0.0005	NA
	K	NA	0.0050	NA	0.0004	0.0159	NA	0.0003	0.0202	NA
	Al	NA	0.0500	NA	0.1223	0.3456	NA	0.2454	0.2438	NA
	Nitr/Min	0.2161	NA	0.0017	0.0026	NA	0.0162	NA	NA	NA

Longitude

		Organic layer			Upper mineral layer			Lower mineral layer		
		Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood
Trend	pH	0	0	---	0	0	0	0	0	NA
	Total C	0	0	0	0	0	0	0	0	NA
	Total N	0	---	0	0	0	0	0	0	NA
	CN ratio	0	NA	0	0	0	0	NA	NA	NA
	Ca	NA	0	NA	0	0	NA	0	0	NA
	Mg	NA	0	NA	0	0	NA	0	0	NA
	K	NA	0	NA	0	0	NA	0	0	NA
	Al	NA	---	NA	0	0	NA	0	0	NA
	Nitr/Min	---	NA	0	0	NA	+++	NA	NA	NA

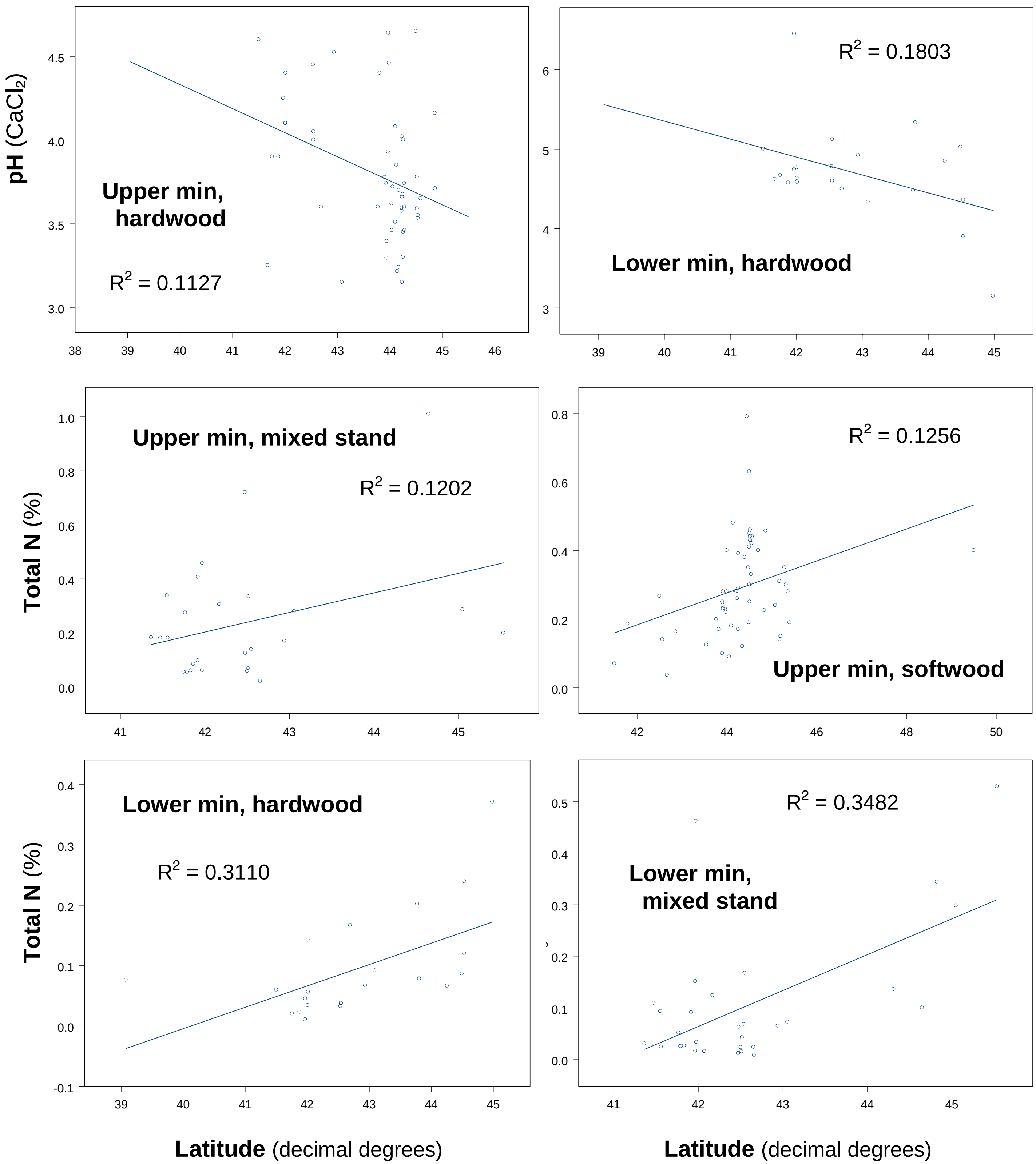
R^2	pH	0.0251	0.0404	0.1069	0.0411	0.0086	0.0053	0.0168	0.0074	NA
	Total C	0.0286	0.0000	0.0076	0.0076	0.0069	0.0078	0.0657	0.0066	NA
	Total N	0.0153	0.1119	0.0215	0.0004	0.0502	0.0031	0.0026	0.0038	NA
	CN ratio	0.0150	NA	0.0074	0.0904	0.0463	0.0132	NA	NA	NA
	Ca	NA	0.0016	NA	0.0018	0.0264	NA	0.0082	0.0315	NA
	Mg	NA	0.0021	NA	0.0006	0.0090	NA	0.0278	0.0089	NA
	K	NA	0.0687	NA	0.0767	0.0817	NA	0.0637	0.0414	NA
	Al	NA	0.1801	NA	0.0112	0.0181	NA	0.0027	0.0339	NA
	Nitr/Min	0.3423	NA	0.0360	0.0506	NA	0.1554	NA	NA	NA

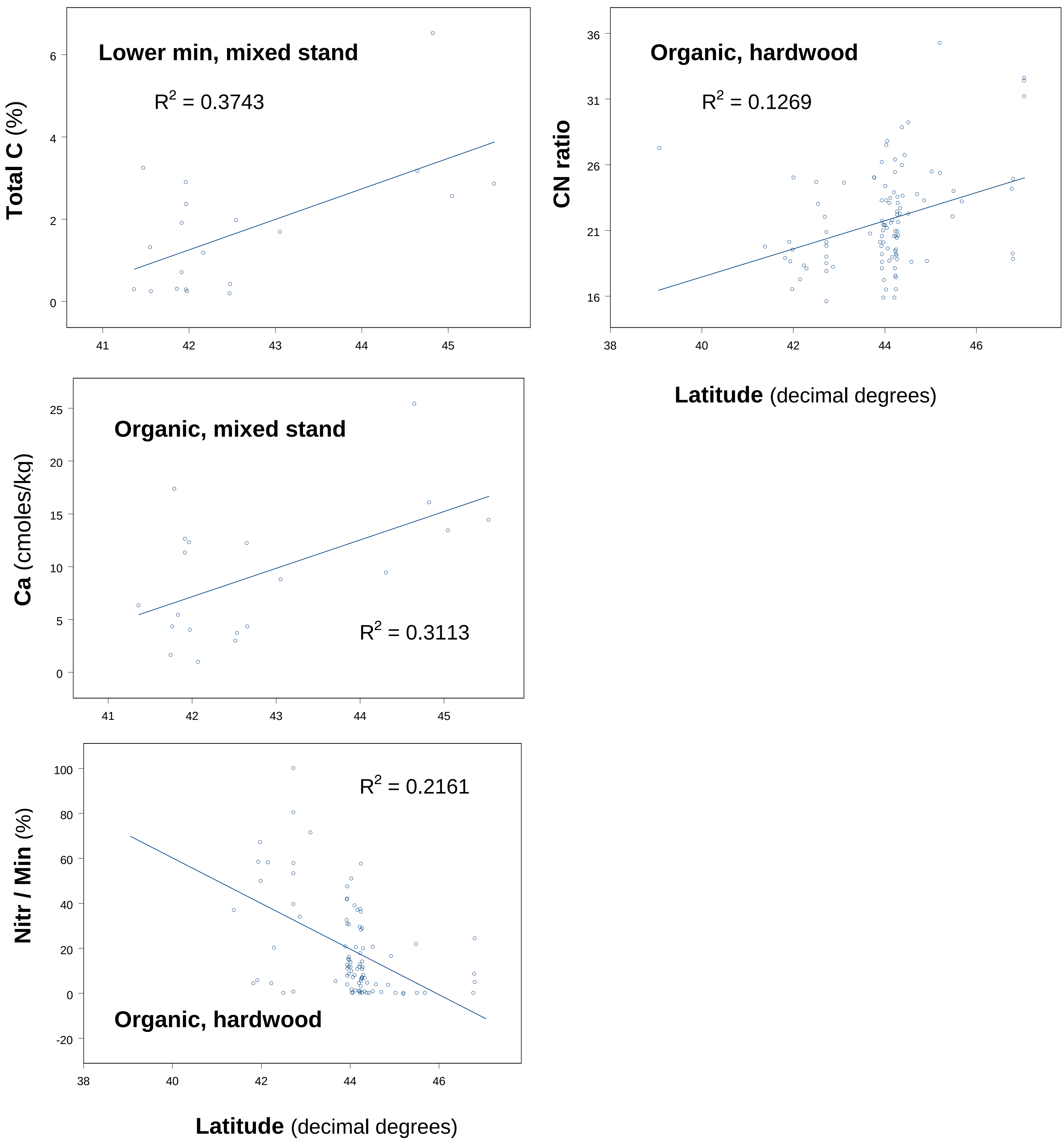
Elevation

		Organic layer			Upper mineral layer			Lower mineral layer		
		Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood	Hardwood	Mixed	Softwood
Trend	pH	0	0	**---**	**---**	0	0	0	0	NA
	Total C	0	0	0	0	0	**+++**	**+++**	**+++**	NA
	Total N	0	**+++**	0	0	0	**+++**	**+++**	**+++**	NA
	CN ratio	0	NA	**---**	0	0	0	NA	NA	NA
	Ca	NA	**+++**	NA	0	0	NA	0	0	NA
	Mg	NA	0	NA	0	0	NA	0	0	NA
	K	NA	0	NA	**+++**	0	NA	0	0	NA
	Al	NA	0	NA	**+++**	**+++**	NA	**+++**	**+++**	NA
	Nitr/Min	0	NA	0	0	NA	0	NA	NA	NA
R^2	pH	0.0121	0.0309	0.2036	0.1409	0.0186	0.0879	0.0718	0.0059	NA
	Total C	0.0968	0.0805	0.0077	0.0202	0.0148	0.1480	0.3817	0.1693	NA
	Total N	0.0142	0.1099	0.0558	0.0247	0.0637	0.2101	0.2385	0.2780	NA
	CN ratio	0.0498	NA	0.2132	0.0047	0.0017	0.0334	NA	NA	NA
	Ca	NA	0.1925	NA	0.0281	0.0086	NA	0.0006	0.0047	NA
	Mg	NA	0.0000	NA	0.0240	0.0022	NA	0.0171	0.0892	NA
	K	NA	0.0182	NA	0.2740	0.0223	NA	0.0427	0.0597	NA
	Al	NA	0.0173	NA	0.3220	0.4691	NA	0.2820	0.3158	NA
	Nitr/Min	0.0121	NA	0.0175	0.0009	NA	0.0027	NA	NA	NA

‘**---**’ indicates a significant negative relationship with an r2 >0.10.
‘**+++**’ indicates a significant positive relationship with r2 >0.10.
‘0’ indicates either no significant relationship or significant with an r2 < 0.10.

Figure 27. Graphs of parameters with strongest trends with latitude. (figure spans multiple pages)




Lower min, mixed stand
R2 = 0.3743
Total C (%)
0
2
4
6
41
42
43
44
45
Organic, hardwood
R2 = 0.1269
CN ratio
16
21
26
31
36
38
40
42
44
46
Latitude (decimal degrees)
Organic, mixed stand
R2 = 0.3113
Ca (cmoles/kg)
0
5
10
15
20
25
41
42
43
44
45
R2 = 0.2161
Organic, hardwood
Nitr / Min (%)
-20
0
20
40
60
80
100
38
40
42
44
46
Latitude (decimal degrees)

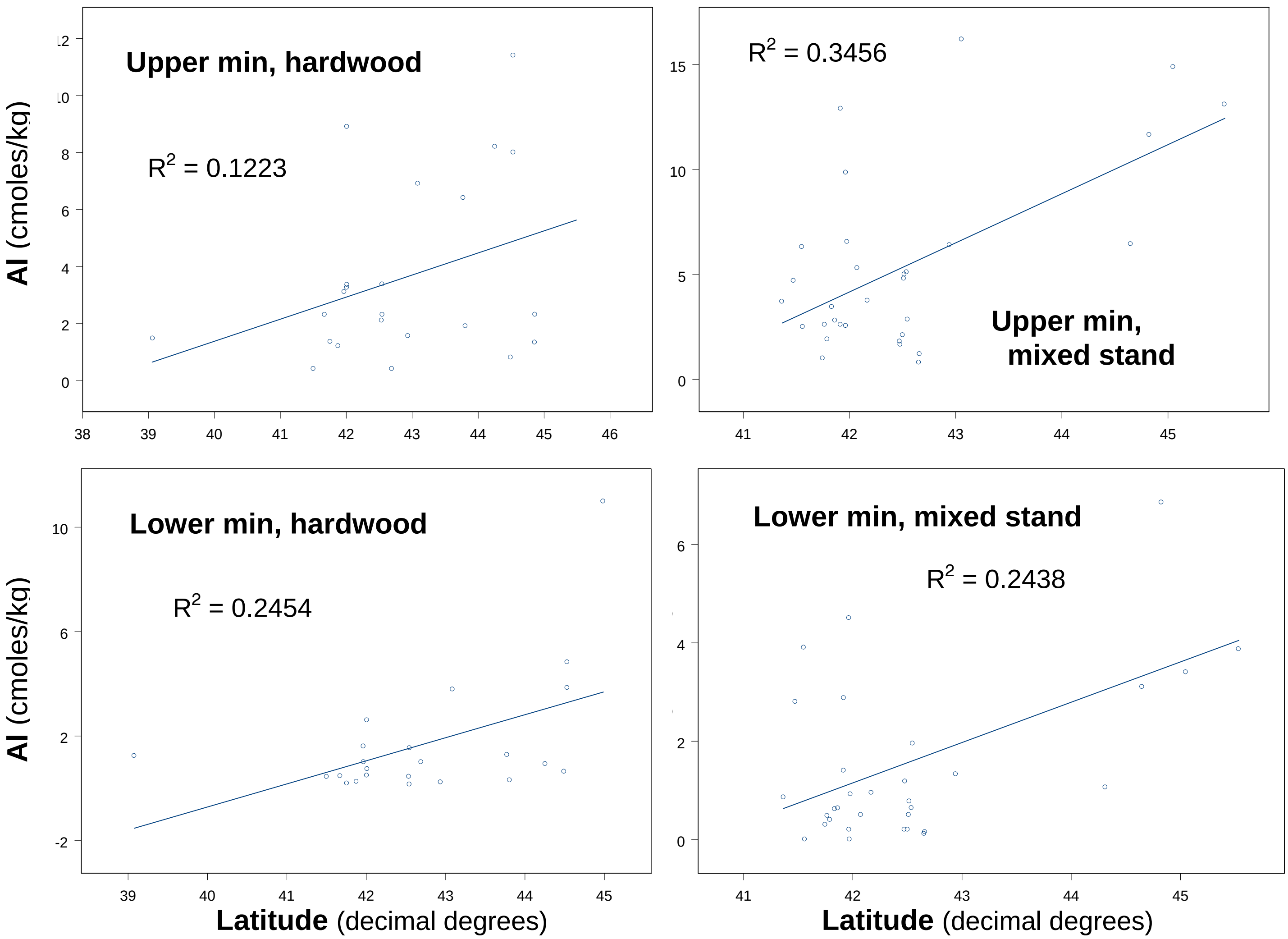

Upper min, hardwood
R2 = 0.1223
R2 = 0.3456
Upper min, mixed stand
Lower min, hardwood
R2 = 0.2454
Lower min, mixed stand
R2 = 0.2438
Al (cmoles/kg)
Al (cmoles/kg)
Latitude (decimal degrees)
Latitude (decimal degrees)

Figure 28. Graphs of parameters with strongest trends with longitude.

