

Table 1a. Method detection limits and calibration ranges for elements measured by ICP-MS (Agilent 7500cx).

Element	Calibration Range (µg/L)	Element	Calibration Range (µg/L)	Element	Calibration Range (µg/L)	Element	Calibration Range (µg/L)
¹⁰⁷ Ag	0.01 - 100	⁵⁹ Co	0.01 - 100	⁵⁵ Mn	0.01 - 100	¹²⁵ Te	0.01 - 100
²⁷ Al	0.01 - 100	⁵³ Cr	0.01 - 100	⁹⁵ Mo	0.01 - 100	²⁰⁵ Tl	0.01 - 100
⁷⁵ As*	0.1 - 1000	⁶³ Cu	0.01 - 100	²³ Na	0.01 - 100	²³⁸ U	0.01 - 100
¹³⁸ Ba	0.01 - 100	⁵⁶ Fe*	0.1 - 1000	⁶⁰ Ni	0.01 - 100	⁵¹ V*	0.01 - 100
⁹ Be	0.1 - 1000	⁷¹ Ga	0.01 - 100	total Pb	0.01 - 100	⁶⁶ Zn	0.1 - 1000
²⁰⁹ Bi	0.01 - 100	³⁹ K*	0.01 - 100	⁸⁵ Rb	0.01 - 100		
⁴³ Ca	1 - 10000	⁷ Li	0.01 - 100	⁸² Se*	0.1 - 1000		
¹¹¹ Cd	0.01 - 100	²⁴ Mg	0.01 - 100	⁸⁸ Sr	0.01 - 100		

* = use of collision cell for interference correction.

total = measurement of 204, 206, 207 and 208 and using the total signal to account for possible isotope fractionation processes.

Table 1b. Isotopes and integration times used for Cu, Zn, and Pb measurements.

Element	Isotopes/integration time (s)			
Cu	63/0.1	65/0.1		
Zn	64/0.1	66/0.1	67/0.1	68/0.1
Pb	204/1	206/0.2	207/0.2	208/0.1

Table 2. Variation in soil physicochemical properties and below-ground biomass across restoration distance gradient sites and soil depth intervals. Values are presented as mean (SD) for the New Site, Old Site, Intermediate 1, Intermediate 2, and Reference sites. Reported variables include soil pH, root biomass, soil depth, soil mass (g m⁻²), and C: N ratio across depth bands. One-way ANOVA

		New Site	Old Site	Intermediate 1	Intermediate 2	Reference	ANOVA F	p-value	Sig.
pH	Depth	1 (N=5)	2 (N=6)	3 (N=5)	4 (N=6)	5 (N=6)			
Mean (SD)	0-5 cm	4.62 (0.28)	4.98 (0.47)	5.02 (0.61)	4.92 (0.53)	5.11 (0.66)	0.640	0.640	ns
	5-10 cm	5.46 (0.44)	4.54 (0.35)	5.13 (0.80)	4.65 (0.49)	4.47 (0.27)	4.116	0.012	*
	10-20 cm	4.97 (0.39)	4.60 (0.16)	4.67 (0.67)	4.50 (0.57)	4.21 (0.22)	2.157	0.106	ns
Root biomass (gm ⁻²)									
Mean (SD)	0-5 cm	4076.06 (1102.41)	6374.12 (3659.67)	5500.39 (3319.81)	4618.89 (2237.55)	8994.45 (2201.01)	2.988	0.040	*
	5-10 cm	5317.73 (1991.53)	5622.63 (1736.16)	6567.88 (2914.63)	5074.71 (1769.61)	6807.02 (2043.42)	0.759	0.563	ns
	10-15 cm	5523.82 (4413.81)	6761.75 (6638.57)	9229.46 (7063.80)	6693.93 (3111.49)	3156.79 (1442.76)	1.106	0.377	ns
Soil depth (cm) Mean (SD)		15.00 (2.12)	17.67 (2.25)	16.26 (2.96)	14.33 (1.29)	14.67 (1.37)	2.659	0.058	ns
Soil mass (g/m ²) Mean (SD)									
Depth band	0-5 cm	4142.95 (1123.81)	9494.97 (4523.69)	6356.52 (5060.33)	4833.22 (1994.48)	10823.10 (2428.10)	4.307	0.010	*
	5-10 cm	13315.03 (5693.80)	6842.67 (2263.18)	6762.43 (4905.80)	3815.90 (1199.66)	12350.42 (4704.39)	5.730	0.002	*
	10-20 cm	9189.39 (5025.19)	17338.13 (12038.46)	8001.55 (8553.83)	3718.28 (2143.37)	8959.65 (4177.78)	2.727	0.054	ns
C:N ratio									
Mean (SD)	0-5 cm	25.65 (2.64)	29.39 (2.71)	26.94 (3.60)	27.78 (3.23)	30.55 (5.03)	1.621	0.203	ns
	5-10 cm	19.19 (1.91)	27.63 (1.95)	24.54 (6.29)	27.94 (3.44)	32.35 (4.81)	8.023	0.000	*
	10-20 cm	22.80 (3.96)	24.82 (2.50)	31.10 (15.68)	28.92 (5.04)	33.96 (6.08)	1.893	0.146	ns

results are shown as F values and associated p-values; significance is indicated by * for statistically significant effects and ns for non-significant effects.

