APPENDIX I

SEQUOIA NATIONAL PARK AC-RINGS, 1857-1984 and 1792-1884

Nutriant and trace element concentrations in woody tissues of two individual Abies concolor. Data are present for annual ring tissues for the periods 1857-1984 and 1792-1884. Tree cores were collected near the General Sherman Tree, Grant Forest, Sequoia National Park.

CONCENTRATION SEQUIOA NATIONAL PARK AC-RINGS,1857-1984 DR. RUNDEL 4-22-85
.I. DRY TISSUE VALUES ARE % OR PPM (1% = 10,000PPM) DK2:042285.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1857	7.6	101	19.1	1.03%	8770	1060	9.38	0.62	104	227	2.06
1858	8.3		11.0	6650	1380	193	6.37	0.36	23.5	66.9	2.0[illegible]
1859	8.0		3.38	3200	1290	130	4.94	0.37	25.8	56.9	1
1860	7.4		10.2	2820	1500	193	6.15	0.67	28.4	82.6	2.[illegible]
1861	7.6		15.4	2420	1920	165	6.77	0.89	57.6	97.4	1.97
1862	7.4		14.3	2780	1550	145	5.80	0.48	31.7	86.5	1.64
1863	8.3		14.8	1400	2280	204	2.92	0.31	16.2	131	1.60
1864	7.5		26.4	600	2110	213	5.02	0.78	26.9	101	2.08
1865	8.6	7.34	33.2	621	1760	201	3.06	0.57	13.9	96.0	1.66
1866	7.4		30.7	1120	2240	234	3.56	0.51	13.2	87.4	2.49
1867	8.6		12.9		403	107	2.74	0.38	18.6	79.9	0.46
1868	8.4		50.7	1710	2050	207	3.75	1.23	66.7	119	1.30
1869	8.1	4.01	36.2	1350	1870	222	4.73	0.76	18.7	70.9	2.26
1870	7.5	18.5	41.8	1460	2440	240	4.11	0.60	14.1	91.0	2.01
1871	7.4	5.40	34.4	1260	2930	215	3.08	0.68	26.0	109	1.83
1872	8.2		42.7	1450	1840	244	3.79	0.68	18.4	79.7	1.28
1873	7.0	0.76	22.3	1250	1190	244	2.97	1.21	16.3	72.3	0.87
1874	8.0	15.4	23.8	1740	2380	255	3.77	0.72	15.3	106	1.77
1875	8.2		29.2	2370	2390	266	2.29	0.48	22.0	94.9	1.09
1876	7.9		30.0	1130	2010	219	3.81	1.70	28.0	89.0	2.03
1877	8.2		42.6	1700	2070	261	3.39	0.61	25.4	101	1.92
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1857	7.6	101	40.2		0.36	0.12	0.72		1.69	68.8	31.4
1858	8.3	20.9	10.1		0.69				0.56	24.2	12.8
1859	8.0	15.9	14.2	0.10	1.12				0.38	15.6	9.24
1860	7.4	11.4	6.45		1.41	0.15	1.25		0.37	18.2	12.2
1861	7.6	44.6	113		1.46	0.16	2.56		1.14	25.2	10.8
1862	7.4	28.9	76.2		1.88	0.09			0.47	15.3	8.37
1863	8.3	10.8	8.38			0.22			0.20	30.2	11.8
1864	7.5	17.5	26.1		0.03	0.23	2.48		0.61	27.7	14.4
1865	8.6	14.4	18.7	0.06		0.33	0.18		0.47	24.2	10.2
1866	7.4	20.1	38.9	0.03		0.05			0.38	29.8	15.8
1867	8.6	6.54	8.14		0.25		0.11		0.17	4.69	2.[illegible]
1868	8.4	41.1	51.2		0.25	0.09			1.53	24.1	9
1869	8.1	15.9	14.8						0.42	26.0	12.[illegible]
1870	7.5	18.3	26.1			0.31			0.51	31.9	14.0
1871	7.4	25.6	36.3		0.02	0.86	1.88		0.82	31.9	13.0
1872	8.2	23.3	34.1						0.39	17.7	7.75
1873	7.0	15.0	22.1			0.28	5.35		0.52	17.2	10.2