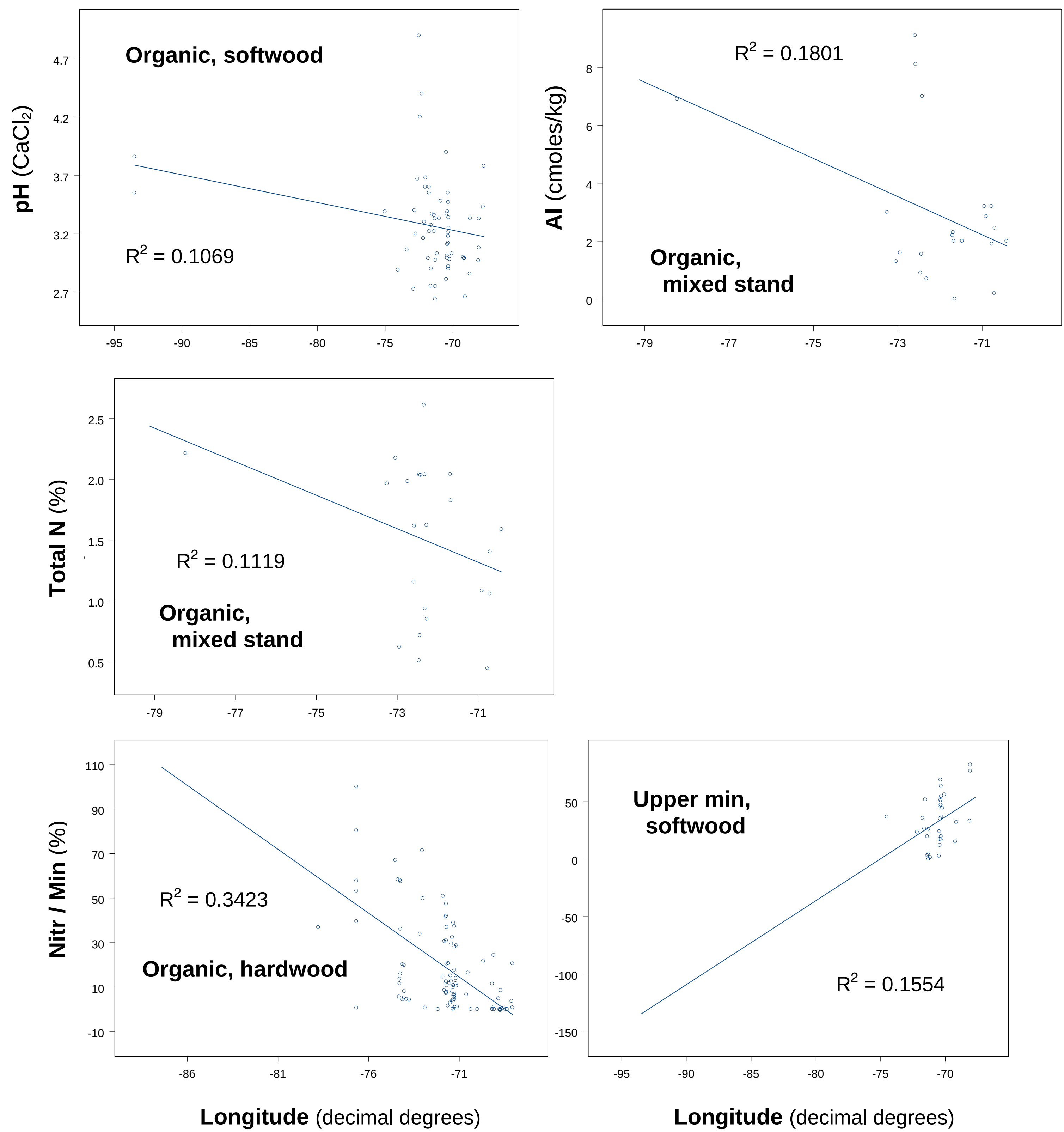
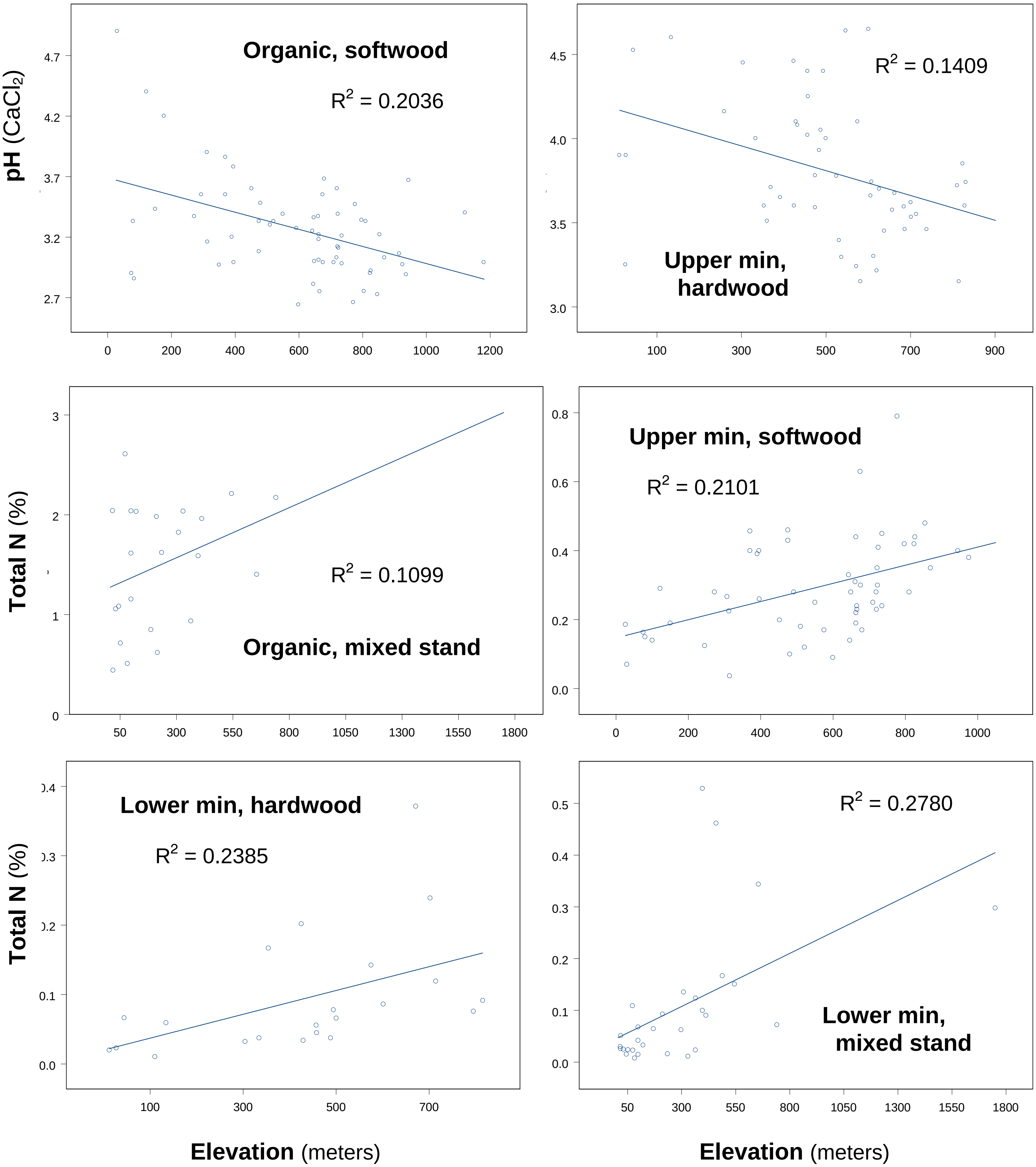
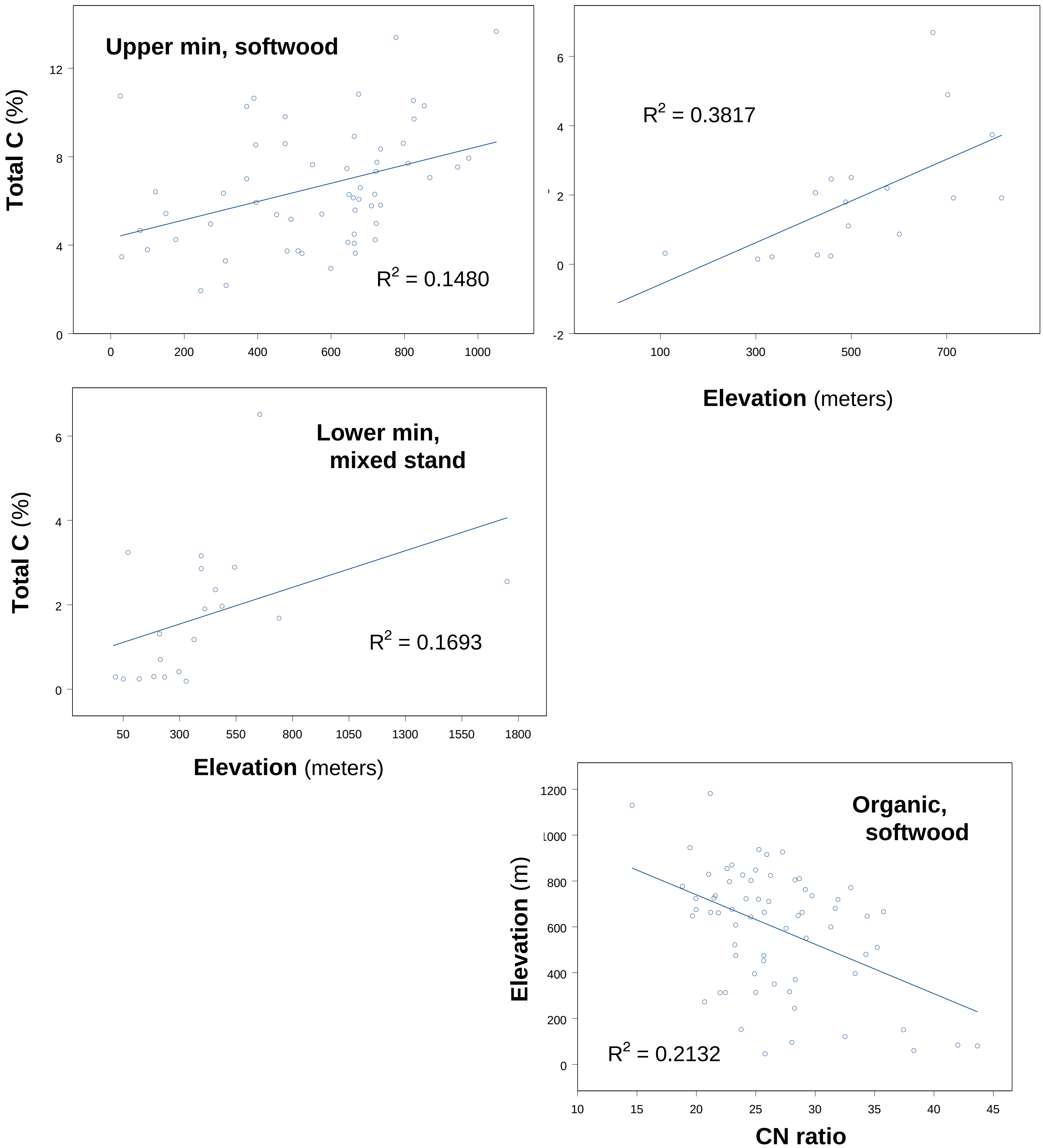
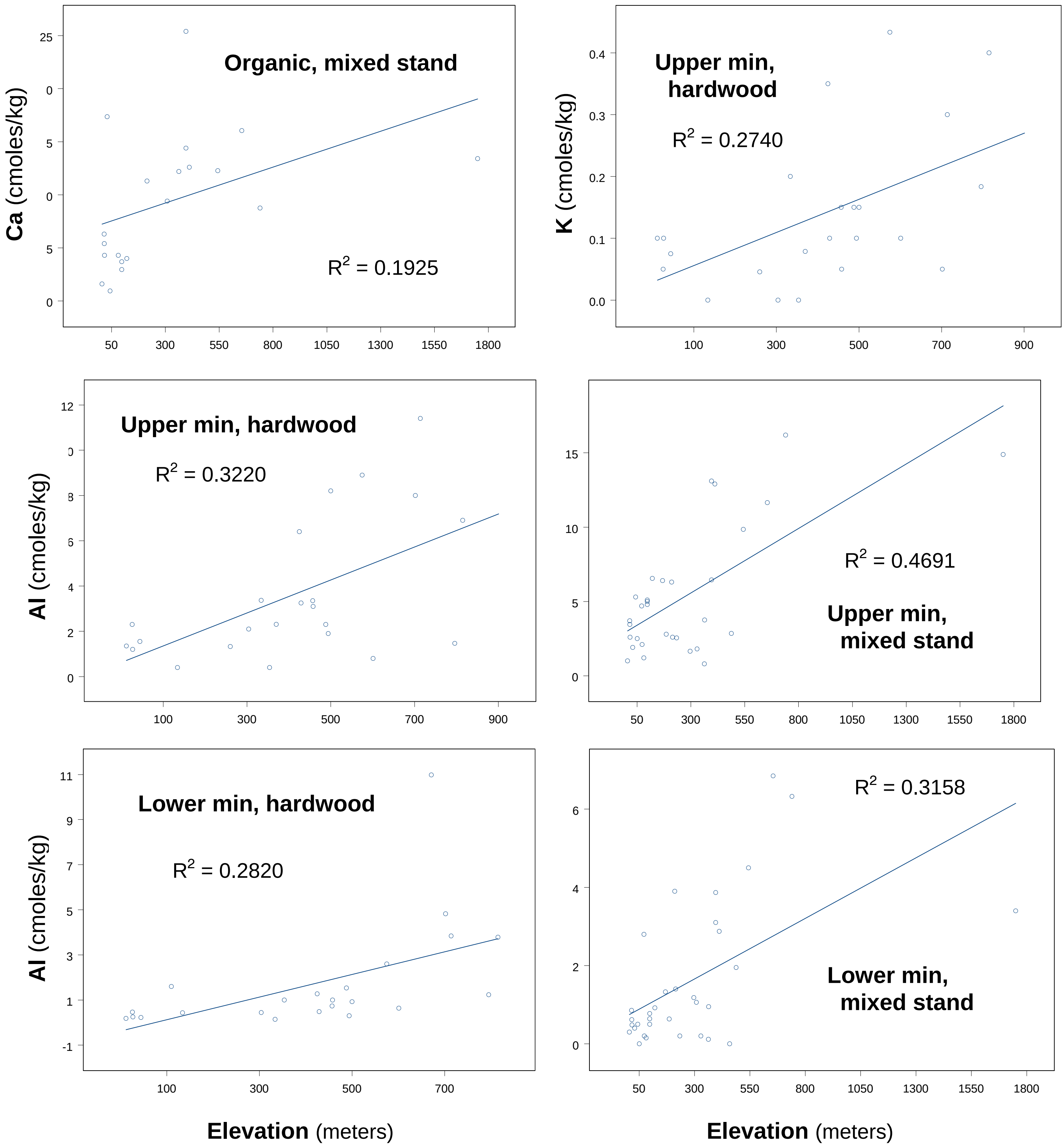


Figure 29. Graphs of parameters with strongest trends with elevation. (figure spans multiple pages)





Upper min, softwood
Total C (%)
R^2 = 0.1480
R^2 = 0.3817
Elevation (meters)
Lower min, mixed stand
Total C (%)
R^2 = 0.1693
Elevation (meters)
Organic, softwood
Elevation (m)
R^2 = 0.2132
CN ratio



Organic, mixed stand
R2 = 0.1925
Ca (cmoles/kg)
25
0
5
0
5
0
50
300
550
800
1050
1300
1550
1800
Upper min, hardwood
R2 = 0.2740
K (cmoles/kg)
0.4
0.3
0.2
0.1
0.0
100
300
500
700
900
Upper min, hardwood
R2 = 0.3220
Al (cmoles/kg)
12
0
8
6
4
2
0
100
300
500
700
900
R2 = 0.4691
Upper min, mixed stand
15
10
5
0
50
300
550
800
1050
1300
1550
1800
Lower min, hardwood
R2 = 0.2820
Al (cmoles/kg)
11
9
7
5
3
1
-1
100
300
500
700
R2 = 0.3158
Lower min, mixed stand
6
4
2
0
50
300
550
800
1050
1300
1550
1800
Elevation (meters)
Elevation (meters)

Appendix C-5: Soil Chemistry Random Forest Diagrams

Figure 30. Random Forest diagrams for soil pH in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

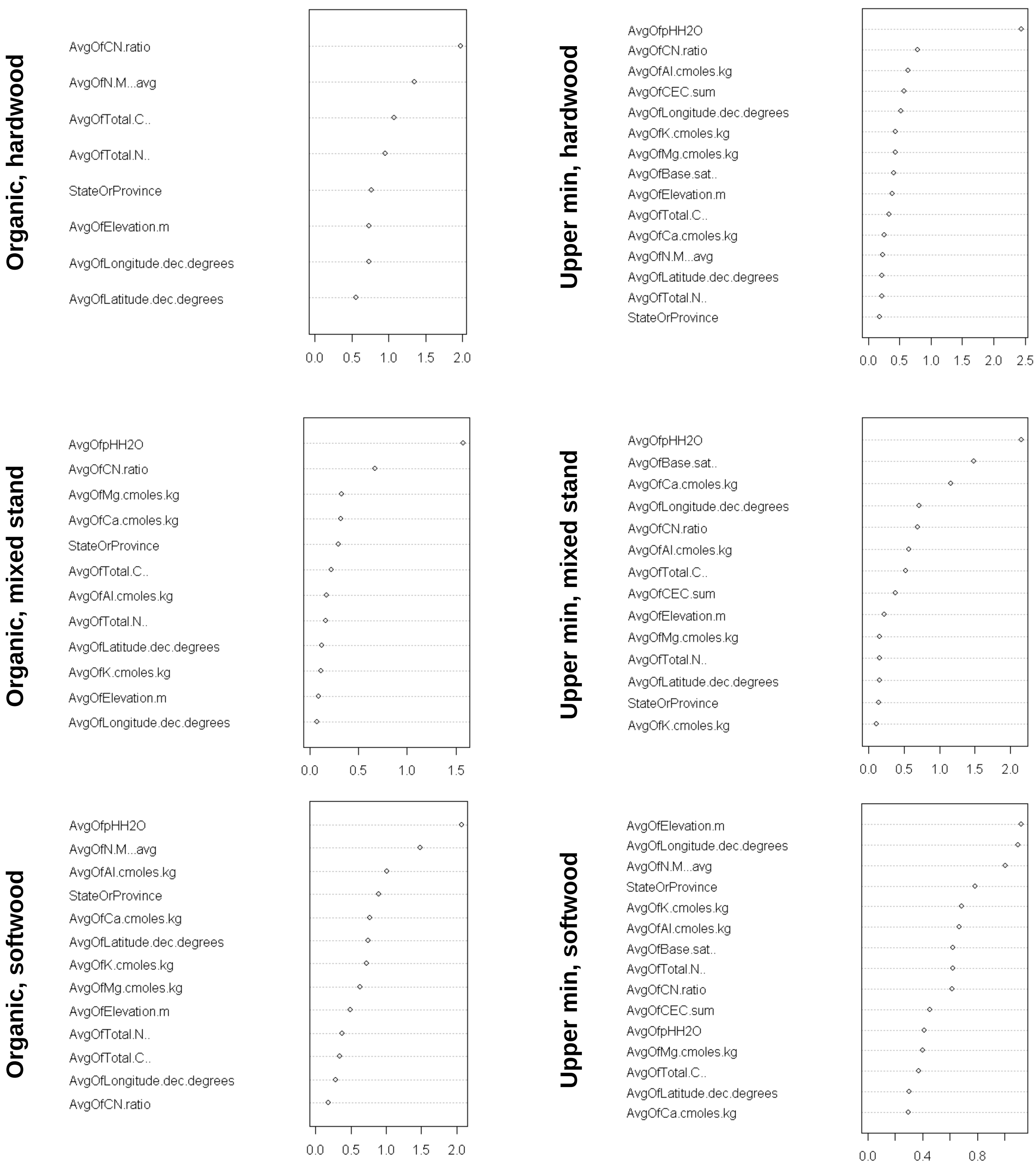
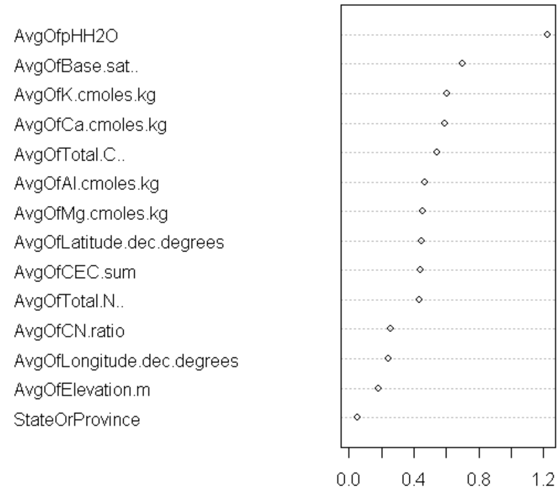
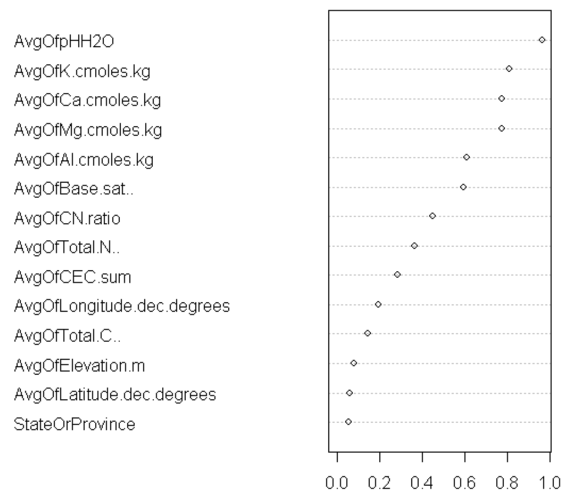


Figure 31. Random Forest diagrams for soil pH in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood



Lower min, mixed stand



Lower min, softwood

NA

Figure 32. Random Forest diagrams for soil nitrogen in organic and upper mineral layers. X axis is “IncnodePurity”, which is an importance value.