Table 3a. Total soil metal concentrations (mg kg^{-1}) across depth intervals and sites.

Depth	Group					ANOVA F	Significant
	New Site	Old Site	Intermediate 1	Intermediate 2	Reference		
	1 (N=5)	2 (N=6)	3 (N=5)	4 (N=6)	5 (N=6)		
Zn0-5							
Mean (SD)	11008 (9278)	6039 (3028)	2880 (1706)	2209 (1800)	748 (111)	4.88	No
Zn5-10							
Mean (SD)	9200 (3107)	8214 (1209)	1347 (379)	1019 (408)	622 (314)	47.92	Yes
Zn10-20							
Mean (SD)	4571 (2889)	8618 (4981)	1461 (481)	1082 (740)	408 (180)	9.78	No
Cu0-5							
Mean (SD)	7233 (7506)	3694 (3836)	532 (105)	182 (114)	92 (23)	3.94	No
Cu5-10							
Mean (SD)	9409 (4310)	10019 (2496)	589 (140)	314 (216)	165 (84)	32.14	Yes
Cu10-20							
Mean (SD)	2104 (1468)	7589 (3728)	393 (184)	299 (201)	100 (37)	17.49	No
Pb0-5							
Mean (SD)	466 (563)	414 (361)	167 (52)	202 (223)	115(54)	1.42	No
Pb5-10							
Mean (SD)	461 (257)	1200 (899)	306 (110)	242 (140)	146 (108)	5.45	No
Pb10-20							
Mean (SD)	149 (54)	642 (303)	165 (122)	173 (105)	102 (43)	11.29	No

Table 3b. Soil metal isotopic signatures across depth intervals and sites.

<i>Depth</i>	<i>Group</i>					<i>ANOVA F</i>	<i>Significant</i>
	<i>New Site</i>	<i>Old Site</i>	<i>Intermediate 1</i>	<i>Intermediate 2</i>	<i>Reference</i>		
	1 (N=5)	2 (N=6)	3 (N=5)	4 (N=6)	5 (N=6)		
<i>Cu65_63_L1 Mean (SD)</i>	0.483 (0.008)	0.480 (0.004)	0.483 (0.002)	0.480 (0.007)	0.479 (0.013)	0.27	No
<i>Cu65_63_L2 Mean (SD)</i>	0.481 (0.008)	0.486 (0.005)	0.482 (0.008)	0.479 (0.005)	0.477 (0.008)	1.48	No
<i>Cu65_63_L3 Mean (SD)</i>	0.480 (0.003)	0.485 (0.008)	0.484 (0.007)	0.480 (0.005)	0.480 (0.005)	0.89	No
<i>Zn67_66_L1 Mean (SD)</i>	0.151 (0.0015)	0.150 (0.0008)	0.155 (0.004)	0.152 (0.002)	0.153 (0.003)	3.01	No
<i>Zn67_66_L2 Mean (SD)</i>	0.151 (0.0008)	0.150 (0.0006)	0.154 (0.003)	0.153(0.003)	0.157 (0.006)	3.35	No
<i>Zn67_66_L3 Mean (SD)</i>	0.152 (0.002)	0.150 (0.001)	0.153 (0.003)	0.153 (0.001)	0.156 (0.003)	6.16	No
<i>Pb206_208_L1 Mean (SD)</i>	0.493 (0.0020)	0.489 (0.0041)	0.501 (0.0301)	0.502 (0.0202)	0.476 (0.0073)	2.58	No
<i>Pb206_208_L2</i>							

<i>Mean (SD)</i>	0.500 (0.0056)	0.489 (0.0049)	0.507 (0.0307)	0.502 (0.0253)	0.478 (0.0048)	2.76	No
<i>Pb206_208_L3</i>							
<i>Mean (SD)</i>	0.506 (0.0215)	0.485 (0.0025)	0.517 (0.0353)	0.513 (0.0274)	0.483 (0.0085)	2.91	No
<i>Pb 206_207_L1</i>							
<i>Mean (SD)</i>	1.189 (0.013)	1.174 (0.004)	1.225 (0.085)	1.226 (0.059)	1.139 (0.016)	3.662	No
<i>Pb 206_207_L2</i>							
<i>Mean (SD)</i>	1.224 (0.021)	1.175 (0.006)	1.243 (0.092)	1.230 (0.070)	1.148 (0.022)	3.429	No
<i>Pb 206_207_L3</i>							
	1.254 (0.075)	1.175 (0.008)	1.2710 (0.102)	1.262 (0.076)	1.179 (0.022)	3.009	No

Table 4. Percentage change in soil metal concentrations with depth, calculated from site-level group means.

