**Supplementary Materials**

Variation in metal concentration across tree organs and stands: implications for reference specimen development

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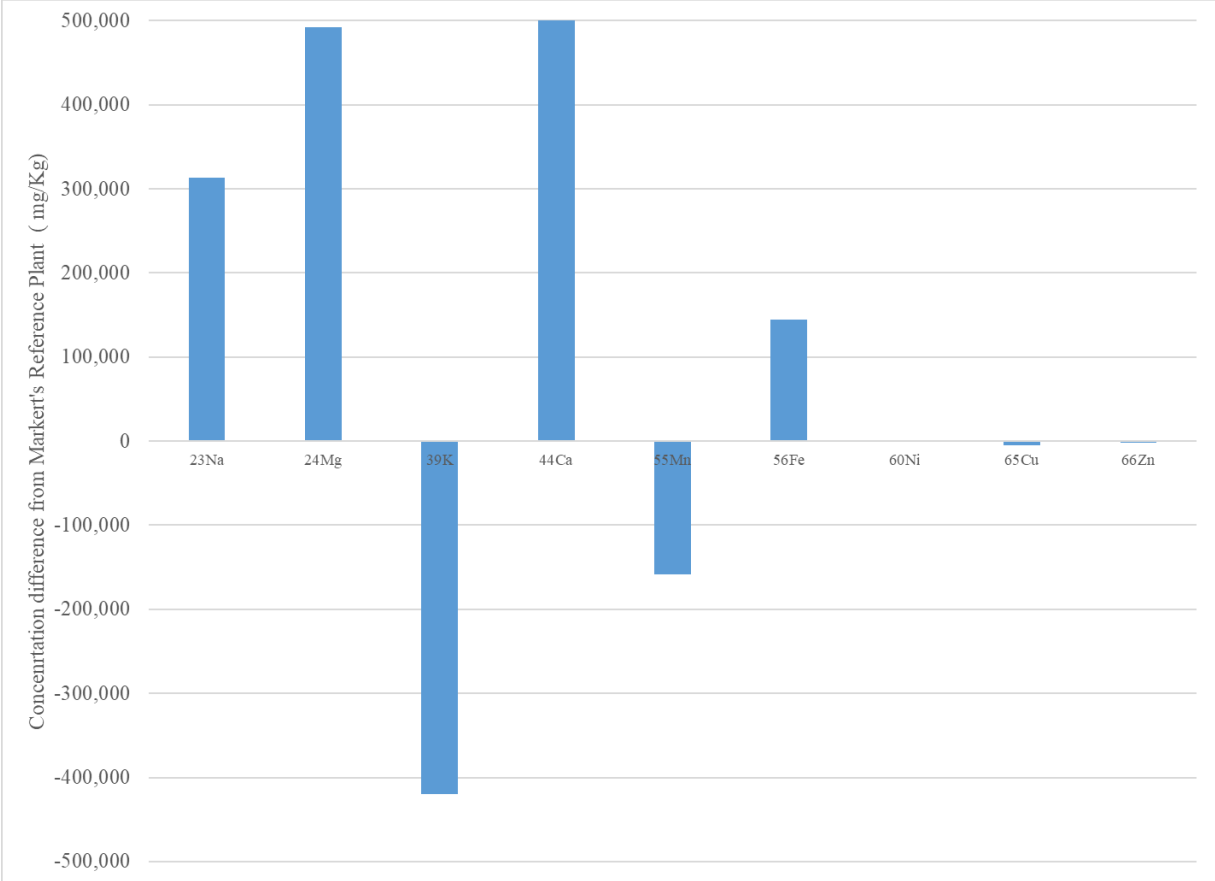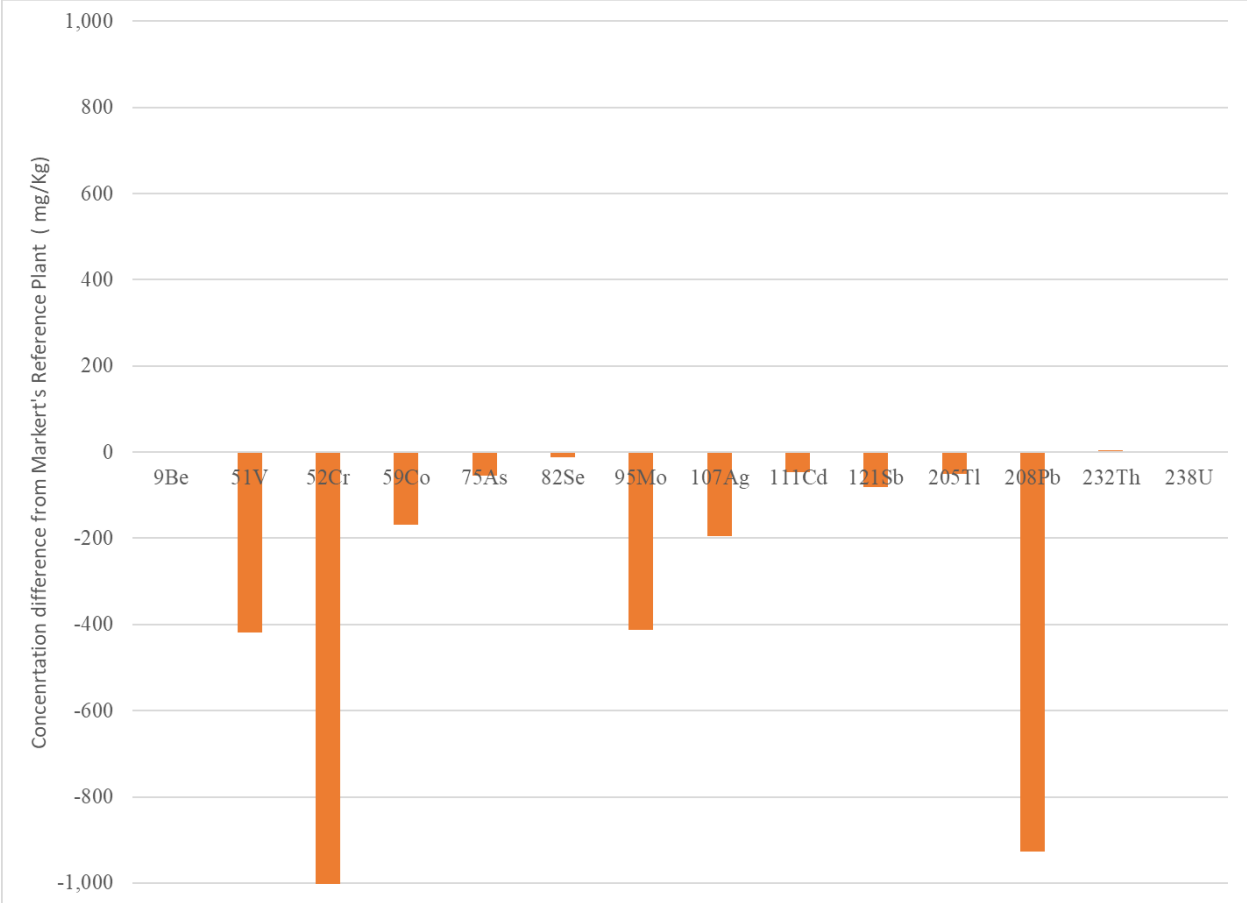
Supplementary Figure 1. Reference Bark as compared to Merkart's Reference Plant for tree nutrient elements
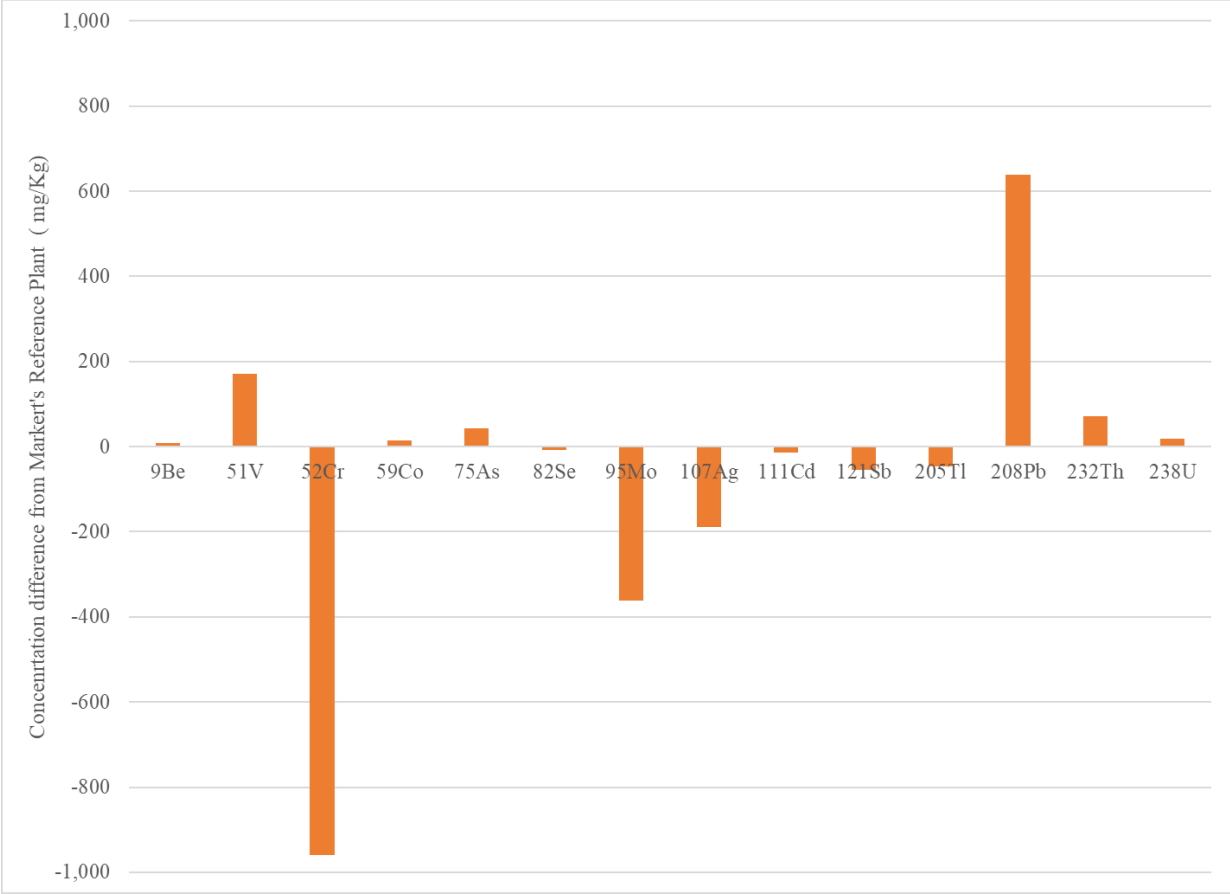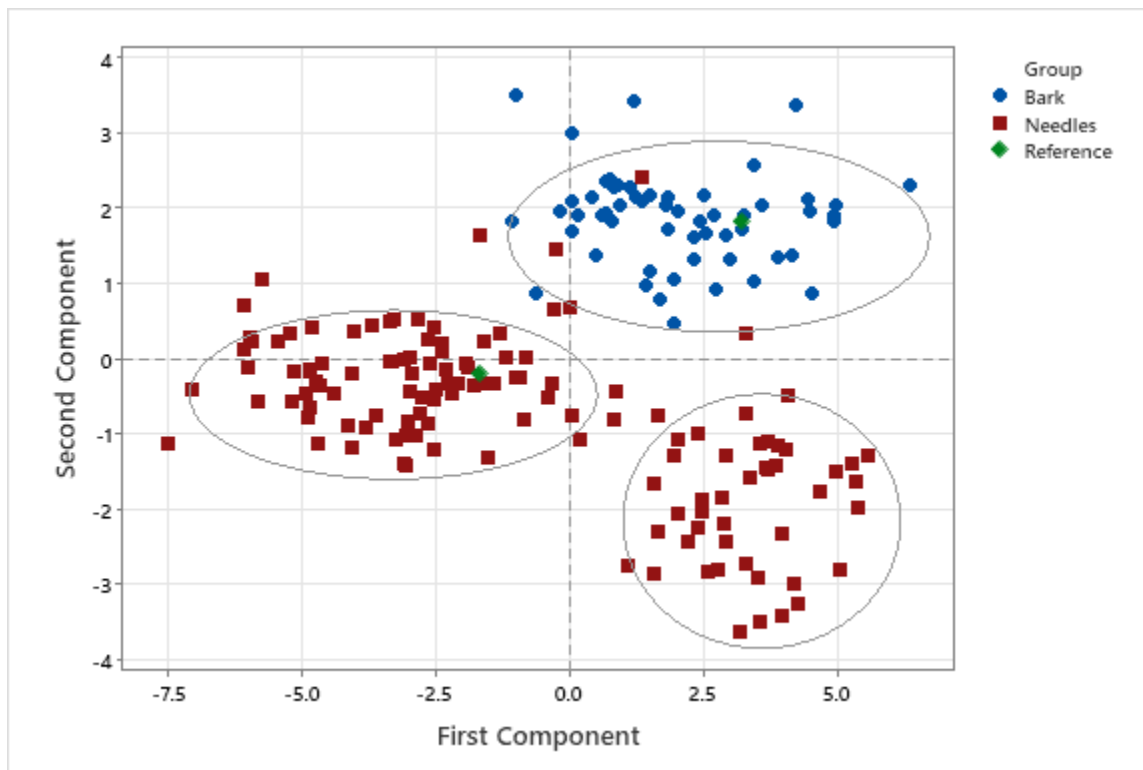