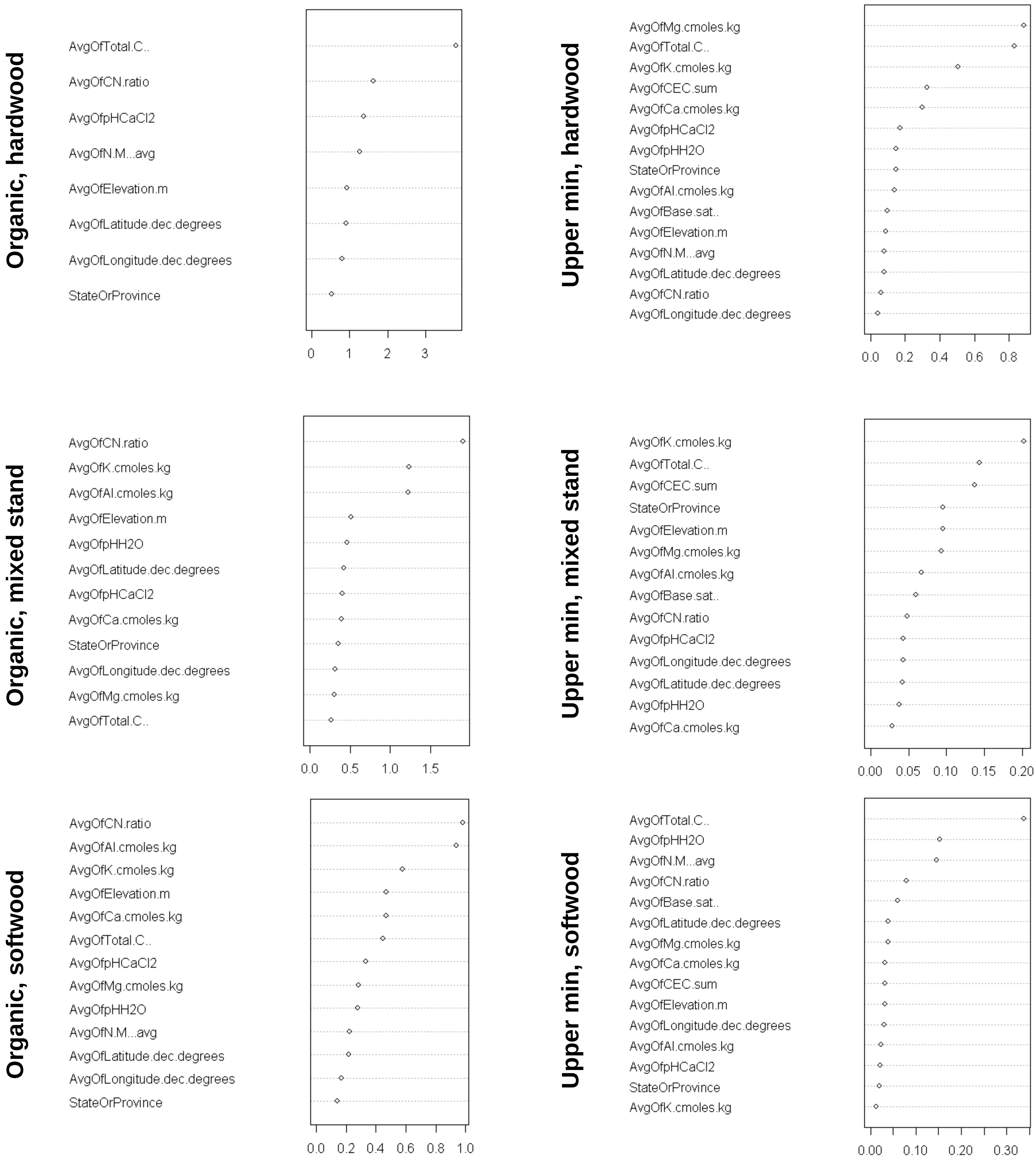


Figure 33. Random Forest diagrams for soil nitrogen in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

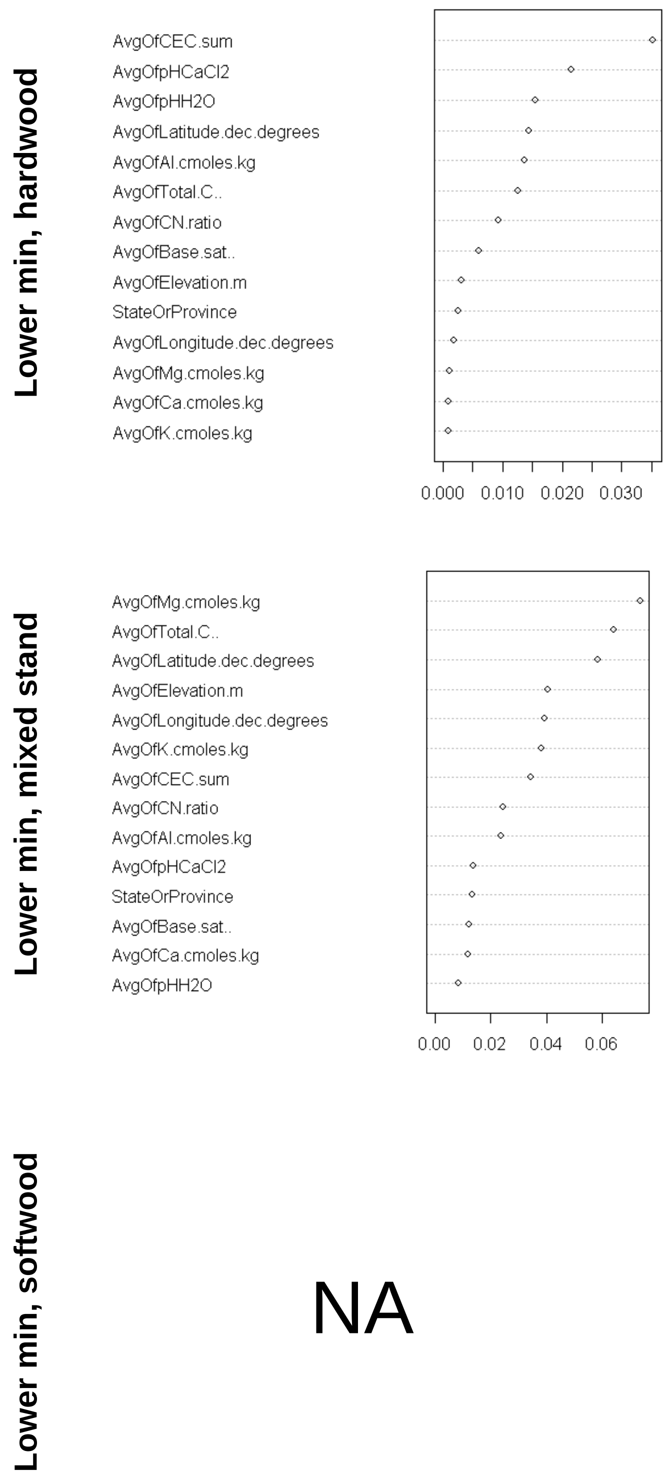


Figure 34. Random Forest diagrams for soil carbon in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

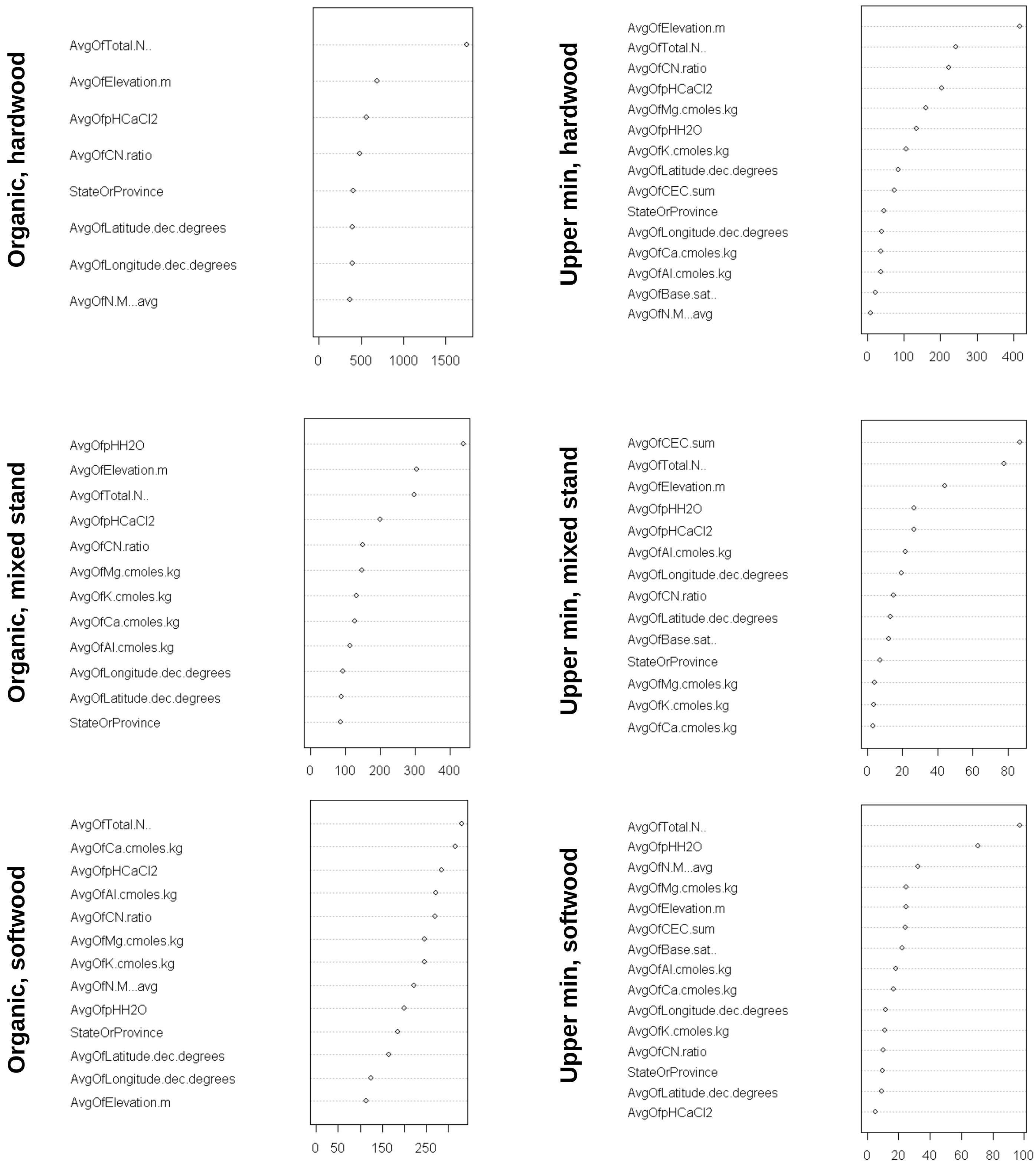
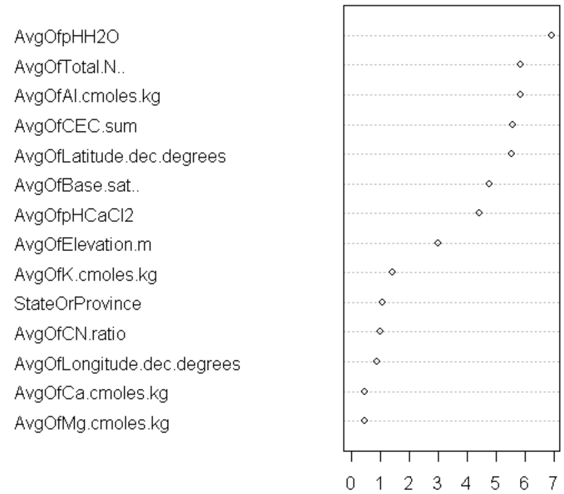
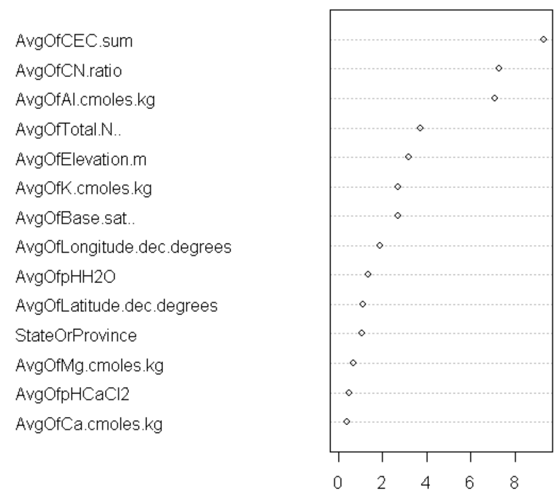


Figure 35. Random Forest diagrams for soil carbon in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood



Lower min, mixed stand



Lower min, softwood

NA

Figure 36. Random Forest diagrams for soil CN ratio in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

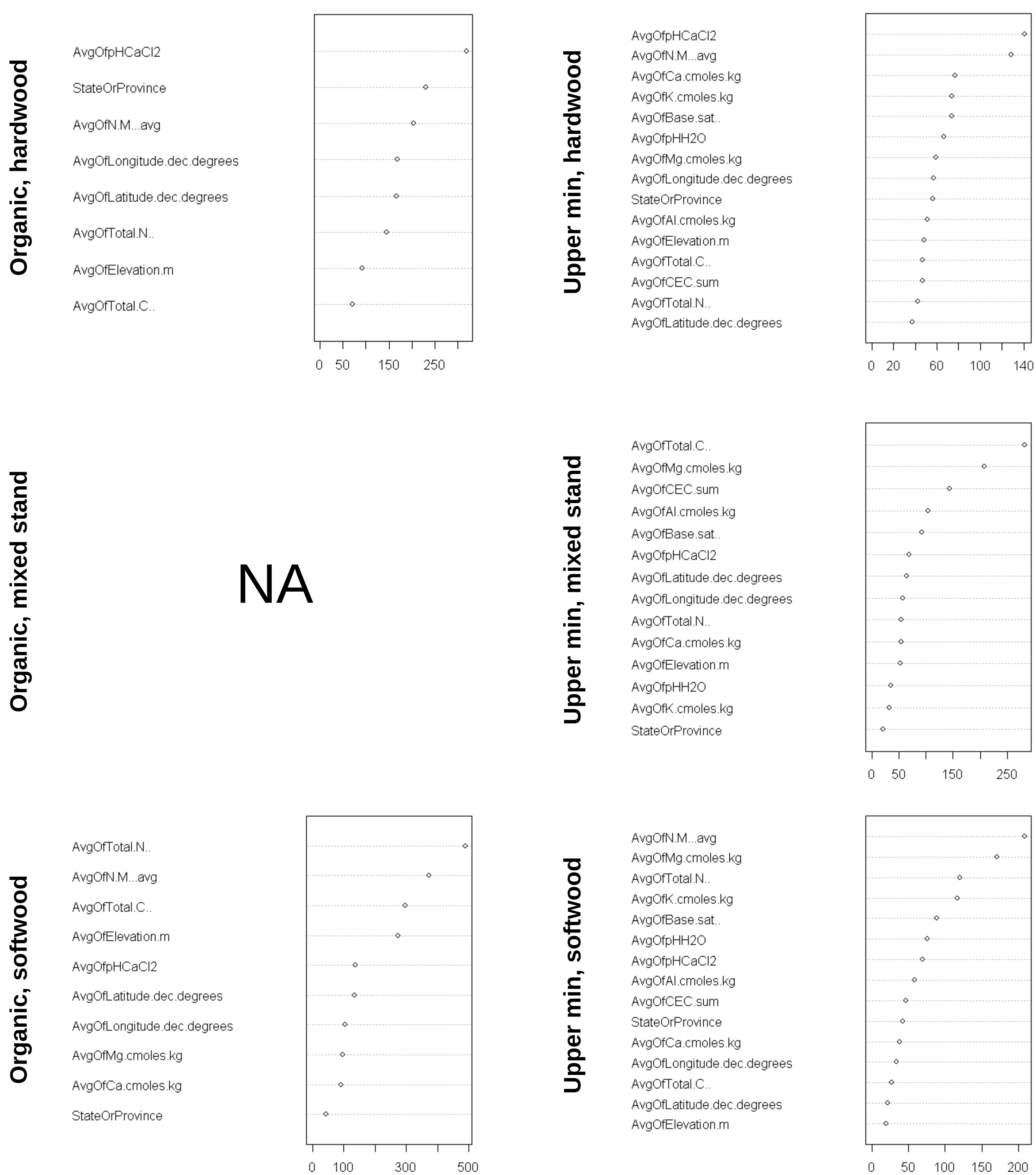


Figure 37. Random Forest diagrams for soil CN ratio in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood

NA

Lower min, mixed stand

NA

Lower min, softwood

NA

Figure 38. Random Forest diagrams for soil calcium in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

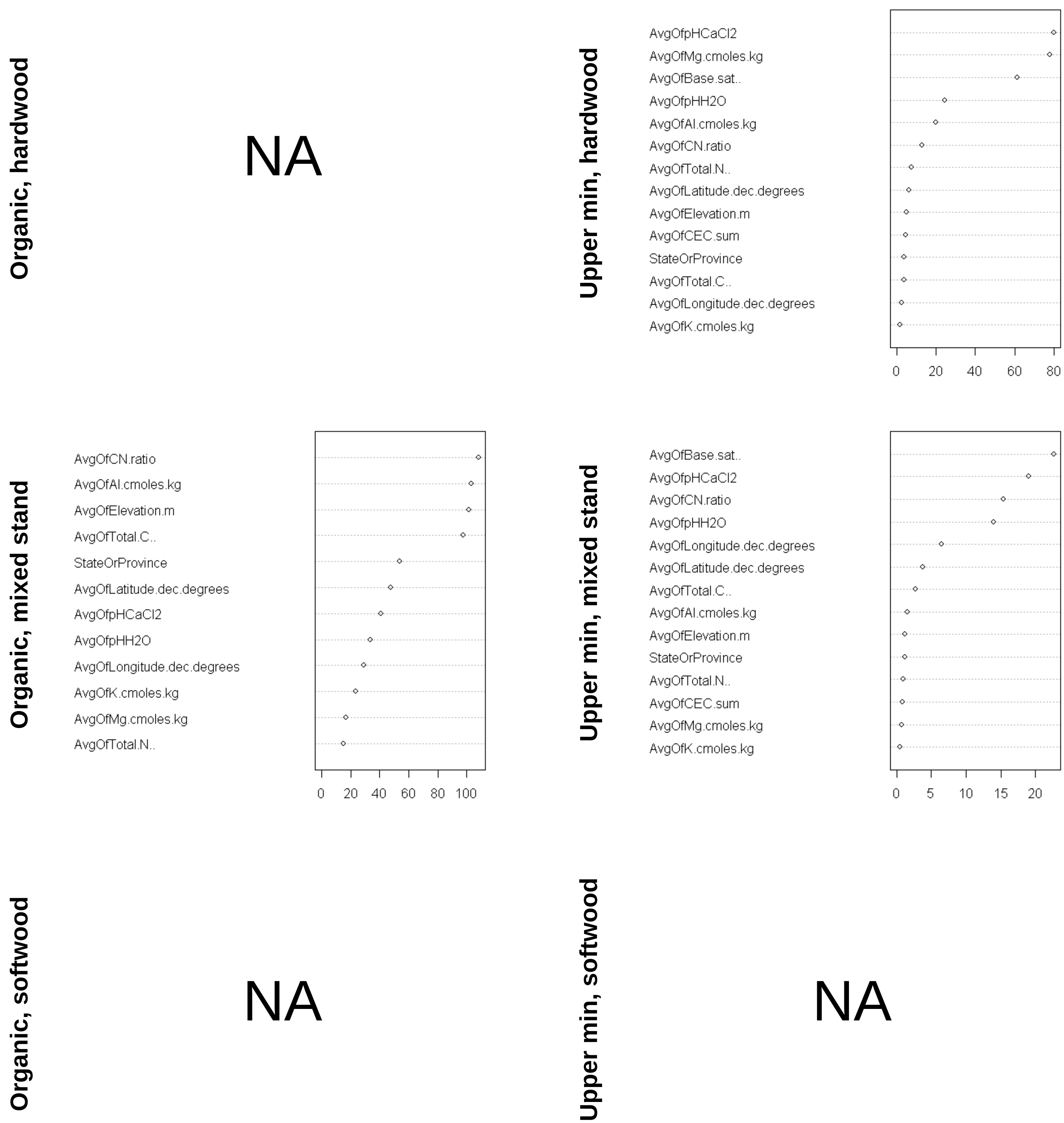
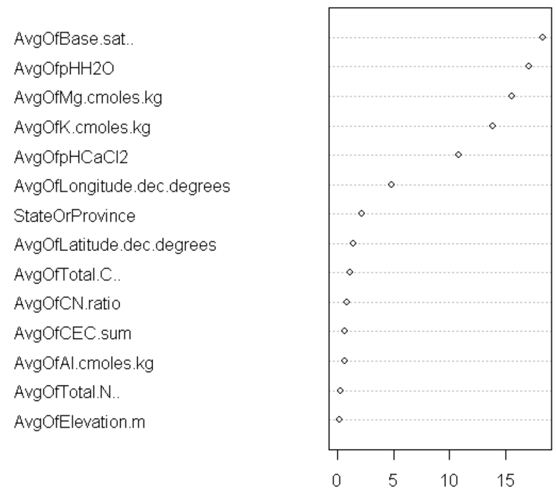
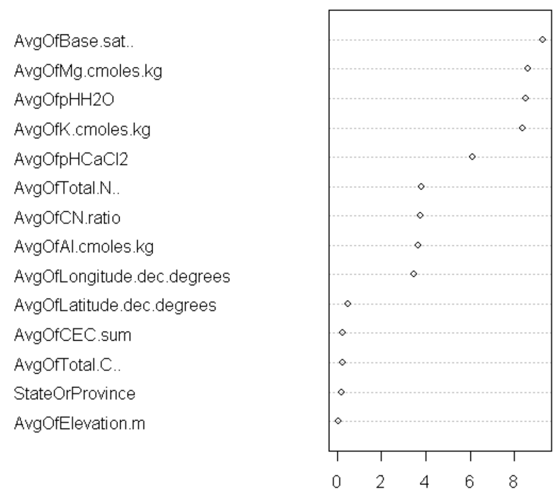