Metal	Group	0–5 → 5–10 cm (%)	5–10 → 10–20 cm (%)	0–5 → 10–20 cm (%)
Cu	New smelter	–9	–62	–65
	Old smelter	+100	–17	+67
	Reference	–18	–39	–50
Pb	New smelter	–33	–65	–77
	Old smelter	+98	–38	+23
	Reference	+64	–37	+3
Zn	New smelter	–51	–33	–67
	Old smelter	–10	–23	–31
	Reference	–43	–44	–68

Table 5. Moss coverage, stable isotope signatures, and metal concentrations across sites.

Variable	New Site Mean (± SD)	Old Site Mean (± SD)	Intermediate 1 Mean (± SD)	Intermediate 2 Mean (± SD)	Reference Mean (± SD)	ANOVA F	p value	Significance
Moss coverage (%)	12.0 ± 13.9 (n=5)	95.5 ± 4.6 (n=6)	83.0 ± 5.7 (n=5)	85.0 ± 7.1 (n=6)	100.0 ± 0.0 (n=6)	122.10	0.0000	***
δ ¹³ C (‰)	-29.79 ± 1.27 (n=4)	-33.19 ± 0.81 (n=6)	-31.57 ± 0.63 (n=5)	-31.75 ± 0.78 (n=6)	-31.78 ± 0.49 (n=6)	11.032	0.0000	***
δ ¹⁵ N (‰)	-3.48 ± 0.84 (n=4)	-5.94 ± 0.50 (n=6)	-5.37 ± 1.21 (n=5)	-5.70 ± 0.741 (n=6)	-6.92 ± 0.72 (n=6)	10.970	0.0000	***
Zn (µg g ⁻¹ dw)	1244.14 ± 1286.29 (n=4)	212.36 ± 32.70 (n=6)	125.61 ± 32.81 (n=5)	93.60 ± 35.78 (n=6)	88.74 ± 22.68 (n=6)	4.73	0.0066	**
Cu (µg g ⁻¹ dw)	253.29 ± 156.90 (n=4)	33.18 ± 8.47 (n=6)	20.16 ± 12.55 (n=5)	14.14 ± 5.52 (n=6)	12.89 ± 10.99 (n=6)	13.59	0.0000	***
Pb (µg g ⁻¹ dw)	36.663 ± 30.263 (n=4)	3.445 ± 0.931 (n=6)	3.147 ± 1.861 (n=5)	2.167 ± 0.645 (n=6)	2.141 ± 0.427 (n=6)	7.8201	0.0004	***

Table 6. *Spruce needle stable isotope signatures and metal concentrations across sites*

Variable	New Site Mean (± SD)	Old Site Mean (± SD)	Intermediate 1 Mean (± SD)	Intermediate 2 Mean (± SD)	Reference Mean (± SD)	ANOVA F	p value	Significance
$\delta^{13}\text{C}$ (‰)	-30.76 ± 1.02 (n=5)	-30.63 ± 0.79 (n=6)	-29.81 ± 1.09 (n=4)	-29.20 ± 0.70 (n=6)	-29.53 ± 0.75 (n=6)	3.57	0.021	*
$\delta^{15}\text{N}$ (‰)	-2.69 ± 1.72 (n=5)	-2.89 ± 2.37 (n=6)	-4.77 ± 1.30 (n=4)	-5.78 ± 0.75 (n=6)	-6.29 ± 1.22 (n=5)	5.64	0.0030	**
Zn (µg g ⁻¹ dw)	88.86 ± 23.94 (n=5)	122.00 ± 74.12 (n=6)	107.12 ± 43.79 (n=4)	65.37 ± 9.34 (n=6)	41.47 ± 16.93 (n=6)	3.50	0.02	*
Cu (µg g ⁻¹ dw)	8.70 ± 3.71 (n=5)	8.13 ± 4.48 (n=6)	9.59 ± 5.09 (n=4)	8.60 ± 9.79 (n=6)	5.56 ± 4.37 (n=6)	0.34	0.84	ns
Pb (µg g ⁻¹ dw)	0.26 ± 0.12 (n=5)	0.43 ± 0.29 (n=6)	0.45 ± 0.02 (n=4)	0.43 ± 0.02 (n=6)	0.27 ± 0.15 (n=6)	1.71	0.18	ns