1874	8.0	21.0	11.9	0.02					0.31	33.1	15.4
1875	8.2	23.1	17.0		0.58	0.84			0.40	24.3	9.94
1876	7.9	20.7	25.7			0.36	2.84		0.80	28.7	13.7
1877	8.2	17.8	17.7			0.31			1.14	32.1	15.1
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1857	7.6	0.54			7.21			0.02
1858	8.3				3.37			
1859	8.0				2.70			
1860	7.4				2.72			
1861	7.6				4.38			
1862	7.4				4.28			0.00
1863	8.3				2.12	0.01		
1864	7.5				4.72			
1865	8.6			0.01	5.00	0.03		
1866	7.4			0.21	4.80	0.04		
1867	8.6				3.76			
1868	8.4				3.83			
1869	8.1				2.91	0.01		
1870	7.5				5.33	0.04		
1871	7.4			0.09	6.01	0.01		
1872	8.2				2.73	0.01		
1873	7.0			0.24	4.87	0.01		
1874	8.0			0.08	4.21	0.03		
1875	8.2				1.87			
1876	7.9				5.07	0.02		
1877	8.2				4.82	0.01		
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUIOA NATIONAL PARK AC-RINGS,1857-1984 — DR. RUNDEL 4-22-85 — DK2:042285.C13;1

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1878	7.8		21.2	466	1070	192	2.56	0.43	23.8	68.6	0.19
1879	7.3		36.3	1220	1930	227	4.50	0.64	53.6	107	2.19
1880	8.4		29.8	1390	1890	219	4.02	0.66	69.5	105	1.86
1881	8.5	4.81	25.4	1770	1910	209	2.89	0.56	17.4	87.3	2.06
1882	8.4		44.4	1450	2550	239	3.85	0.71	50.3	111	2.32
1883	8.7		41.7	2940	2290	273	3.44	0.64	28.5	97.3	1.92
1884	8.4		42.5	1910	2170	246	3.27	0.66	26.2	88.1	2.37
1885	8.6		37.8	1910	1390	233	1.68	0.85	33.0	72.6	1.80
1886	8.4	10.1	46.7	1630	2570	232	3.04	0.65	19.4	114	2.90
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1878	7.8	13.0		0.49		0.28	0.23		0.67	13.6	5.88
1879	7.3	28.1	47.2			0.33	1.84		2.27	24.0	13.3
1880	8.4	21.5	32.5	0.00			0.68		3.70	27.5	13.3
1881	8.5	16.3	16.9		0.17	0.32			0.34	27.2	13.6
1882	8.4	25.5	35.7		0.59	0.63	1.50		1.69	34.8	18.7
1883	8.7	22.4	26.8			0.20			0.56	31.2	15.9
1884	8.4	19.8	19.8			0.33			0.78	28.2	16.2
1885	8.6	26.2	52.6		3.63	2.38	7.15	0.08	0.64	12.6	8.47
1886	8.4	14.6	4.45			0.66	1.09		0.36	32.3	16.4
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1878	7.8				4.44	0.00		
1879	7.3				4.19			
1880	8.4				3.12			
1881	8.5				3.37	0.01		
1882	8.4				5.44			
1883	8.7			0.21	3.72			
1884	8.4				4.87	0.02		
1885	8.6		0.04	0.27	6.38			0.01
1886	8.4				5.00	0.03		
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS;1857-1984 DR. RUNDEL 4-22-85 — DK2:042285.C13;3

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1887	7.9		39.2	1760	1810	258	0.14	0.40	30.3	97.7	2.07
1888	7.3	2.64	19.0		47.2	65.1	0.12	0.25	5.47	38.9	
1889	8.9	46.9	32.7	1070	1570	198	0.07	0.34	8.51	72.7	1.
1890	7.8		24.9	969	1570	220	0.08	0.44	41.3	85.6	1.