Figure 39. Random Forest diagrams for soil calcium in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood



Lower min, mixed stand



Lower min, softwood

NA

Figure 40. Random Forest diagrams for soil magnesium in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

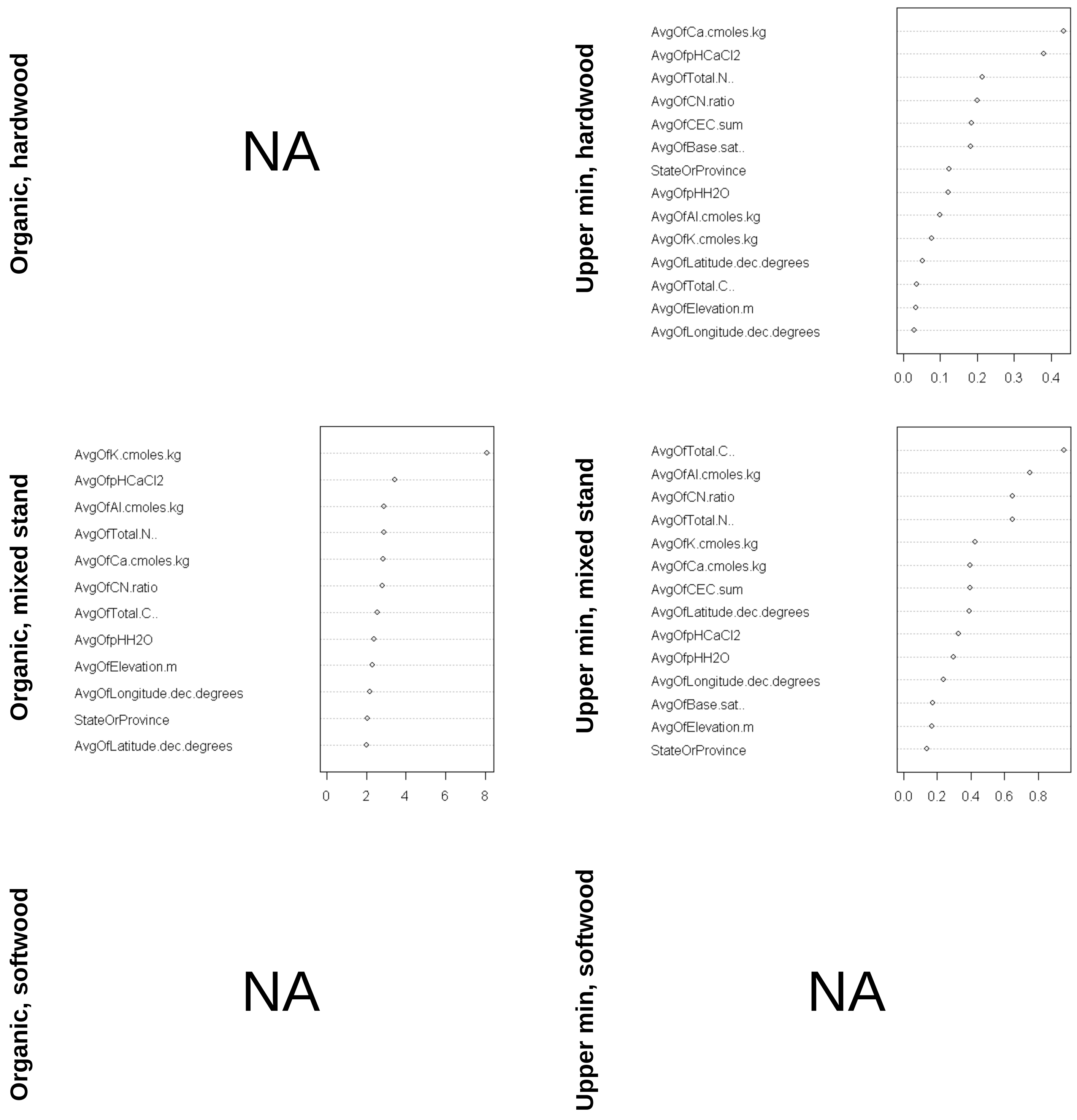
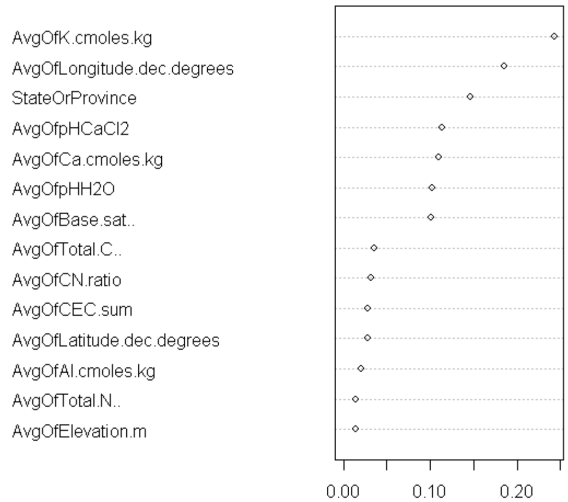
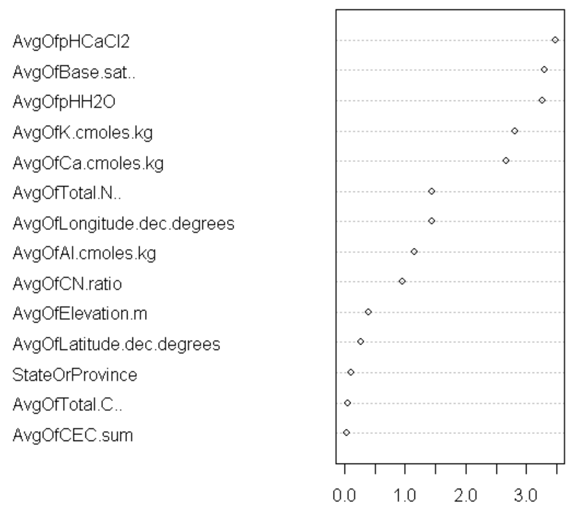


Figure 41. Random Forest diagrams for soil magnesium in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood



Lower min, mixed stand



Lower min, softwood

NA

Figure 42. Random Forest diagrams for soil potassium in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

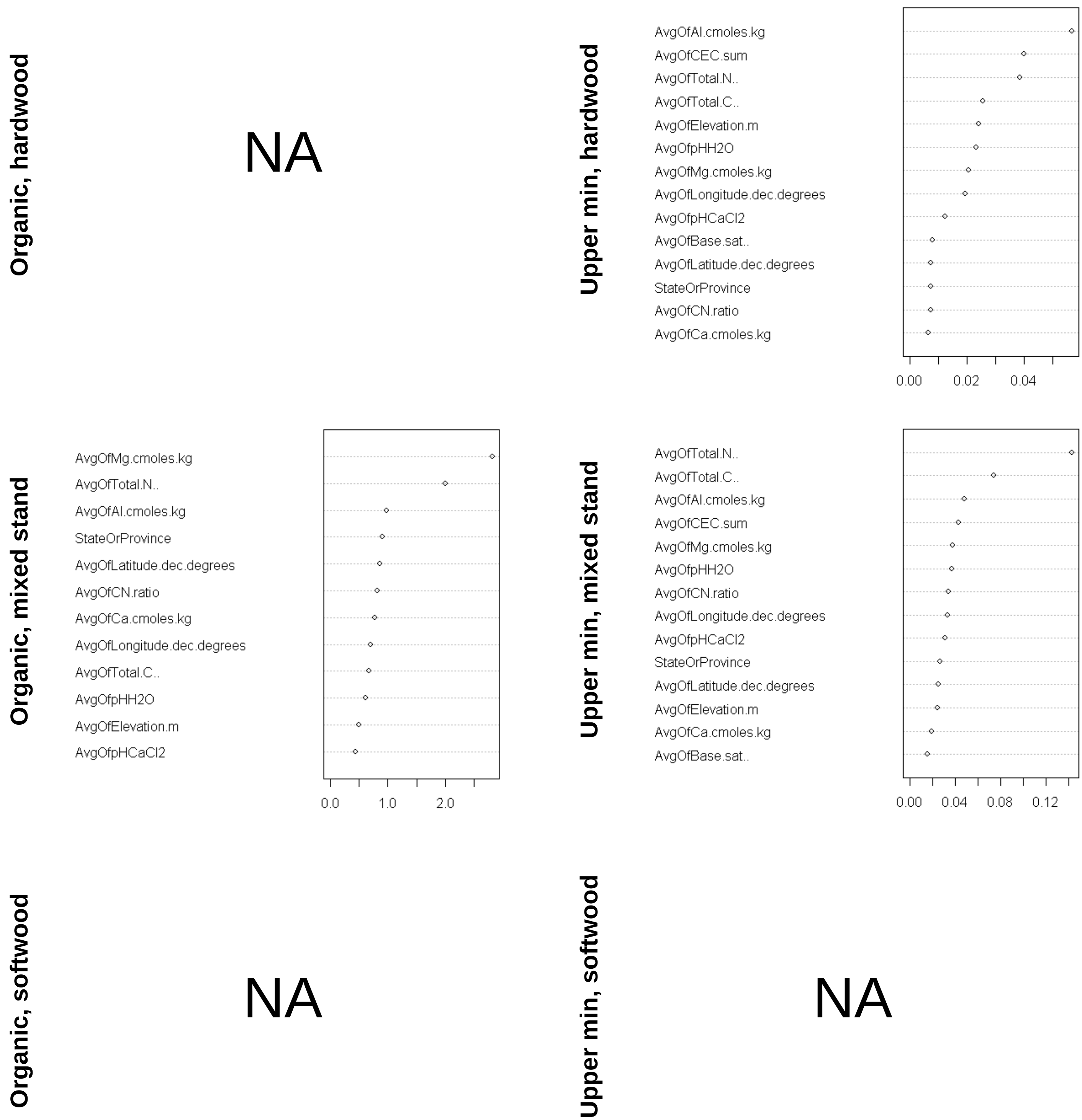


Figure 43. Random Forest diagrams for soil potassium in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

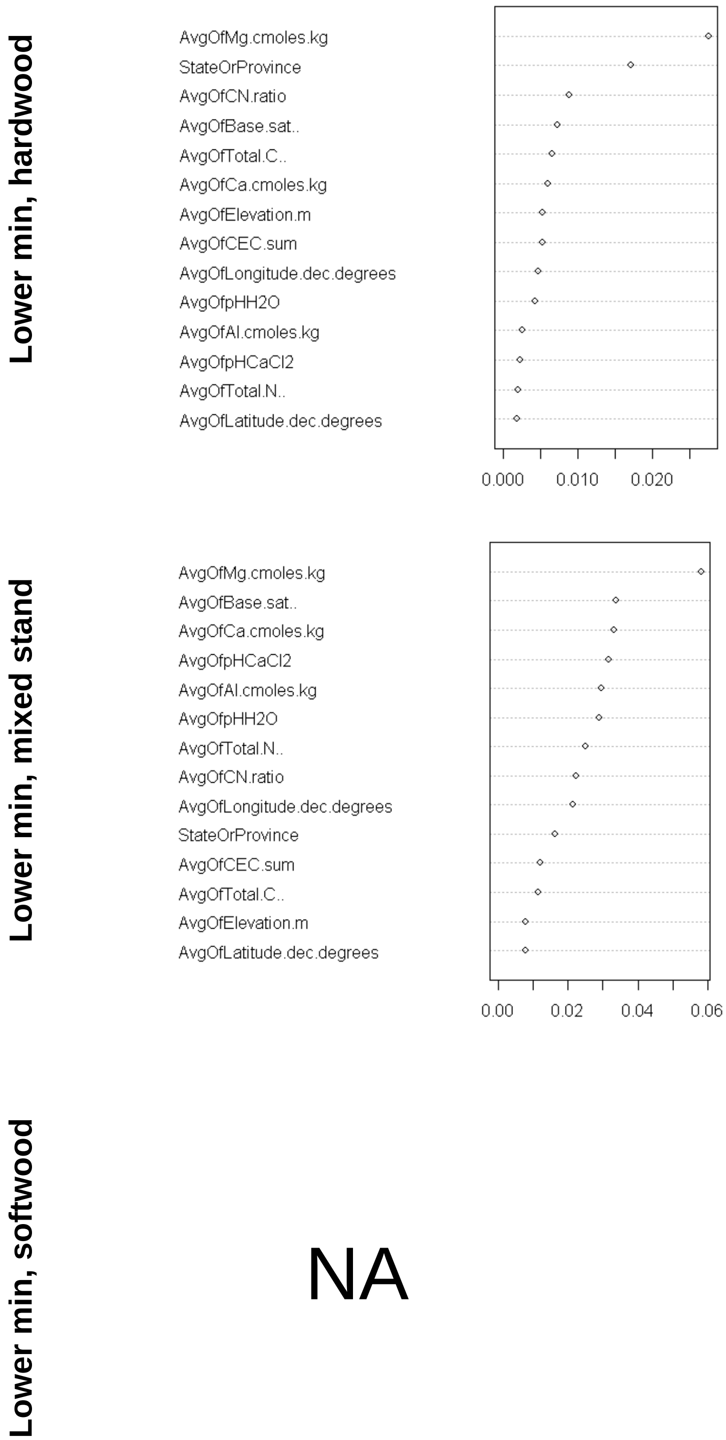


Figure 44. Random Forest diagrams for soil aluminum in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

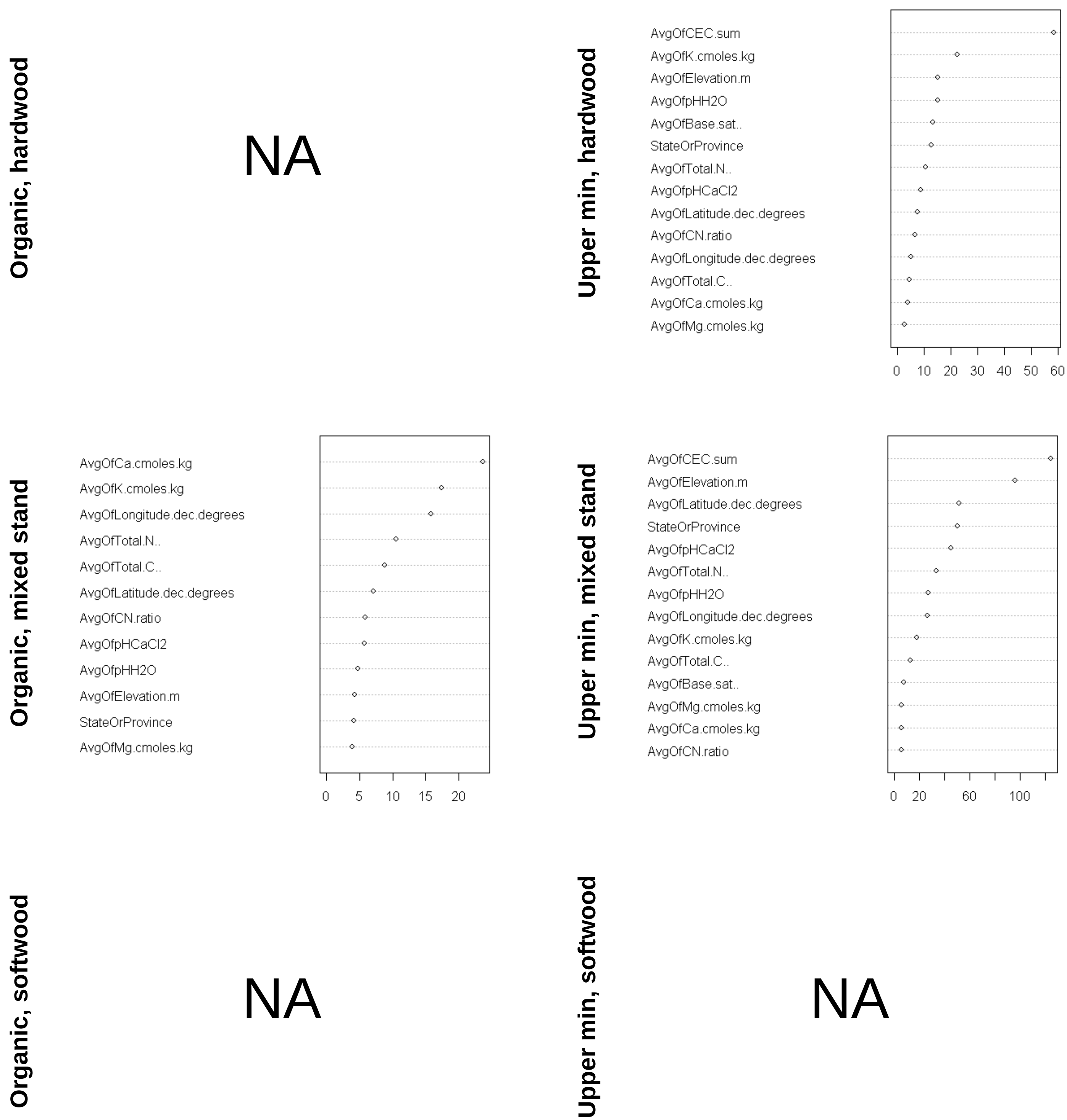
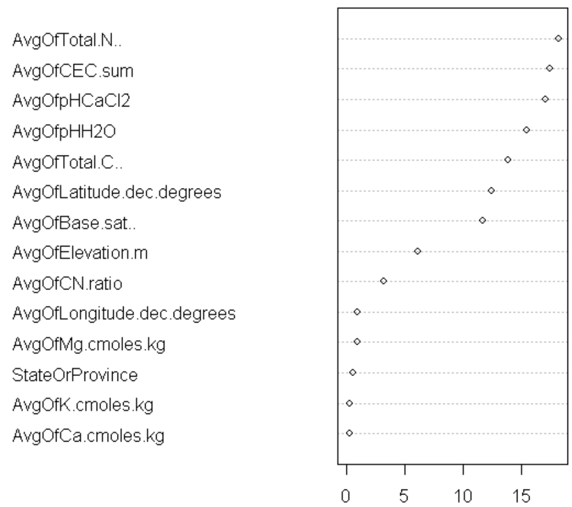
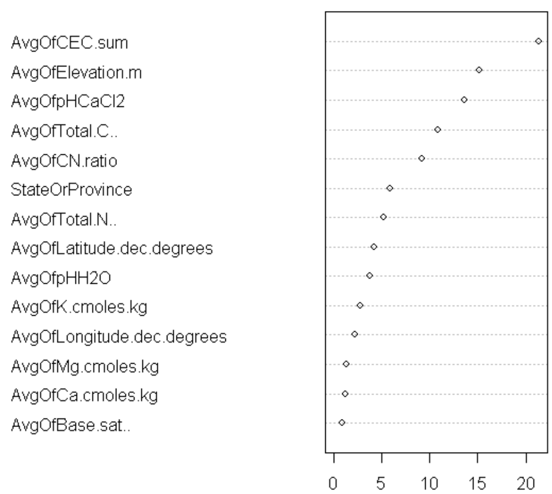


Figure 45. Random Forest diagrams for soil aluminum in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood



Lower min, mixed stand



Lower min, softwood

NA

Figure 46. Random Forest diagrams for soil nitrification/mineralization in organic and upper mineral layers. X axis is "IncnodePurity", which is an importance value.