Supplementary Figure 2. Reference Bark as compared to Merkart's Reference Plant for trace elements
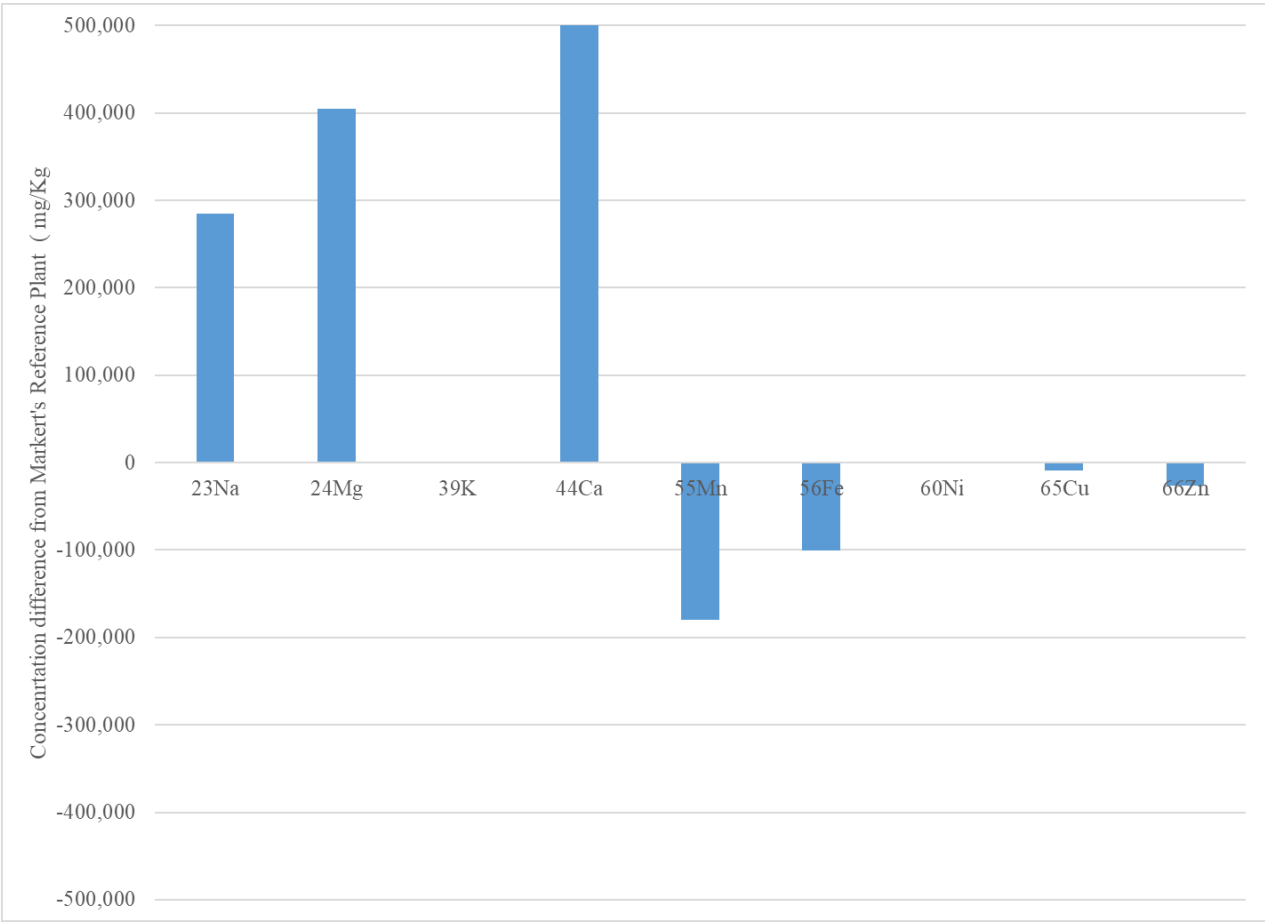
Supplementary Figure 3. Reference Needles as compared to Merkart's Reference Plant for tree nutrient elements

Supplementary Figure 4. Reference Needle as compared to Merkart's Reference Plant for trace elements

Supplementary Figure 5. Principal component analysis of data for all elements and