1891	7.5	30.7	33.9	325	2130	248	0.17	1.23	75.9	105	2.05
1892	7.7	41.9	36.4	713	2350	270	0.20	0.87	52.3	90.5	2.94
1893	8.3	12.8	14.5		113	61.4	0.01	0.14	8.87	32.2	0.52
1894	8.2	66.0	39.0	1240	1820	233	0.03	0.46	22.7	85.6	1.71
1895	7.5	13.7	45.6	702	861	207	0.52	0.43	38.1	76.2	0.91
1896	8.2		51.0	1770	854	205	0.10	0.42	50.4	67.9	1.06
1897	8.3	102	124	2300	1720	318	0.34	0.62	45.6	130	2.02
1898	7.2	116	74.6	2280	1490	281	0.25	0.57	30.1	85.2	1.58
1899	7.7	63.3	134	2340	2610	296	0.24	0.82	43.4	103	1.98
1900	7.8	47.3	129	1590	2380	277	0.16	1.24	43.3	92.4	2.07
1901	8.5	60.5	119	476	1630	269	0.42	0.92	64.8	76.5	2.04
1902	7.1	70.2	86.9	1240	2180	260	0.27	0.50	25.7	87.8	1.75
1903	8.4	31.1	141	1690	2070	240	1.14	0.95	49.1	81.6	1.86
1904	8.5	29.6	103	1140	1740	206	0.26	0.75	35.3	69.6	1.49
1905	8.1	47.6	106	595	1380	194	0.08	0.70	18.8	60.4	0.48
1906	7.5	69.5	115	1110	1960	192	0.30	0.88	30.7	74.9	2.85
1907	8.2	16.5	159	1580	2380	189	0.02	1.09	33.6	63.8	2.30
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1887	7.9	19.9	27.4	0.11		1.63	0.87		1.04	22.9	14.4
1888	7.3	5.38	20.1	0.64		1.76	0.89		0.39		0.70
1889	8.9	11.7	9.36	0.03		0.92			0.21	19.2	13.2
1890	7.8	14.9	11.3	0.35		0.81			1.03	19.0	11.7
1891	7.5	22.3	28.3	0.51		1.96	6.31		3.91	30.7	17.3
1892	7.7	19.6	20.2	0.17	2.37	1.52	4.83		1.00	30.3	18.1
1893	8.3	2.94	2.61	0.10		1.54	1.07		0.30	0.50	2.20
1894	8.2	14.4	5.48	0.03		1.64	0.74		0.46	21.8	14.7
1895	7.5	17.4	16.5	0.49		0.80			0.80	12.8	12.0
1896	8.2	17.6	20.0	0.23		1.17			1.17	10.3	11.5
1897	8.3	21.6	21.0	0.53		0.95			0.97	22.4	18.9
1898	7.2	22.7	15.2	0.43		0.81			0.58	17.3	1[illegible]
1899	7.7	27.7	18.9	0.19		1.46	0.41		0.74	26.1	1[illegible]
1900	7.8	26.9	16.2	0.56		1.94	3.59		0.92	27.4	21.7
1901	8.5	32.7	42.5	0.65		1.15	1.22		1.63	19.5	20.1
1902	7.1	30.6	18.9	0.40	2.46	1.27			0.56	21.7	20.7
1903	8.4	32.7	37.4	0.67		1.05	0.54		0.88	22.6	20.7
1904	8.5	25.8	20.5	0.31		0.82			0.60	18.8	17.1
1905	8.1	21.8	12.4	0.38		1.60	1.37		0.54	12.8	11.5
1906	7.5	23.4	19.4	0.25		1.71	0.84		0.77	21.5	19.0
1907	8.2	24.2	15.8	0.26		1.78	2.36		0.64	23.2	20.4
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1887	7.9		0.04		2.80			
1888	7.3	0.04	0.05	0.23	6.21	0.00		
1889	8.9	0.04	0.01		2.45	0.01		
1890	7.8		0.00		2.28			
1891	7.5		0.05		4.21			
1892	7.7	0.06	0.04		4.11			
1893	8.3		0.04		5.02	0.01		
1894	8.2		0.05		3.21			
1895	7.5		0.01		3.21			
1896	8.2		0.02		2.36			
1897	8.3		0.01		2.24			
1898	7.2	0.02	0.01		2.16			
1899	7.7		0.03		3.24			
1900	7.8		0.04		3.18			
1901	8.5	0.08	0.02		3.36			
1902	7.1		0.02		2.05			
1903	8.4		0.02		2.15			
1904	8.5	0.01	0.01		1.59			
1905	8.1		0.04	0.24	3.28			
1906	7.5		0.04		3.16			