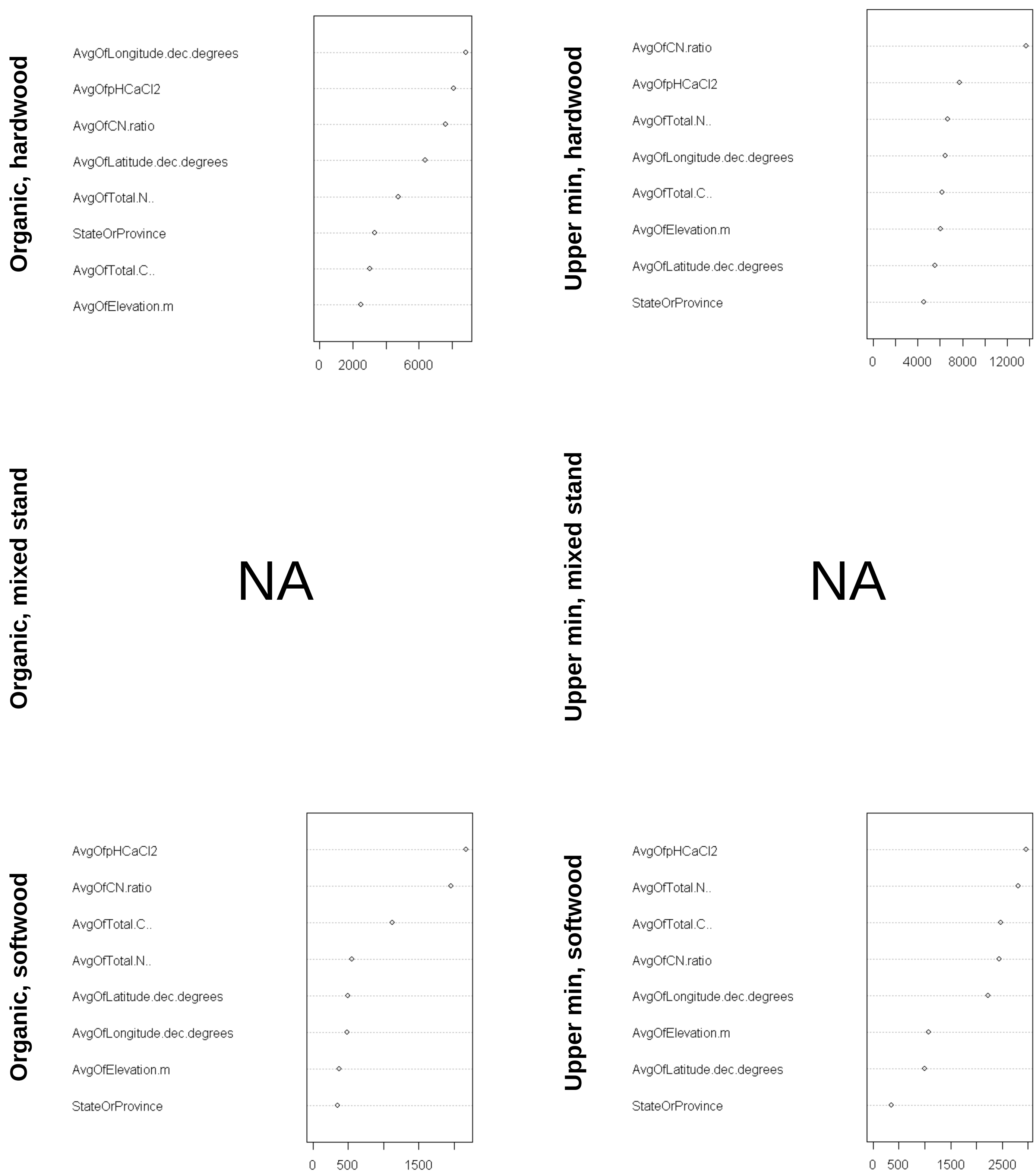


Figure 47. Random Forest diagrams for soil nitrification/mineralization in lower mineral layers. X axis is "IncnodePurity", which is an importance value.

Lower min, hardwood

NA

Lower min, mixed stand

NA

Lower min, softwood

NA

Appendix D: Regional Atmospheric Deposition Maps

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Figure 1. Estimated total nitrogen deposition based on the ClimCalc model. Map is from the following source:

Ollinger, S.V., J.D. Aber, G.M. Lovett, S.E. Millham and R.G. Lathrop. 1993. A spatial model of atmospheric deposition for the northeastern U.S. Ecological Applications 3: 459-472.

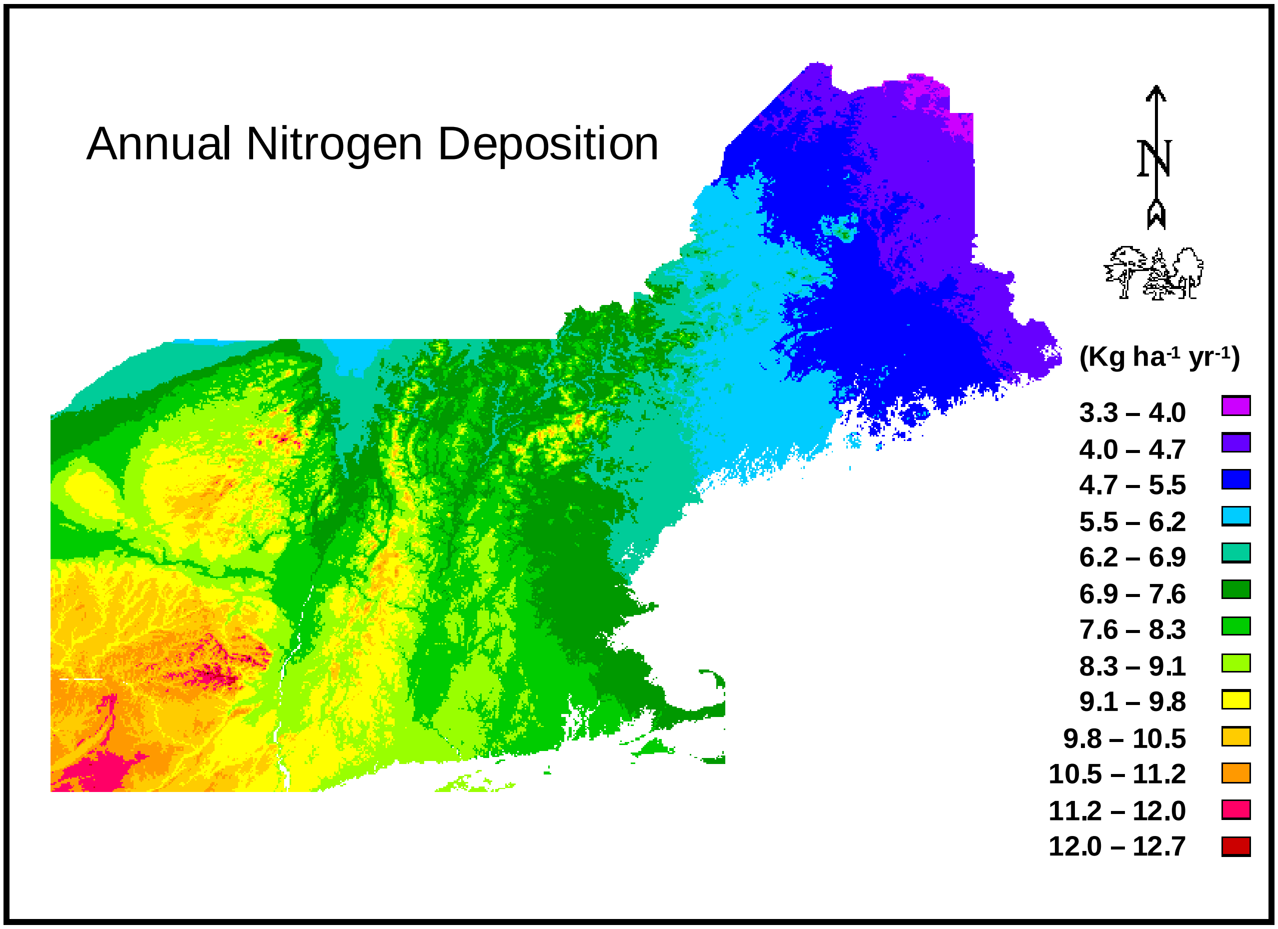


Figure 2. Estimated total sulfur deposition based on the ClimCalc model. Map was made from data from the following source:

Ollinger, S.V., J.D. Aber, G.M. Lovett, S.E. Millham and R.G. Lathrop. 1993. A spatial model of atmospheric deposition for the northeastern U.S. Ecological Applications 3: 459-472.

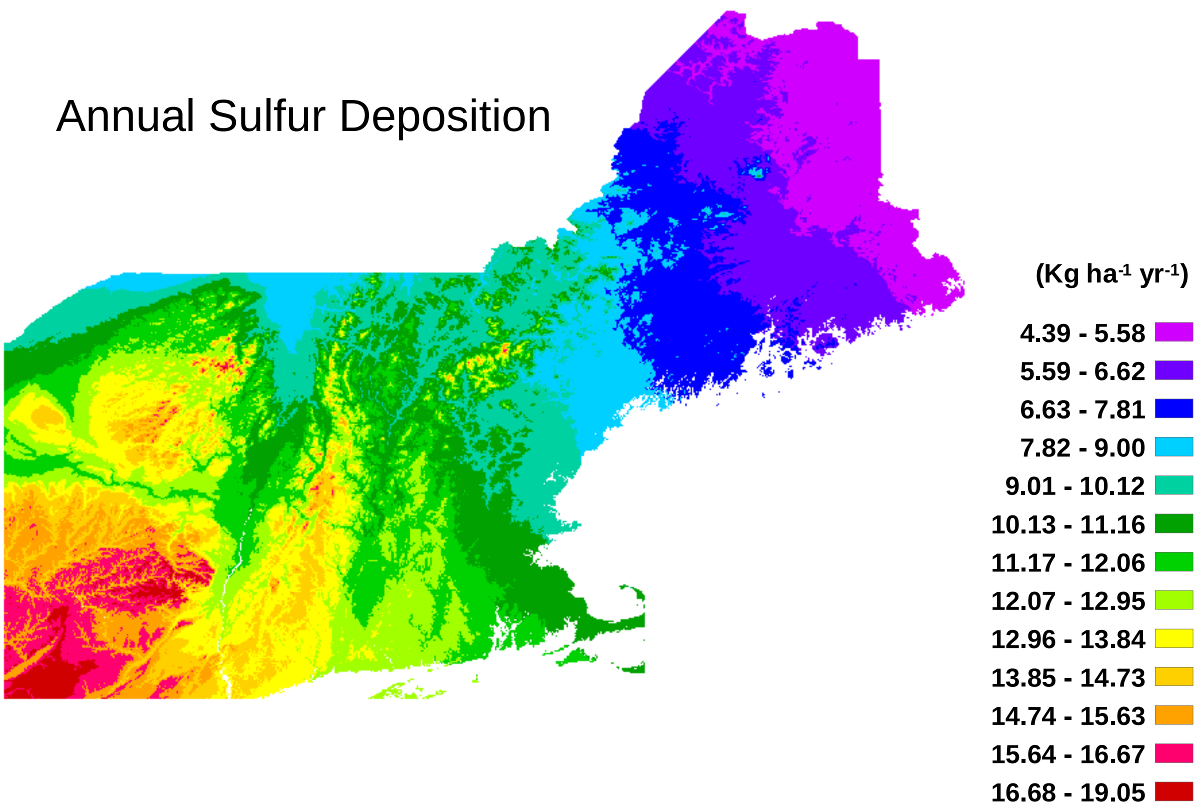
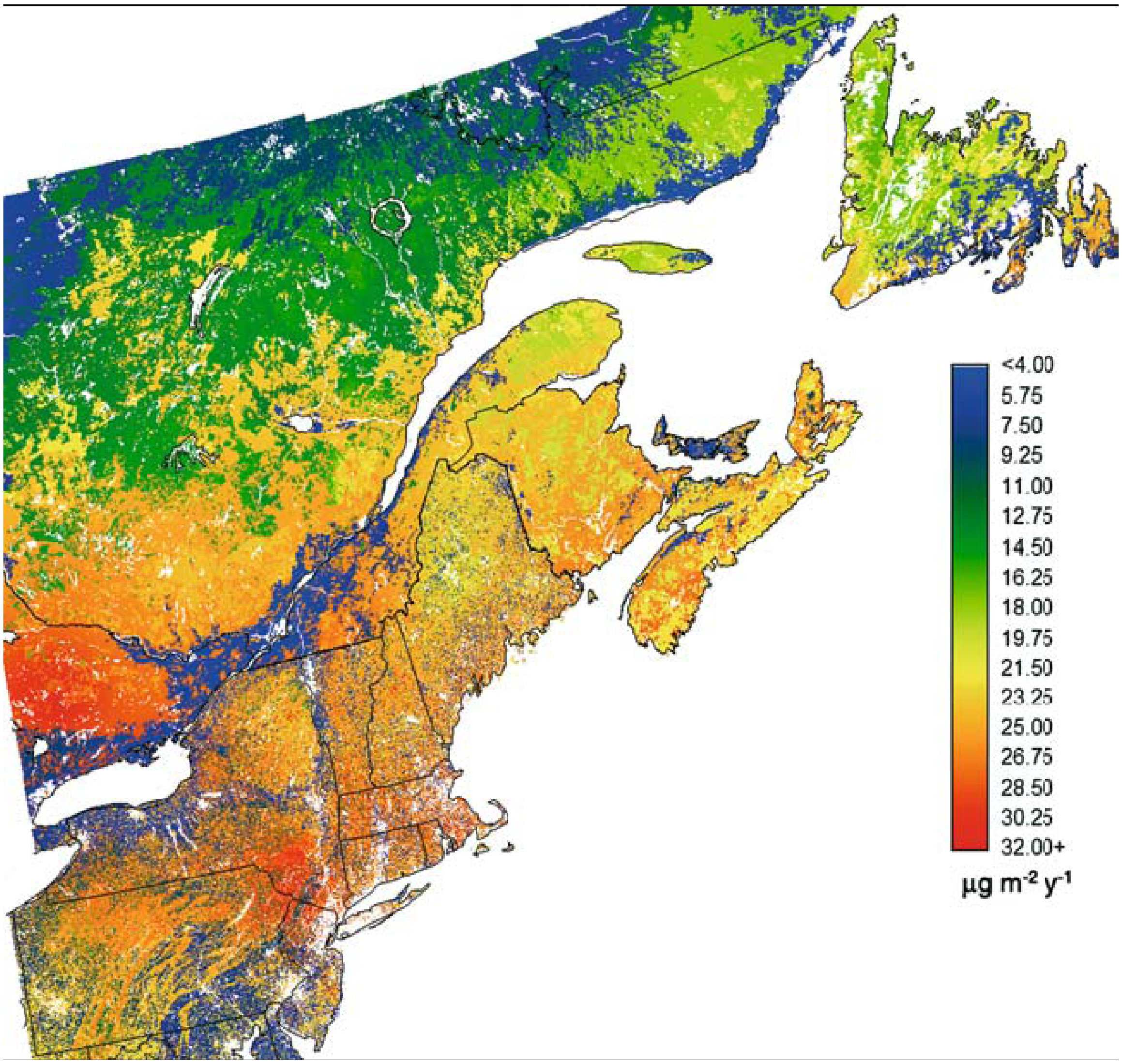


Figure 3. Estimated total mercury deposition to rural areas. Deposition was not estimated for areas with urban or residential land cover. Mercury deposition is likely to be much greater than depicted here in the immediate vicinity of urban areas and emissions sources.

Caption and graphic are from the following source:

Miller, E., VanArsdale, A., Keeler, G., Chalmers, A., Poissant, L., Kamman, N., Rulotte, R. 2005. Estimation and mapping of wet and dry mercury deposition across northeastern North America. Ecotoxicology 14: 53-70.