samples used to develop the reference bark and needles. The green diamonds are the reference needles and bar. The circle around the needles in the bottom right hand corner indicates needles with elevated concentrations of both trace (PC1- Cu, Cr, Fe, and Pb) and tree nutrients (PC 2-K, Mo, and Mg)

Supplementary Table 1. Method limits of detection, and concentration of pine-certified reference material values compared with six replicate analysis of the CRM

Element (Mass Number)	Method Detection Limit (ng/g)	CRM-PN-A (µg/g)	6 replicate extraction and analyses (µg/g)
Beryllium (9)	0.012	--	--
Sodium (23)	10	62 (±3)	87 (±2)
Magnesium (24)	10	1000 (±30)	961 (±19)
Aluminum (27)	0.3	1010 (±40)	908 (±18)
Potassium (39)	10	540 (±25)	481 (±11)
Calcium (44)	10	5020 (200)	5275 (±107)
Vanadium (51)	0.3	--	--
Chromium (52)	0.1	0.5	0.2 (±0.05)
Manganese (55)	0.1	232 (±13)	236 (±5)
Iron (56)	10	133 (±12)	62 (±1)
Cobalt (59)	0.05	--	--
Nickle (60)	0.05	0.85	0.64 (±0.01)
Copper (65)	0.05	1.85	1.37 (±0.03)
Zinc (66)	0.5	28.8 (±1.5)	17 (±1)
Arsenic (75)	0.5	--	--
Selenium (82)	0.03	--	--
Molybdenum (95)	0.1	--	--
Silver (107)	1	--	--
Cadmium (111)	0.05	0.13 (±0.01)	0.08 (±0.002)
Antimony (121)	0.05	--	--
Barium (137)	10	10.6 (±0.6)	8.58 (±0.2)
Thallium (205)	0.05	--	--

Lead (208)	0.05	1.1	0.87 (±0.02)
Thorium (232)	0.5	--	--
Uranium (238)	0.05	--	--