1907	8.2		0.05	0.04	3.41			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS;1857-1984 DR. RUNDEL 4-22-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042285.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1908	7.7	56.3	138	918	1280	170	0.02	0.63	15.3	49.6	2.21
1909	7.7	78.2	118	1220	1340	186	0.37	0.63	19.9	53.9	2.11
1910	8.0	53.3	119	536	1330	158	0.13	1.33	50.0	36.7	3.10
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1908	7.7	20.4	15.5	0.24		0.90			0.42	14.9	15.7
1909	7.7	21.7	22.0	0.12		1.13			0.31	15.9	13.9
1910	8.0	31.6	28.1	0.67		2.00	5.09		1.12	16.4	16.3
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1908	7.7	0.24	0.00		2.60	0.00		
1909	7.7		0.02		1.79			
1910	8.0		0.07		4.28			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS,1857-1984 — DR. RUNDEL 4-23-85 — DK2:042385.C13;1

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1911	8.1	59.3	107	2310	1700	99.7	7.09	0.69	33.0	40.0	2.52
1912	6.4	96.2	66.8	1370	1290	74.1	5.49	0.49	24.9	33.1	7
1913	8.9	70.7	66.0	1780	1190	86.4	4.26	0.47	18.1	25.4	1
1914	7.3	119	71.9	2000	1200	79.2	6.17	0.46	14.2	38.5	1.80
1915	7.5	105	50.1	1780	1330	86.0	7.18	0.56	37.7	28.5	2.95
1916	7.3	100	61.2	1740	909	67.0	5.89	0.47	29.0	29.5	1.66
1917	7.7	205	54.3	1520	981	67.6	5.58	0.47	8.86	27.0	3.38
1918	8.6	107	68.5	1450	1140	68.0	4.27	0.41	20.8	28.3	2.31
1919	8.4	57.5	119	1890	1550	75.6	5.21	0.70	38.9	30.7	2.16
1920	8.2	17.7	74.6	1590	864	74.8	4.98	0.49	48.0	28.8	1.73
1921	7.9	421	119	8930	181	13.8	94.6	0.84		8.40	2.04
1922	7.9	106	88.4	1970	1050	73.8	2.74	0.57	19.0	41.1	1.71
1923	7.8	120	84.7	2020	1060	68.2	2.85	0.54	18.6	35.9	2.14
1924	8.8	135	75.4	1840	2130	87.2	3.64	0.57	25.5	71.3	2.04
1925	7.9	132	94.9	1370	1030	66.3	2.82	0.62	13.9	38.8	1.78
1926	6.6	580	38.5	4310	1050	134	5.44	2.12	160	135	10.7
1927	8.1	120	88.6	1550	2240	84.4	3.87	0.69	43.9	81.3	2.04
1928	8.7	129	64.4	1110	1420	73.5	2.13	0.57	14.6	69.3	1.52
1929	8.0	49.6	48.5	841	527	51.4	2.21	0.50	19.6	37.9	
1930	6.8	66.9	85.8	1210	1580	81.0	4.30	0.75	32.4	63.2	2.68
1931	7.2	92.8	66.6	921	1280	62.2	3.46	0.47	33.8	74.8	2.15
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1911	8.1	20.1	16.4	0.28					0.43	15.0	13.3
1912	8.4	25.4	29.0	0.15		0.29	0.61		0.28	12.8	11.5
1913	8.9	8.39	24.6	0.65					0.39	11.3	11.0
1914	7.3	12.9	6.98			0.58	0.42		0.06	11.7	10.2
1915	7.5	23.2	35.2	0.62		0.29	0.19		0.63	11.6	11.5
1916	7.3	9.53	17.9	0.26					0.19	9.70	9.05
1917	7.7	12.3	18.4	0.61					0.07	11.7	13.1
1918	8.6	14.1	4.00			0.19	0.18		0.31	12.9	11.3
1919	8.4	23.3	17.4	0.08		0.51	1.23		0.52	14.1	12.5
1920	8.2	17.1	27.6	0.57			0.01		1.08	9.09	10.4
1921	7.9	13.4	86.2				2.49	1.22		1.07	[illegible]