Appendix E: Regional Climate, Soil, and Landscape Maps

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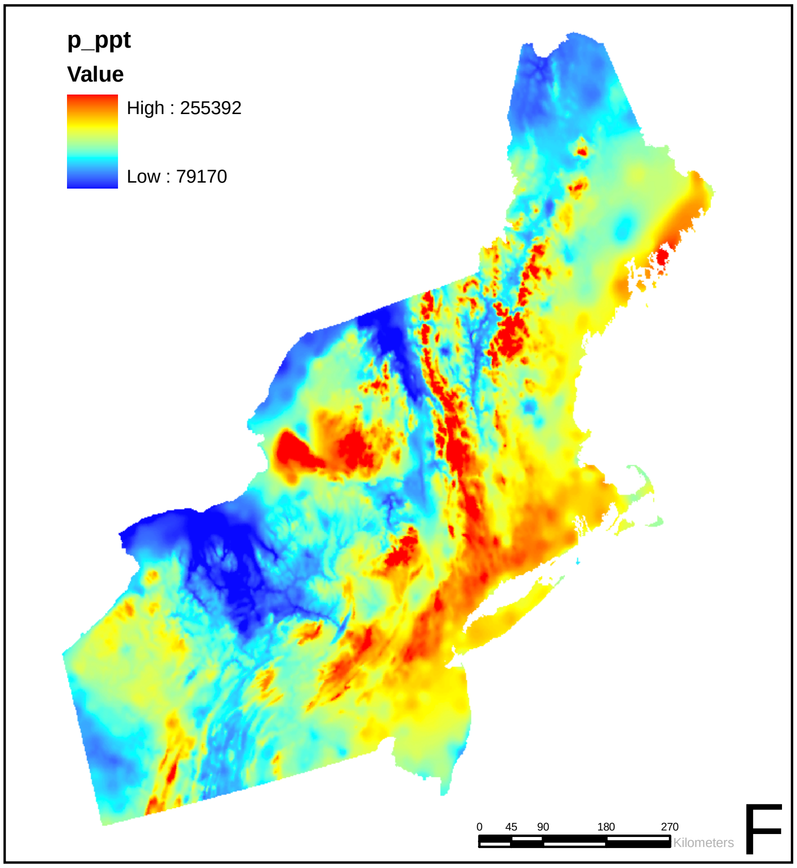
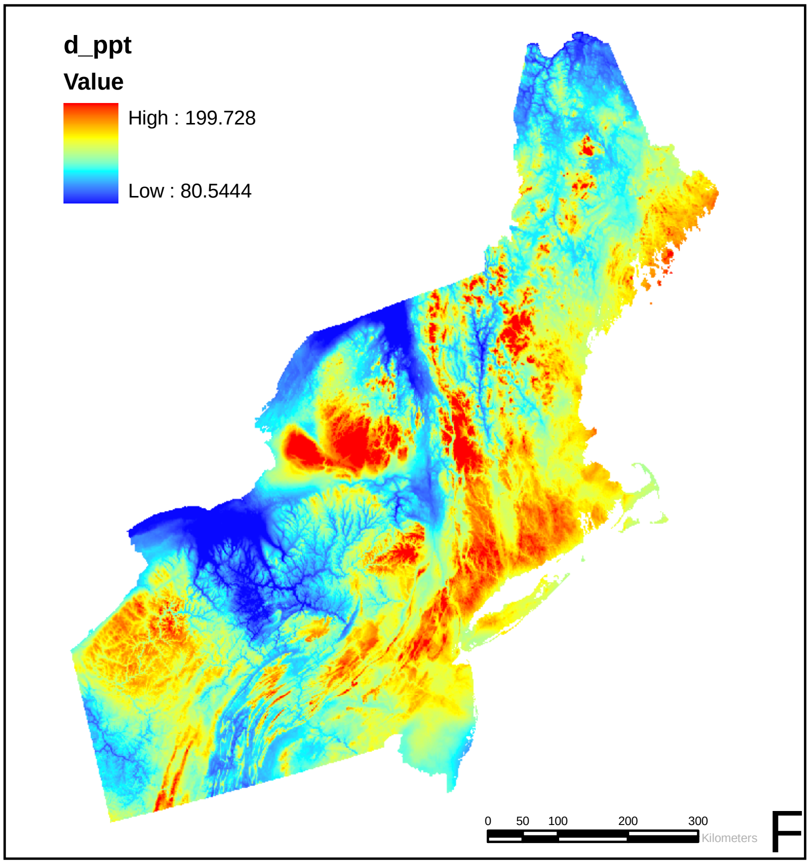
Appendix E-1: Regional Climate Maps

Figure 1. Average annual precipitation for the 30-yr period of 1971-2000 (PRISM).
Source: http://nature.berkeley.edu/boyerlab/nercgis.html



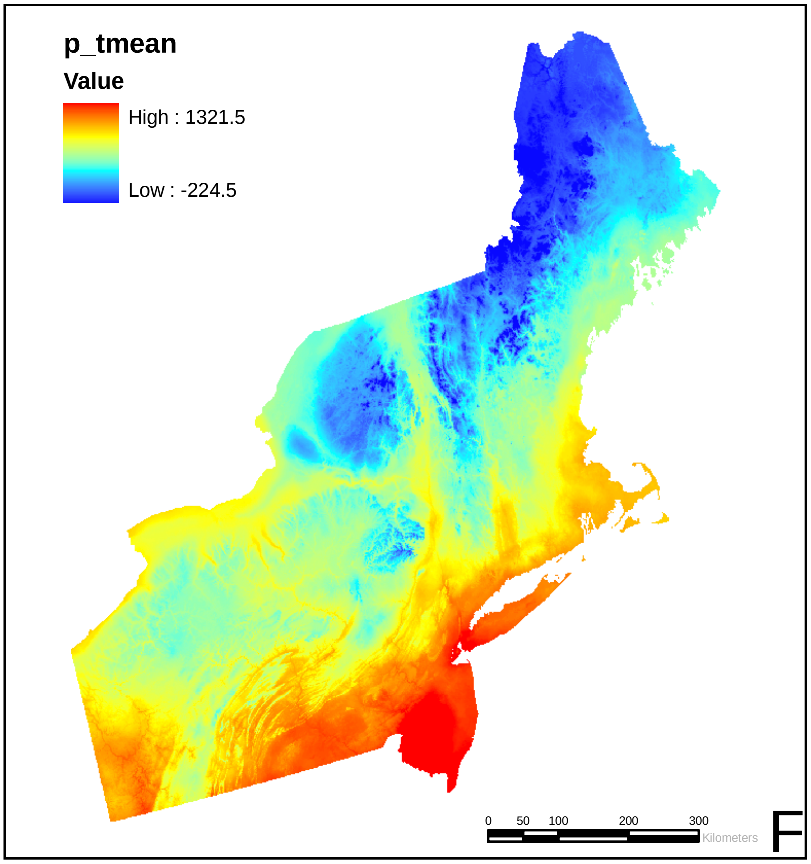
p_ppt
average annual precipitation, 1971-2000
cm/yr (*1000)

Figure 2. Average annual precipitation for the 18-yr period of 1980-1997 (DAYMET). Source: http://nature.berkeley.edu/boyerlab/nercgis.html



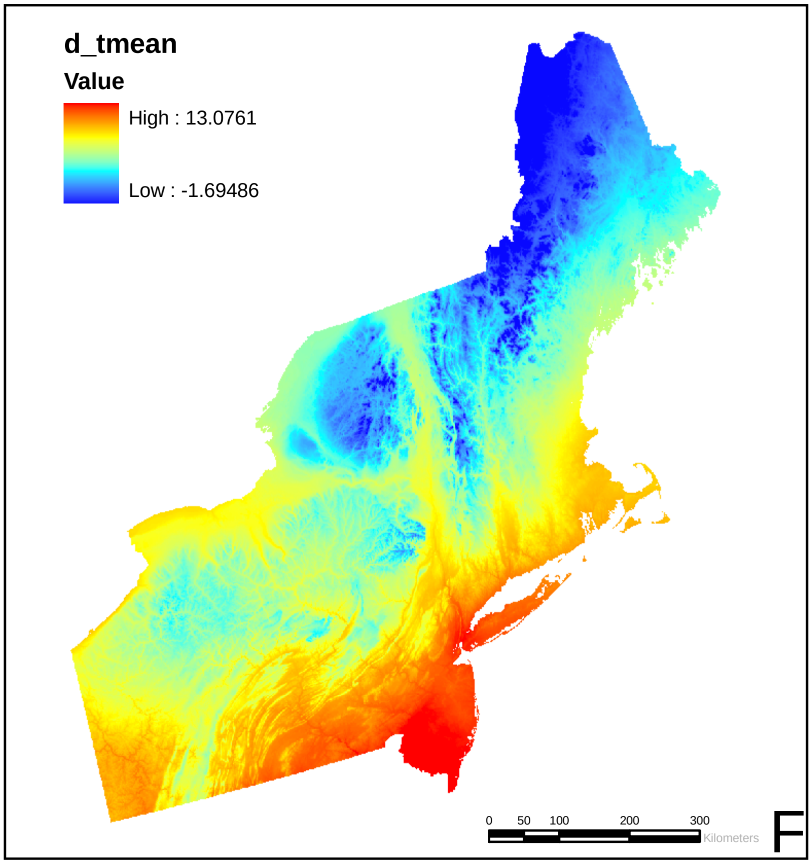
d_ppt
average annual precipitation 1980-1997
cm/yr

Figure 3. Average annual air temperature for the 30-yr period of 1971-2000 (PRISM).. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



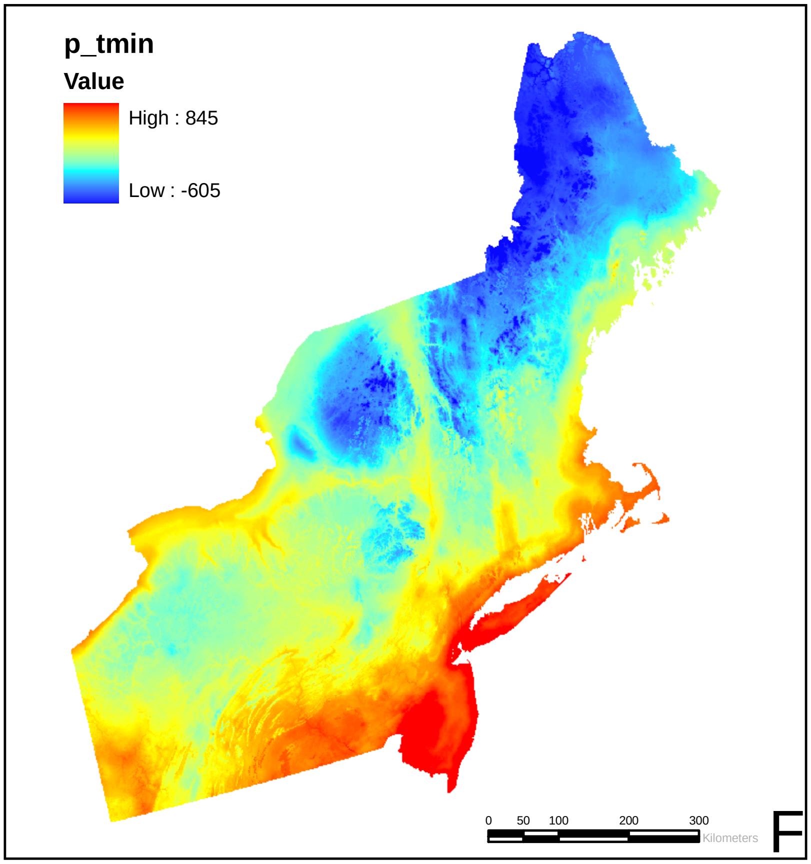
p_tmean
average annual air temperature 1971-2000
degrees C (* 100)

Figure 4. Average annual air temperature for the 18-yr period of 1980-1997 (DAYMET). Source: http://nature.berkeley.edu/boyerlab/nercgis.html



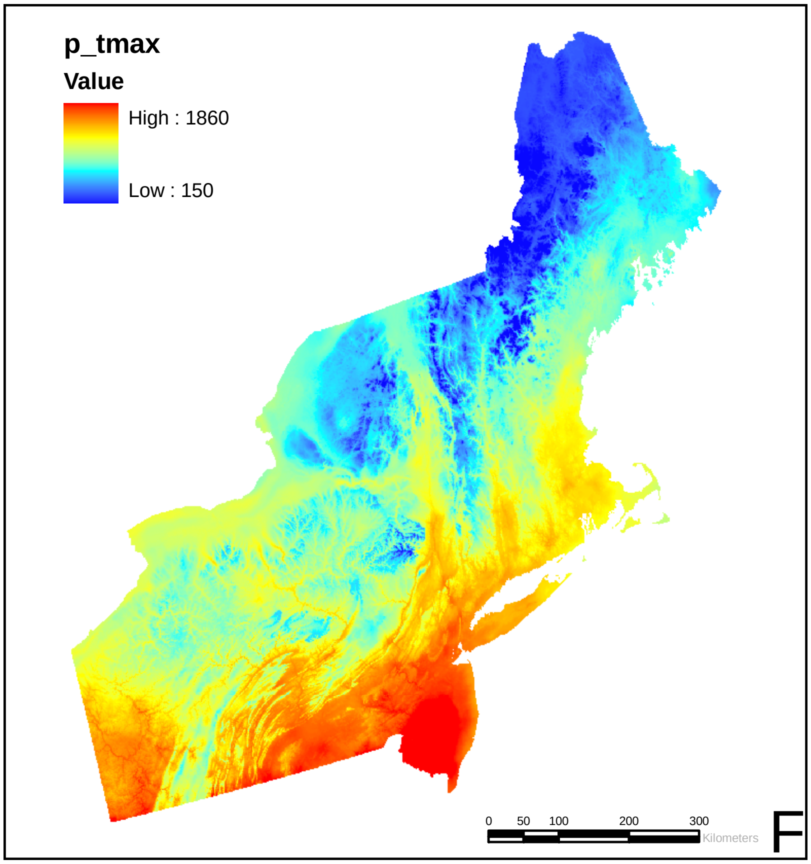
d_tmean
average annual air temperature 1980-1997
degrees C

Figure 5. Average annual minimum air temperature for the 30-yr period of 1971-2000 (PRISM).. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



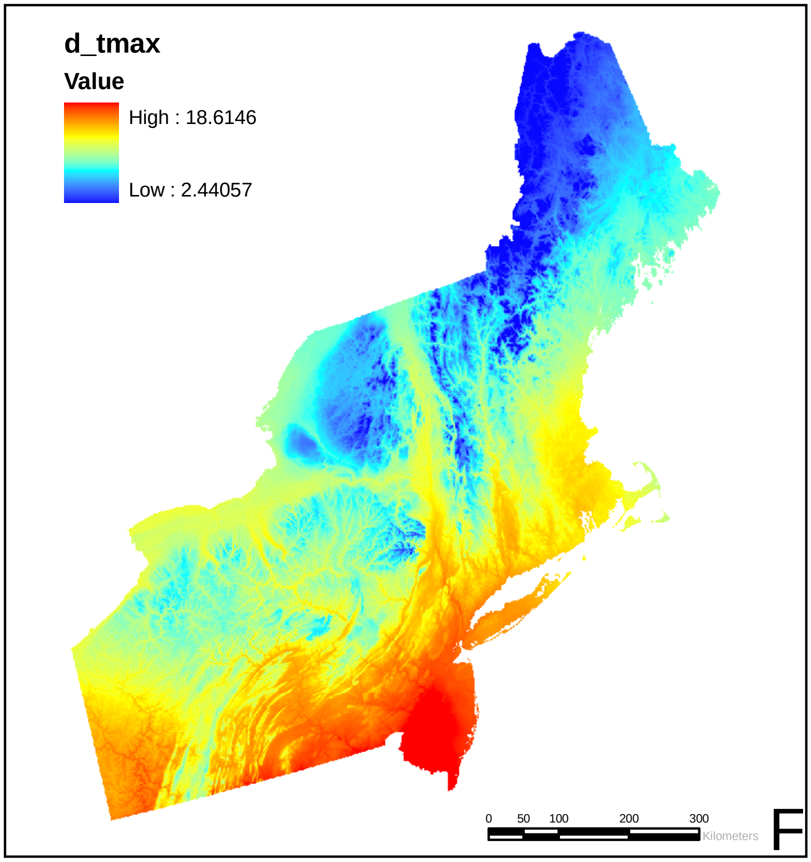
p_tmin
average annual minimum air temperature 1971-2000
degrees C (* 100)

Figure 6. Average annual maximum air temperature for the 30-yr period of 1971-2000 (PRISM).. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



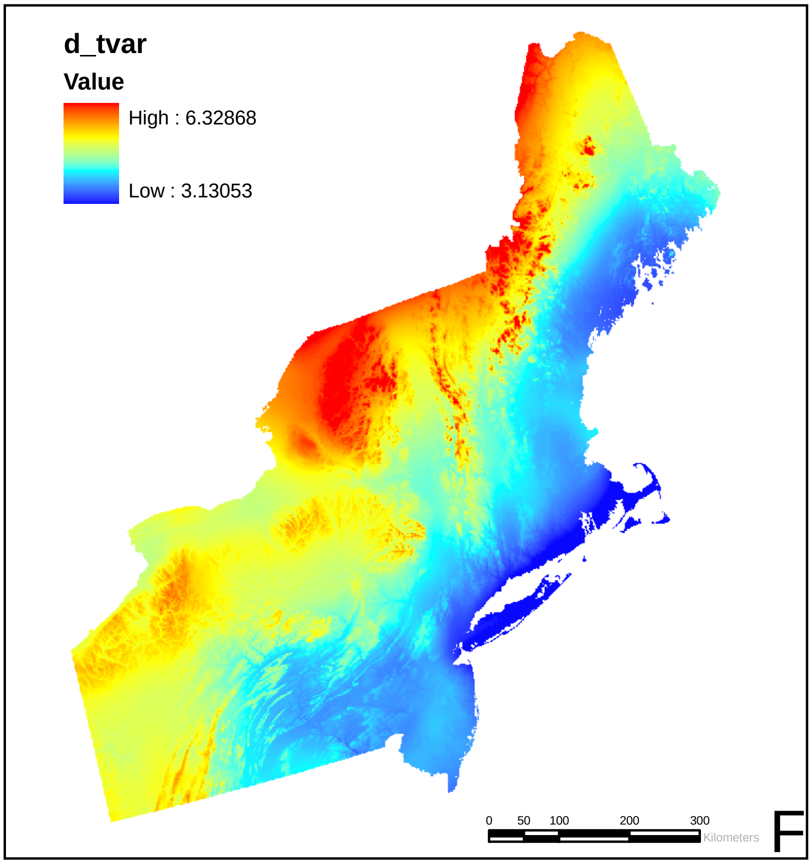
p_tmax
average annual maximum air temperature 1971-2000
degrees C (* 100)

Figure 7. Average annual maximum air temperature for the 18-yr period of 1980-1997 (DAYMET). Source: http://nature.berkeley.edu/boyerlab/nercgis.html



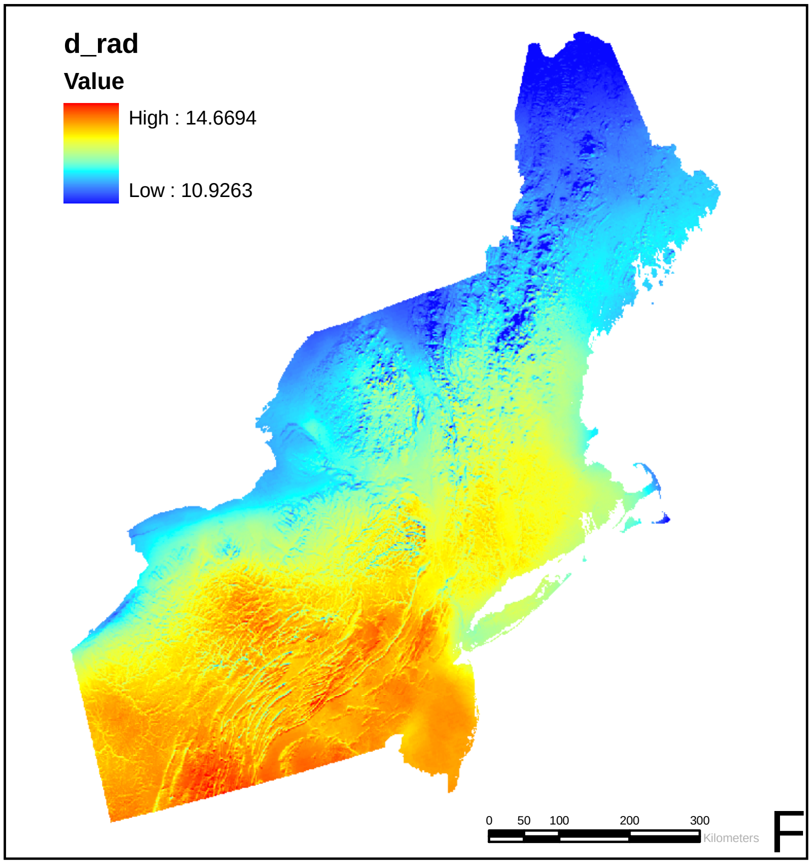
d_tmax
average annual maximum air temperature 1980-1997
degrees C