1922	7.9	9.23	9.11	0.29		0.61	0.17		0.19	10.7	[illegible]
1923	7.8	8.76	0.44	0.36		0.53	0.63		0.16	10.2	12.2
1924	8.8	13.0	7.24	0.35		0.32	0.02		0.34	20.1	17.0
1925	7.9	11.3	32.4	0.80		0.43			0.20	9.36	10.8
1926	6.6	40.8	95.9	1.37		0.50	2.23		2.92	14.1	11.6
1927	8.1	15.4	16.5	0.26		0.52	0.52		0.68	23.0	14.8
1928	8.7	9.72				0.65	0.39		0.00	13.9	11.5
1929	8.0	11.2	40.1	0.61		0.93	0.90		0.39	3.49	2.22
1930	6.8	12.5	25.5	0.33		1.12	0.77		0.32	11.6	14.0
1931	7.2	19.7	21.9	0.27		1.19	1.50		0.40	11.2	10.0
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1911	8.1	1.47			4.00			
1912	8.4	0.10	0.01		3.10			
1913	8.9	1.55			1.88		0.06	
1914	7.3	0.19	0.02		5.01		0.12	
1915	7.5	0.20	0.02		3.89		0.13	
1916	7.3	0.60			4.46		0.25	
1917	7.7	0.77			6.34	0.03		
1918	8.6				2.42			
1919	8.4		0.01		4.21		0.16	
1920	8.2	0.53			3.50		0.08	
1921	7.9	11.2		5.68			0.64	
1922	7.9	1.90	0.01		2.73			
1923	7.8	1.29	0.01		2.70			
1924	8.8	1.33	0.01	0.13	2.63			
1925	7.9	2.14	0.01		4.36	0.00		
1926	6.6	1.04	0.02	0.10	4.92			
1927	8.1	0.68	0.01		4.43			
1928	8.7	0.31	0.01		1.58			
1929	8.0	0.73	0.03		4.90			
1930	6.8		0.04		2.58			
1931	7.2		0.03		4.00			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS,1857-1984 DR. RUNDEL 4-23-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042385.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1932	8.3	110	51.4	1040	1380	61.9	3.31	0.78	19.6	60.4	2.32
1933	7.7	113	61.8	1300	1900	67.6	3.49	0.53	23.9	91.4	2.25
1934	7.6	117	59.9	1350	1620	73.0	3.48	0.56	31.1	98.9	2.06
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1932	8.3	11.0	8.45	0.52		0.85	1.33		0.15	13.2	12.4
1933	7.7	11.4	12.4	0.19		0.93	1.17		0.23	17.5	12.6
1934	7.6	10.6	4.24	0.44		0.13			0.31	15.0	11.0
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1932	8.3	0.00	0.02		3.25			
1933	7.7		0.03		4.47			
1934	7.6	0.57	0.00		1.85			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS,1857-1984 — DR. RUNDEL 4-23-85 — DK2:042385.C13;3

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1935	5.7	155	139	2430	1670	80.4	7.28	0.75	41.1	137	2.91
1936	7.5	12.1	97.4	1590	1700	85.7	3.24	0.80	92.5	147	[illegible]
1937	7.6	104	72.1	1780	1130	79.7	3.17	0.42	38.9	123	1
1938	7.9	133	85.0	1690	1750	73.5	3.39	0.62	47.3	151	2.43
1939	8.3	131	72.2	1760	1040	79.1	2.15	0.79	29.4	139	1.96
1940	8.1	129	70.9	1530	1220	70.7	2.76	0.56	44.9	113	2.52
1941	8.1	111	63.5	1560	1290	68.8	2.87	0.54	33.9	112	2.11
1942	8.1	129	89.8	1540	1990	81.3	3.49	0.70	47.4	174	2.66
1943	8.5	74.7	65.8	1580	1490	81.7	3.25	0.88	55.5	180	2.06
1944	8.0	141	76.5	1400	1360	74.6	3.82	0.54	40.8	180	2.26
1945	7.4	90.3	72.8	1240	840	70.7	3.54	0.45	44.7	118	1.78
1946	7.0	174	62.4	647	841	60.2	2.79	0.67	32.0	123	3.13
1947	7.8	108	58.0	1590	1080	73.6	5.07	1.16	43.1	201	2.06
1948-49	7.7	122	50.9	989	1210	74.4	4.47	0.96	52.1	169	3.59
1950	5.8	99.0	57.5	1830	1500	84.9	5.99	0.85	67.1	337	2.94
1951	7.4	84.1	42.3	1250	940	66.1	3.77	0.86	59.5	193	3.02
1952-53	9.9	227	94.7	392	903	42.0	8.75	0.77	17.3	141	2.82
1954	8.2	97.6	39.8	1310	1480	67.0	2.68	0.62	42.5	250	2.22
1955-56	8.3	101	21.9	704	1260	77.6	3.64	0.61	38.3	218	2.31
1957	7.1	103	20.9	1240	1110	62.3	2.55	0.67	43.6	191	2.41
1958	5.6	177	32.9	1330	1770	81.3	3.50	0.79	55.4	230	3.57
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1935	5.7	11.2	16.7	0.51		0.82	1.10		0.33	16.8	13.3
1936	7.5	19.9	38.8			0.56	1.25		2.09	17.4	12.0
1937	7.6	11.9	30.6	0.14		0.15			0.14	11.6	9.56
1938	7.9	15.7	28.6	0.02		0.57	0.98		0.60	17.4	12.3
1939	8.3	11.1	22.5	0.39		0.36	0.44		0.14	10.4	9.44
1940	8.1	23.1	58.5	0.92		0.27	0.55		0.68	13.3	11.2
1941	8.1	8.37	32.3	0.60					0.27	12.4	10.2
1942	8.1	17.3	35.7	0.35		0.62	0.76		0.97	20.1	14.1
1943	8.5	14.6	24.1			0.66	1.34		1.27	14.0	11.1
1944	8.0	16.5	31.8			0.62	0.98		0.51	15.5	12.6
1945	7.4	9.59	32.4	0.19		0.69	1.49		0.77	9.87	[illegible]
1946	7.0	12.3	26.4	0.69		0.57	0.92		0.21	10.4	[illegible]
1947	7.8	24.1	37.6	0.67		0.50	0.96		0.58	10.8	9.63
1948-49	7.7	19.1	52.8	2.33					0.52	15.2	14.3
1950	5.8	9.69	23.4	1.08		0.20			0.72	14.5	14.1
1951	7.4	14.0	11.1	1.79		0.67	1.35		0.64	11.8	11.6
1952-53	9.9	7.58	44.4	0.72		0.56		0.27	0.12	7.19	7.74
1954	8.2	14.4	13.9	0.17		0.65	1.18		0.55	14.3	11.9
1955-56	8.3	3.95	28.8	0.01		0.44	0.72		0.27	14.4	12.4
1957	7.1	8.50	20.1	0.84		0.87	1.11		0.92	10.7	10.7
1958	5.6	12.5	208	0.65	0.31	3.04	4.00		1.61	12.0	11.5
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1935	5.7	1.83	0.03		5.17			
1936	7.5	1.03	0.01		2.24			
1937	7.6	0.70			0.73			
1938	7.9	0.47	0.01	0.07	3.59			
1939	8.3	0.96	0.01		1.56			
1940	8.1	0.42	0.00		2.24			
1941	8.1	1.64			2.27			
1942	8.1	0.73	0.02	0.42	3.35			
1943	8.5	0.46	0.02		3.34			
1944	8.0	0.21	0.02		2.97			
1945	7.4		0.01		2.60			
1946	7.0	1.57			5.89			
1947	7.8		0.01		2.67			
1948-49	7.7	1.84			4.99			
1950	5.8	2.23	0.02		5.00			
1951	7.4	0.06	0.02		3.35			
1952-53	9.9	4.84		0.96	11.5	0.09		0.04
1954	8.2	0.61	0.02		2.84			
1955-56	8.3	0.29	0.01		2.07			
1957	7.1	0.57	0.03		5.27			
1958	5.6	0.61	0.14		8.71			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-RINGS;1857-1984 — VALUES ARE % OR PPM (1% = 10,000PPM) — DR. RUNDEL 4-23-85 — DK2:042385.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
1959	8.4		15.1	1070	1200	81.7	2.47	0.94	138	240	1.90
1960-61	9.1	27.5	20.0	1300	1600	99.4	1.92	1.18	93.8	220	2.73