Figure 8. Average annual variability in air temperature for the 18-yr period of 1980-1997 (DAYMET). Source: http://nature.berkeley.edu/boyerlab/nercgis.html



d_tvar
average annual variation in air temperature 1980-1997
degrees C

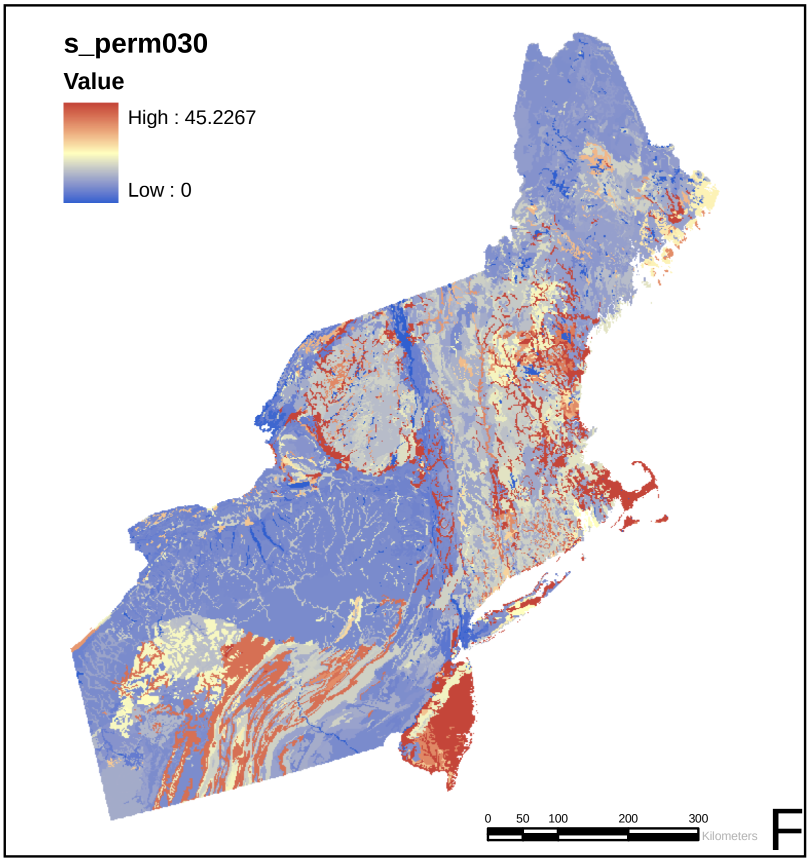
Figure 9. Average annual radiation for the 18-yr period of 1980-1997 (DAYMET).
Source: http://nature.berkeley.edu/boyerlab/nercgis.html



d_trad
average annual radiation 1980-1997
MJ m2 day-1

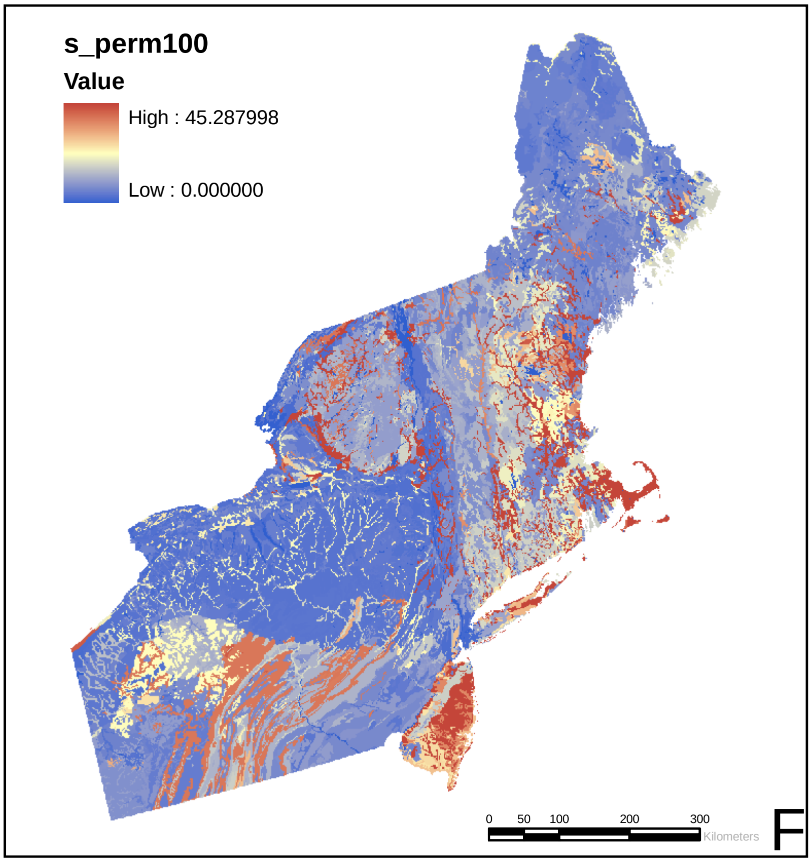
Appendix E-2: Regional Soil Characteristics Maps

Figure 10. Soil permeability rate from 0-30 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



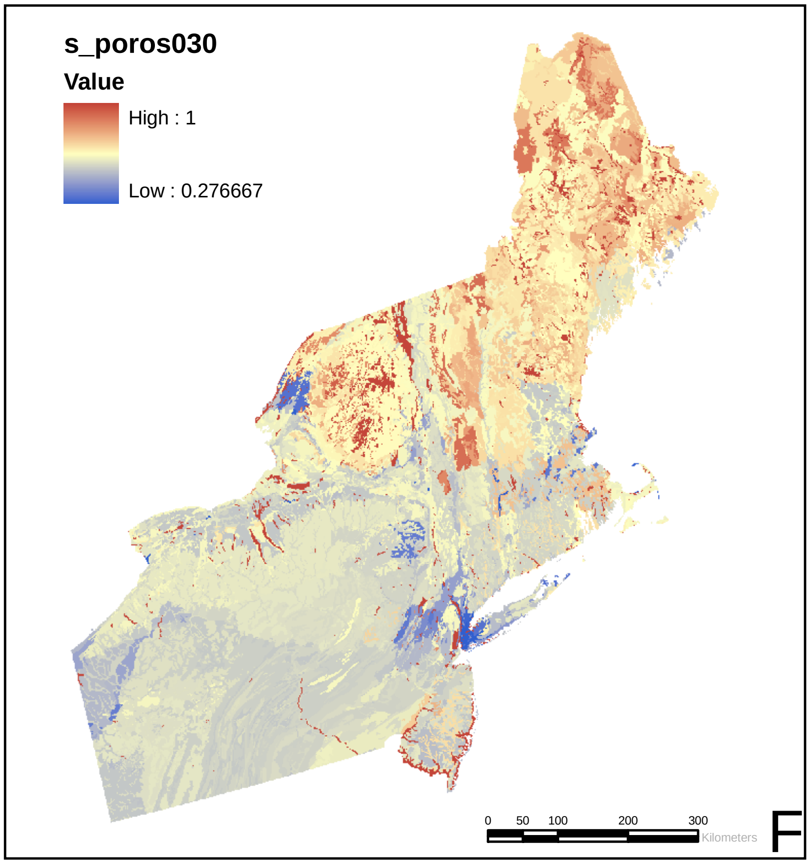
s_perm030
soil permeability rate, 0-30 cm depth
cm/hr

Figure 11. Soil permeability rate from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



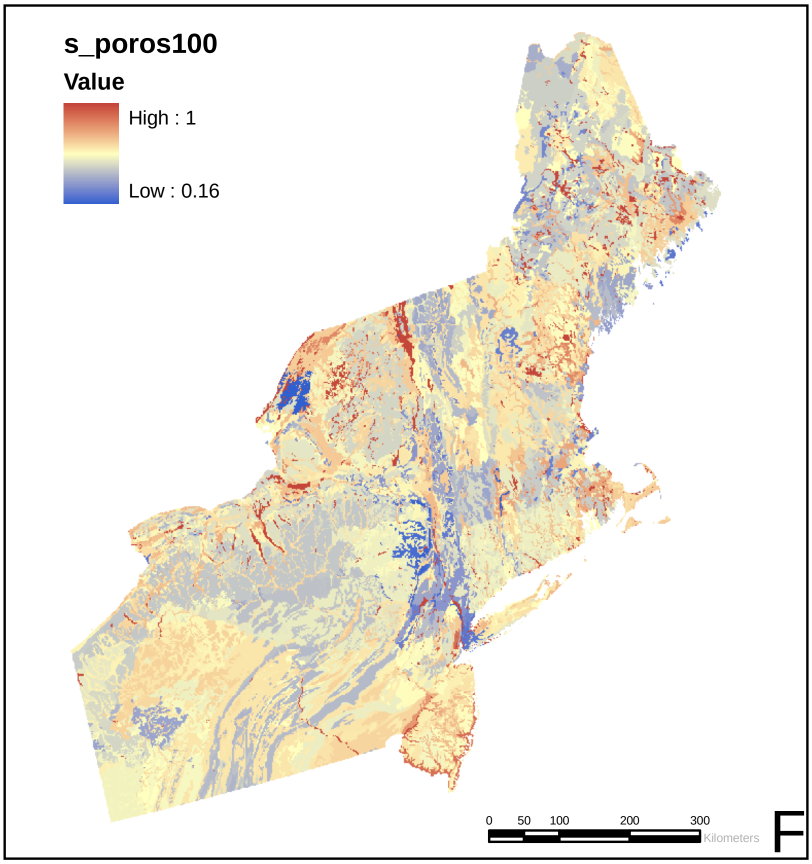
s_perm100
soil permeability rate, 0-100 cm depth
cm/hr

Figure 12. Soil porosity from 0-30 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



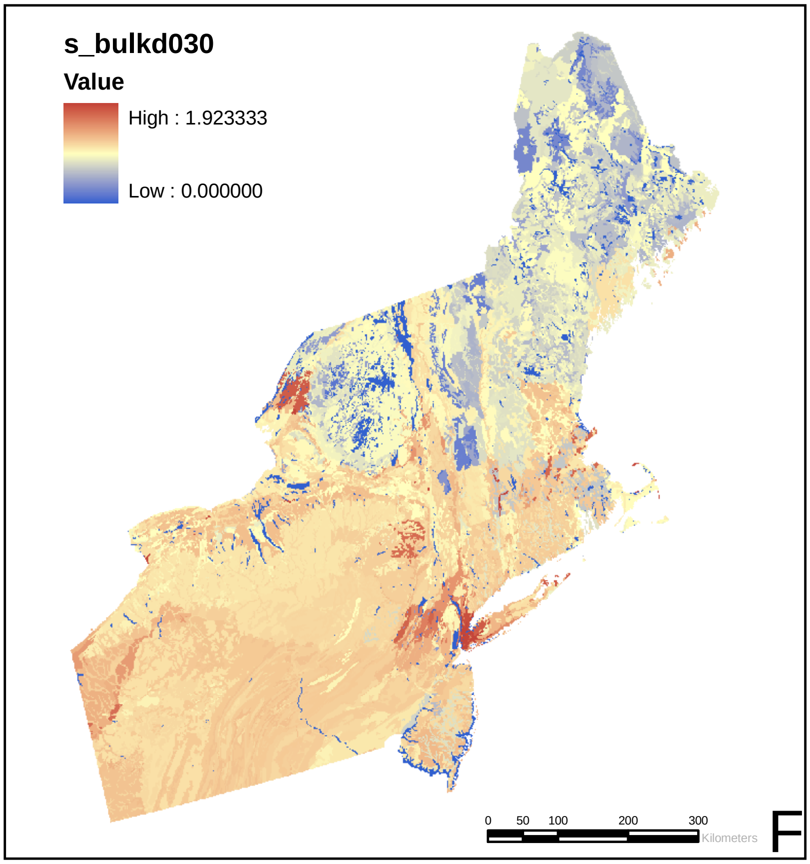
s_poros030
soil porosity, 0-30 cm depth
%

Figure 13. Soil porosity from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



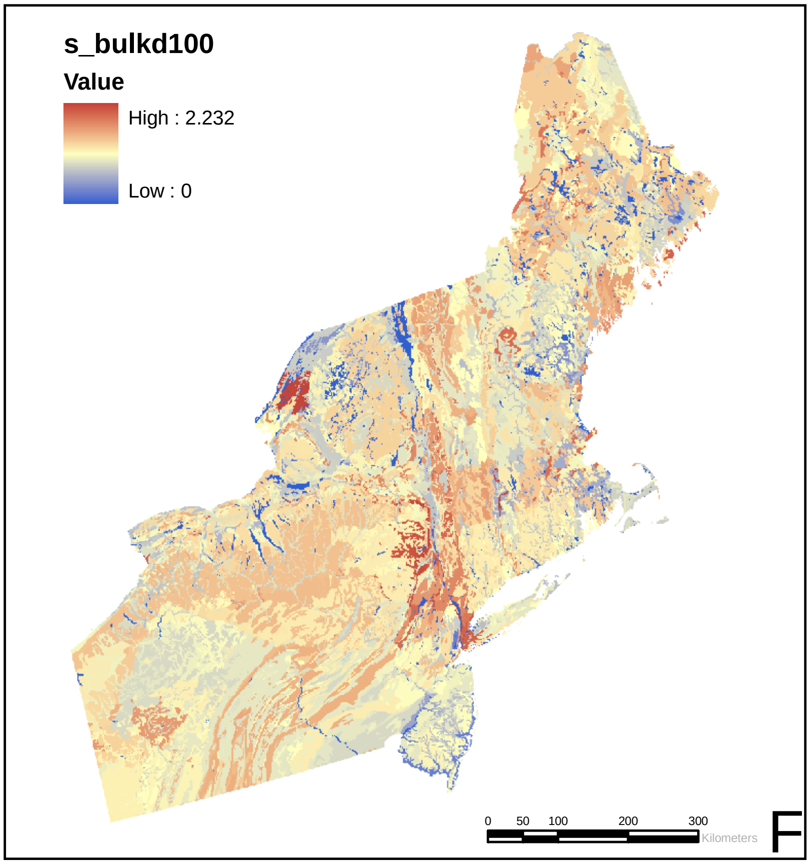
s_poros100
soil porosity, 0-100 cm depth
%

Figure 14. Soil bulk density from 0-30 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



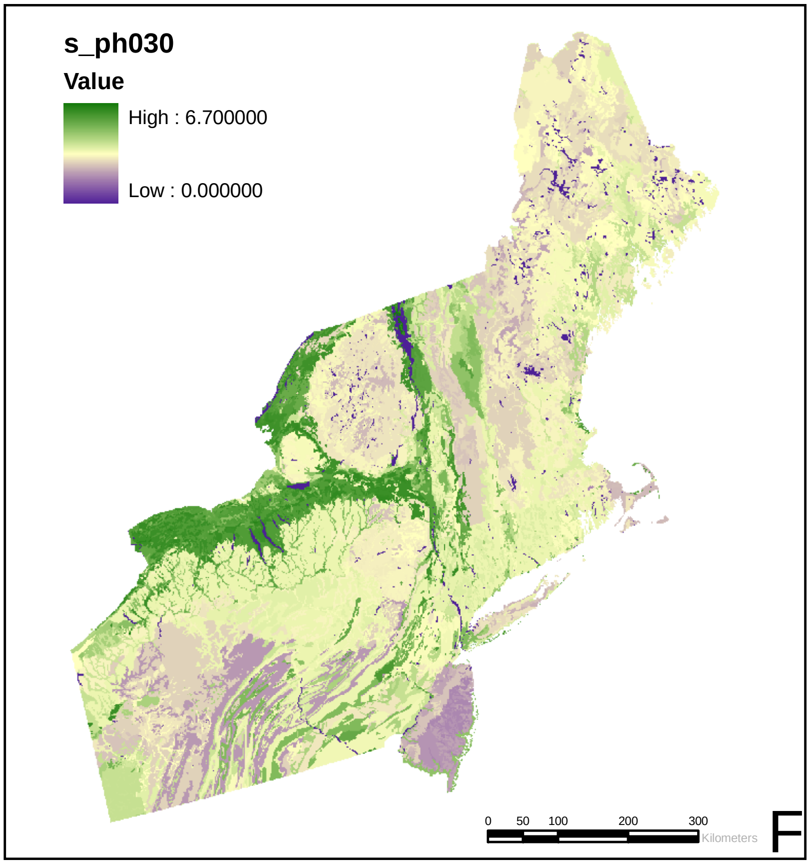
s_bulkd030
soil bulk density, 0-30 cm depth
g/cm3

Figure 15. Soil bulk density from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



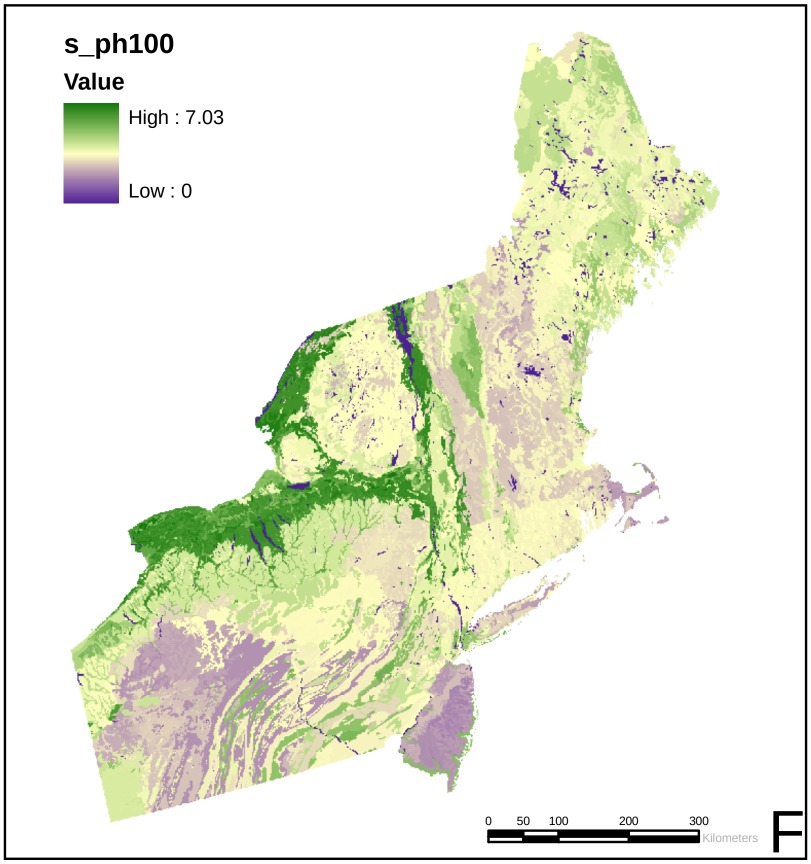
s_bulkd100
soil bulk density, 0-100 cm depth
g/cm3

Figure 16. Soil pH from 0-30 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