1962-63	9.9	123	15.0	936	1400	56.5	1.58	0.63	36.2	158	3.00
1964	7.6	85.5	10.9	1060	1540	74.2	2.35	0.87	76.2	200	2.26
1965-66	9.2	88.6	13.4	1010	1240	64.6	2.19	1.05	66.4	165	2.72
1967	8.2	150	9.47	1330	970	57.1	1.81	0.62	28.2	109	1.78
1968-69	9.6	122	14.5	1060	802	47.9	1.69	0.71	42.4	134	2.47
1970	7.0	178	17.8	1550	661	68.7	2.23	1.28	67.4	126	3.08
1971	6.4	213	15.4	1880	355	53.0	3.58	0.68	43.6	81.9	2.19
1972	6.8	257	13.6	1850	630	51.6	2.82	0.90	59.4	113	2.37
1973-74	9.1	232	9.92	1350	268	42.6	1.75	0.77	30.8	88.4	1.33
1975	7.8	873	19.8	3000	849	135	4.54	2.01	95.7	179	2.24
1976-77	9.9	620	18.6	2050	384	61.7	3.74	1.07	54.7	107	1.55
1978	9.0	99.6	69.1	1920	1370	64.1	0.74	0.47	33.9	39.8	3.79
1979-80	8.7	469	42.8	3960	776	148	1.14	1.52	155	90.4	4.46
1981-82	9.9	341	99.5	3560	324	61.5	0.90	1.92	182	49.5	2.86
1983-84	9.6	370	97.8	3490	171	67.2	0.97	1.30	142	23.3	2.33
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
1959	8.4	13.1	35.6	0.61		0.27	4.00		18.4	11.9	9.84
1960-61	9.1	13.0	41.0	0.25		1.15	2.22		2.03	13.6	11.8
1962-63	9.9	16.4	39.7	0.59		0.71	1.06		1.02	14.7	12.8
1964	7.6	18.8	29.0	0.36		0.55	0.47		1.12	13.6	11.0
1965-66	9.2	17.0	33.4	0.12		0.17	0.73		1.28	13.7	11.9
1967	8.2	4.66	18.8	1.22					0.33	10.2	9.27
1968-69	9.6	12.7	30.6	0.59		0.94	1.78		1.13	7.63	8.79
1970	7.0	20.8	56.4	1.50		0.99	1.53		1.44	8.32	12.8
1971	6.4	11.5	38.6	1.28		0.09			0.96	4.70	6.65
1972	6.8	16.5	46.0	1.64		0.50	0.44		1.22	8.83	10.2
1973-74	9.1	9.41	23.3	0.52		0.43	0.28		0.68	4.24	4.73
1975	7.8	30.6	51.2	1.10		0.05	0.74		1.52	11.7	14.4
1976-77	9.9	20.9	39.6	0.63		0.49	0.48		1.13	4.83	5.40
1978	9.0	7.42	37.1	1.45		0.48			0.52	12.3	13.5
1979-80	8.7	45.1	104	1.59		0.95	2.19		3.33	11.1	13.9
1981-82	9.9	47.9	152	1.94		0.91	2.22		4.35	7.75	9.82
1983-84	9.6	33.1	320	1.46		0.49	3.16		7.40	4.38	5.41
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
1959	8.4	0.61	0.00		0.06			
1960-61	9.1	1.18	0.05		0.46			
1962-63	9.9	0.96	0.02		2.20			
1964	7.6	0.68	0.01		1.16			
1965-66	9.2	0.93			1.83			
1967	8.2	2.12			1.96			
1968-69	9.6	0.19	0.03		2.98			
1970	7.0	1.13	0.02		5.12			
1971	6.4	1.85			3.56			
1972	6.8	1.55	0.01		5.44			
1973-74	9.1	1.02	0.01		3.07			
1975	7.8	1.39			2.84			
1976-77	9.9	1.10	0.01		2.64			
1978	9.0	1.35	0.01		1.50			
1979-80	8.7	1.50	0.03		3.55			
1981-82	9.9	1.18	0.03		2.69			
1983-84	9.6	0.87	0.01		2.36			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-24-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042485.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1792-93	8.1	39.3	11.5	5400	2640	264	4.77	1.40	59.0	104	2.65
AC 1794	8.6	83.7	3.03	5120	1850	228	3.94	0.84	45.9	82.1	2.