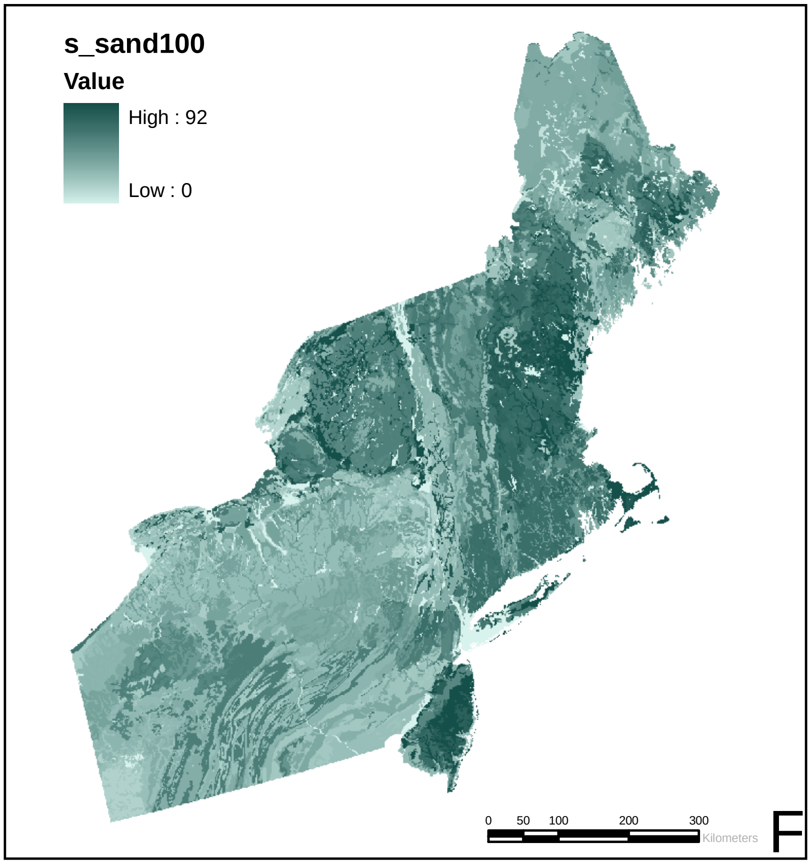
s_pH030
soil pH, 0-30 cm depth
pH units

Figure 17. Soil pH from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



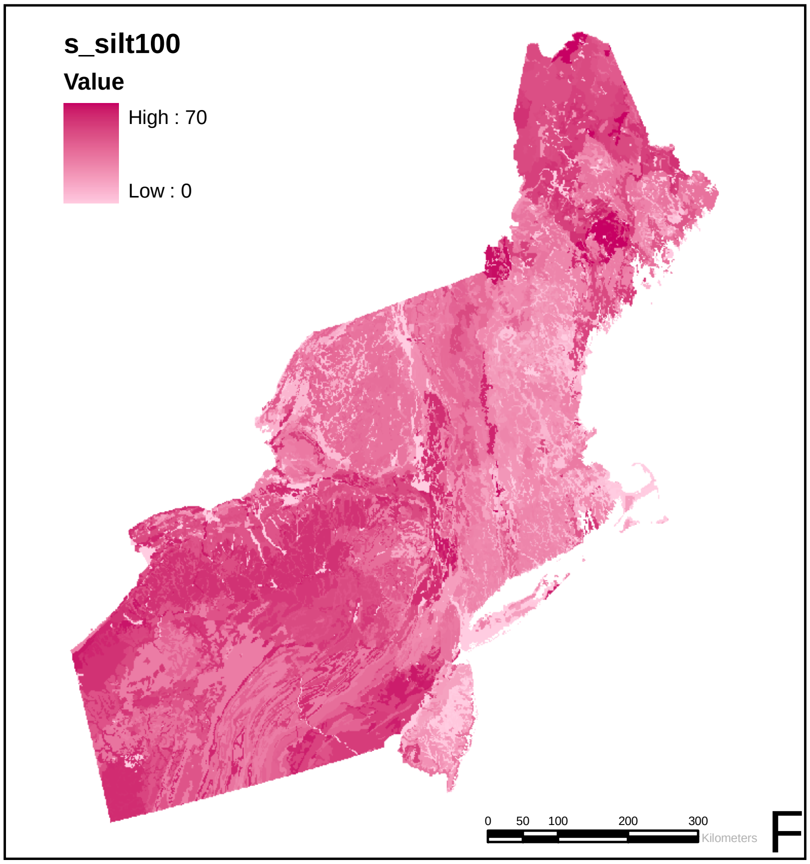
s_pH100
soil pH, 0-100 cm depth
pH units

Figure 18. Soil sand content from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



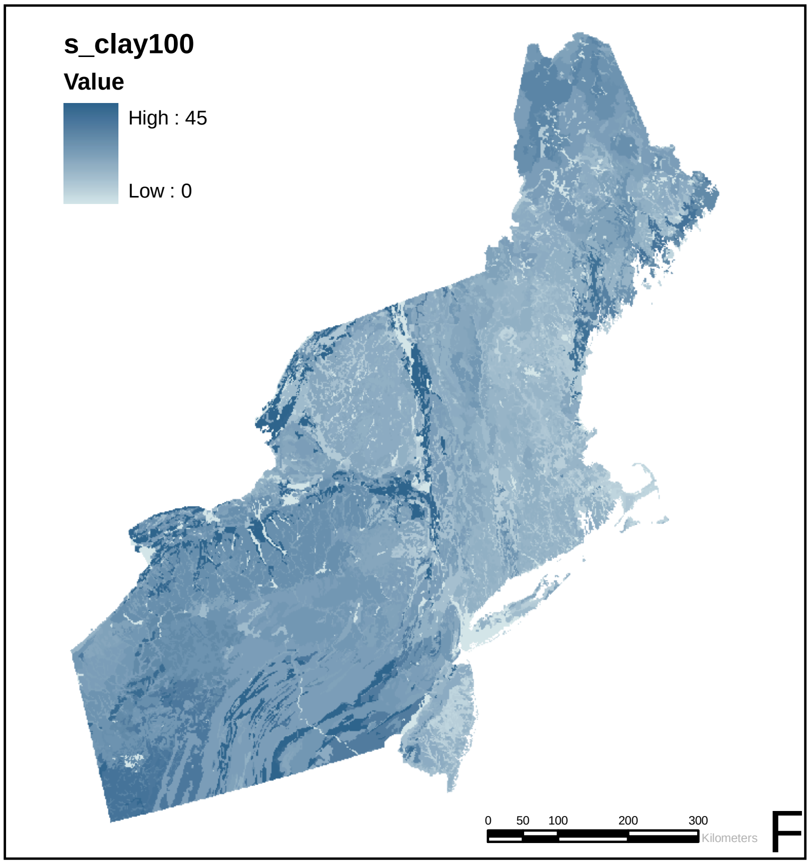
s_sand100
soil sand content, 0-100 cm depth
%

Figure 19. Soil silt content from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



s_silt100
soil silt content, 0-100 cm depth
%

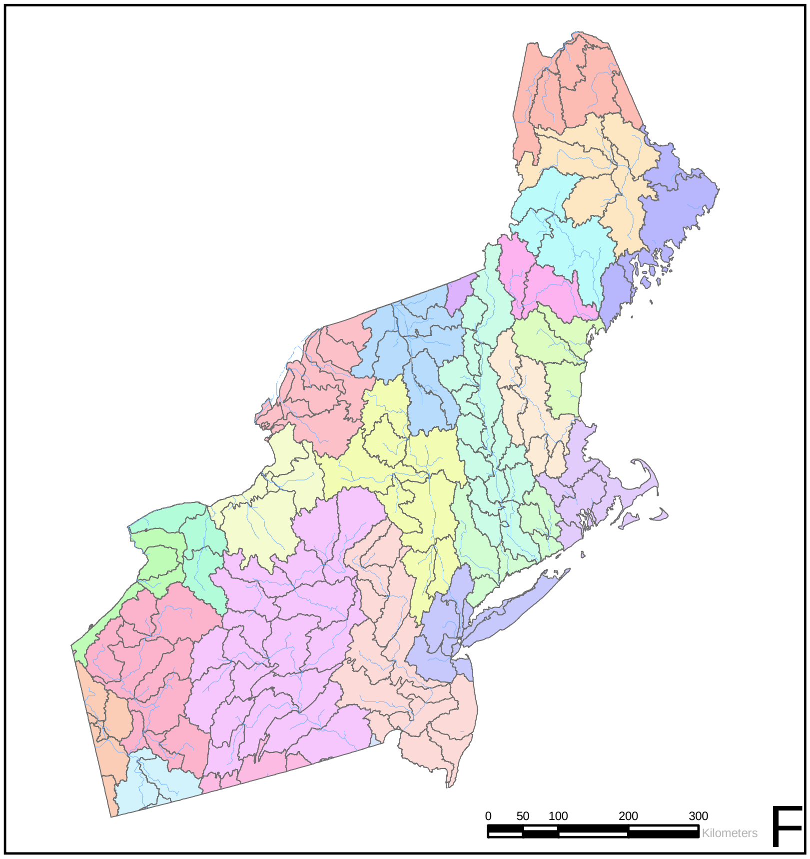
Figure 20. Soil clay content from 0-100 cm depth of soil. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



s_clay100
soil clay content, 0-100 cm depth
%

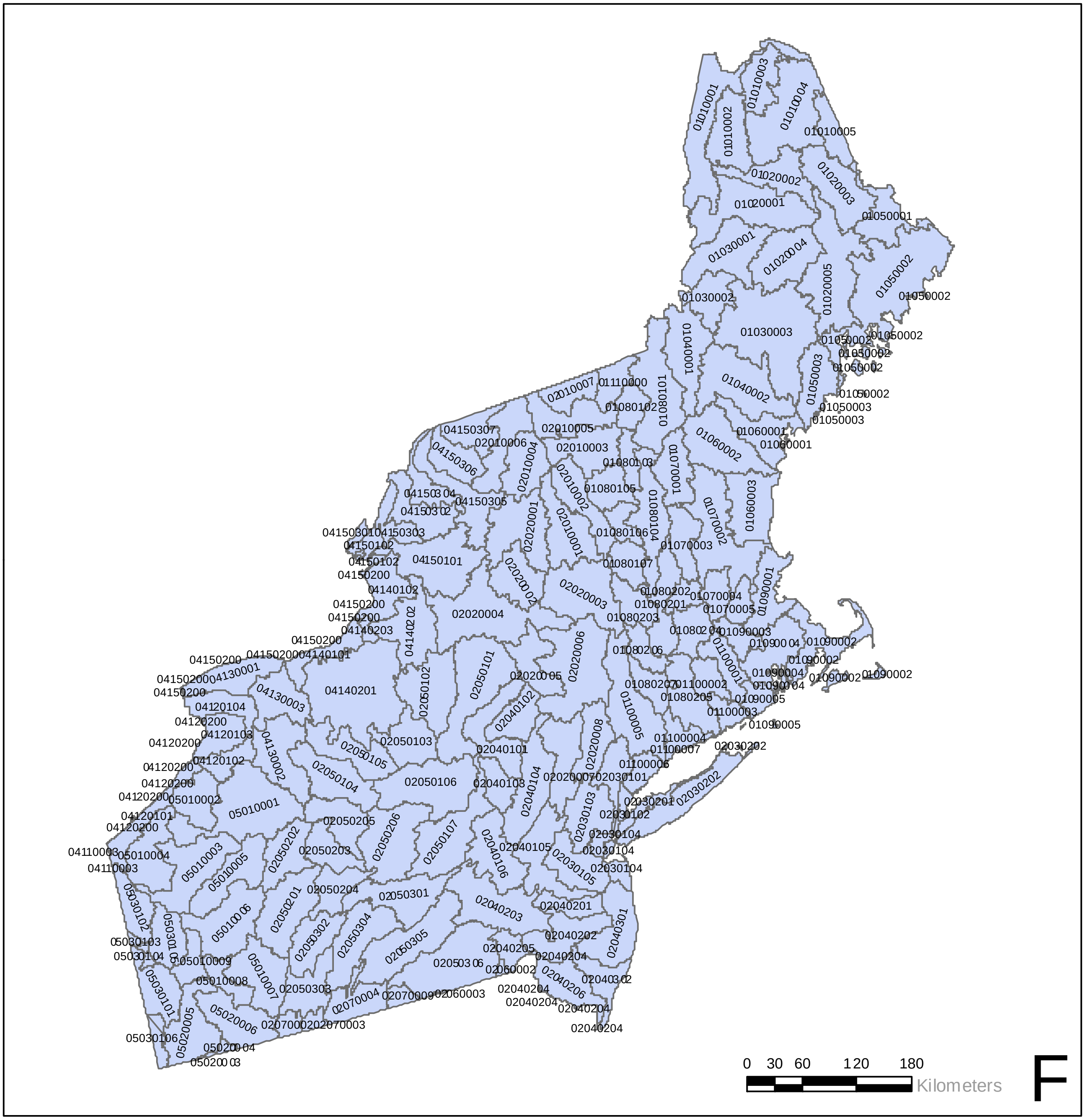
Appendix E-3: Regional Landscape Characteristics Maps

Figure 21. Watershed boundaries. Source:
http://nature.berkeley.edu/boyerlab/nercgis.html



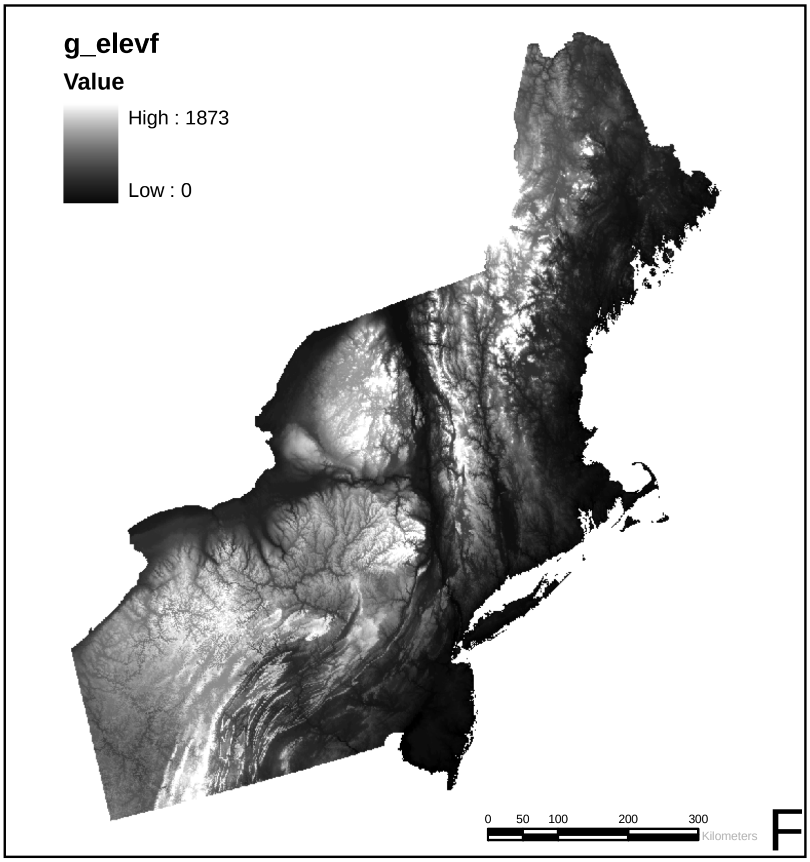
lm_huc8
watershed boundaries
hydrologic unit codes (2- to 8- digit)

Figure 22. Watershed boundaries with 8-digit Hydrologic Unit Codes. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



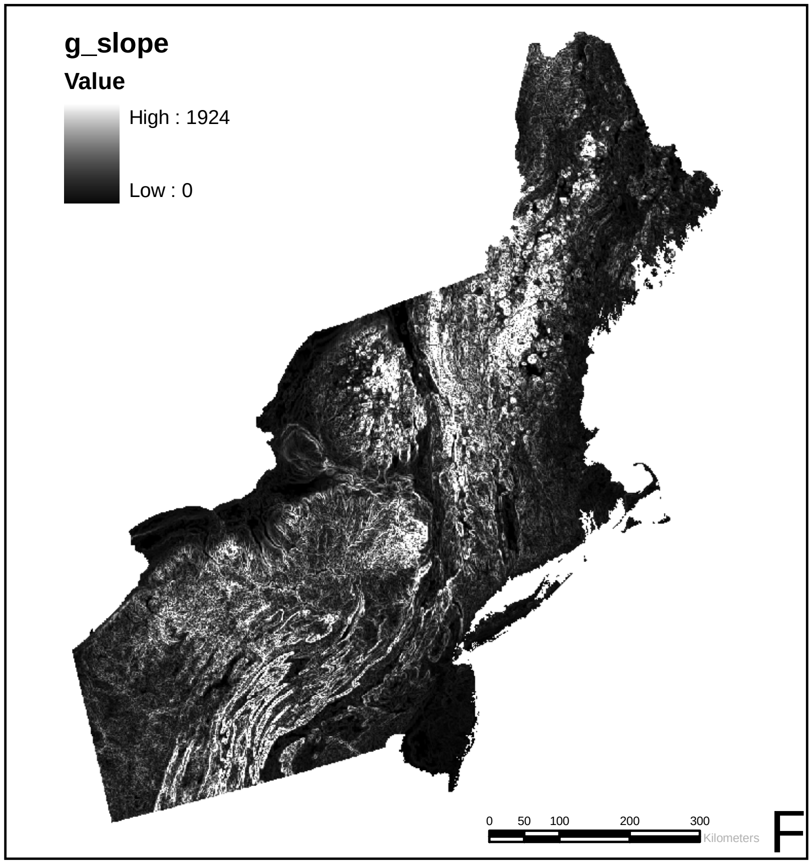
lm_nehucs
Watershed Boundaries
8-digit Hydrologic Unit Codes

Figure 23. Digital elevation data from the USGS GTOPO30 global digital elevation model of the world, and hydrologically corrected (for example with filled pits, to allow routing of water from inlands to the coast). Source: http://nature.berkeley.edu/boyerlab/nercgis.html



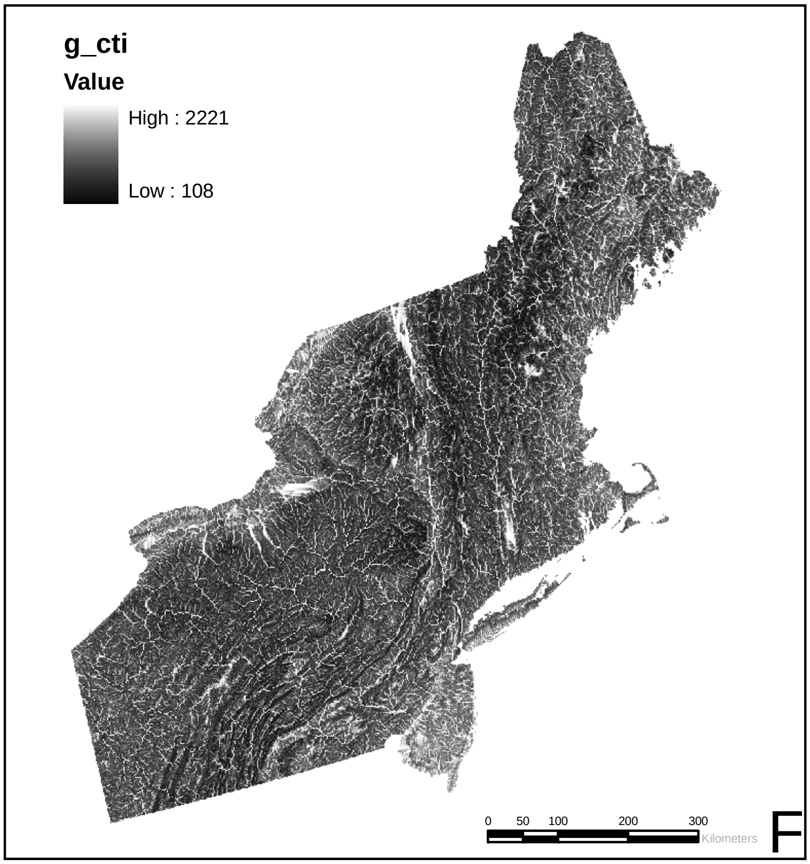
g_elevf
elevation (m), conditioned & filled
georeferenced to HYDRO1K terrain data

Figure 24. Slope of elevation, based on GTOPO30 terrain. Describes the maximum change in the elevations between each cell and its eight neighbors, in units of degrees of slope between 0 and 90. Source: http://nature.berkeley.edu/boyerlab/nercgis.html



g_slope
slope (of g_elevf)
degree (* 100)

Figure 25. Compound Topographic Index (CTI), based on GTOPO30 terrain. A wetness index that provides a metric of potential for landscape wetness, based solely on topography (i.e., independent of soil characteristics or precipitation regime).
Source: http://nature.berkeley.edu/boyerlab/nercgis.html



g_cti
compound topographic index (of g_elevf)
dimensionless (* 100)