AC 1795	8.7	69.7	5.95	5580	3980	293	4.30	1.47	38.4	115	2.
AC 1796	7.5	71.3	25.6	6330	2540	257	6.43	1.13	26.2	104	3.05
AC 1797	7.2	53.3	8.87	5730	2730	249	6.42	1.02	36.9	130	0.41
AC 1798	7.7	1.67	6.77	5230	1920	162	5.15	0.84	26.0	89.8	2.33
AC 1799	8.2	30.0	19.4	5440	2430	190	4.73	1.10	42.5	93.6	3.66
AC 1800	8.4	75.7	21.3	6050	2510	200	5.40	1.40	27.7	108	3.27
AC 1801	8.2	10.4	14.0	1010	32.2	13.4	2.93	0.41	5.56	24.4	0.23
AC 1802	8.5	49.0	29.0	4690	3960	182	4.32	1.34	28.5	120	3.16
AC 1803	8.5	1.25	9.08	4210	1650	125	4.02	0.86	40.0	92.3	1.60
AC 1804	7.7	1.91	9.64	4980	2610	139	4.41	0.70	18.2	110	0.29
AC 1805	7.6	35.0	16.7	4500	1870	148	4.82	1.20	33.3	102	2.06
AC 1806	7.8	0.24	14.5	3530	1650	123	4.02	0.84	23.3	92.8	1.43
AC 1807	8.6	15.8	10.0	3460	1660	111	4.15	0.76	24.1	82.8	2.43
AC 1808	8.8	44.1	21.1	3930	2550	182	3.99	1.46	20.7	111	2.71
AC 1809	7.1	17.7	43.1	4610	2270	170	5.84	1.61	43.2	135	2.73
AC 1810	6.7		25.0	4360	2240	135	6.11	1.70	62.0	140	3.31
AC 1811	7.1	46.6	28.0	4340	3050	144	5.97	1.47	34.6	115	3.27
AC 1812	5.8	43.9	21.4	4770	2170	126	7.39	1.35	36.8	163	3.34
AC 1813	8.3	36.4	16.3	3860	1630	126	4.42	1.04	25.6	75.7	2.19
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1792-93	8.1	35.3				0.20	1.16		0.35	26.3	33.5
AC 1794	6.6	27.8	3.02	1.39			0.40		0.09	16.9	30.4
AC 1795	8.7	48.6							0.19	25.7	38.4
AC 1796	7.5	22.3								23.0	36.0
AC 1797	7.2	20.4								19.5	21.0
AC 1798	7.7	17.1	6.31							15.9	27.9
AC 1799	8.2	19.0	2.37				0.14		0.02	23.5	35.0
AC 1800	8.4	15.3	0.77						0.10	23.1	34.6
AC 1801	8.2	0.67			2.52	0.76	0.88	0.12	0.11	0.42	0.25
AC 1802	8.5	18.0	4.59				0.11		0.04	23.8	34.
AC 1803	8.5	12.4							0.03	13.9	2.
AC 1804	7.7	13.7			0.29					14.8	14.5
AC 1805	7.6	22.4	1.84				0.91			16.1	23.4
AC 1806	7.8	13.1			0.01		0.79			13.7	19.6
AC 1807	8.6	13.3	1.69							14.0	23.6
AC 1808	8.8	20.6	0.71				0.26		0.02	22.5	33.3
AC 1809	7.1	15.7	3.35		0.13	0.15	1.16		0.06	18.7	25.7
AC 1810	6.7	15.3	5.92						0.13	16.9	26.5
AC 1811	7.1	16.1			0.32		0.59		0.01	21.7	29.5
AC 1812	5.8	12.1			0.53		0.73		0.02	16.5	25.0
AC 1813	8.3	16.3	3.18		0.35				0.06	12.8	21.9
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1792-93	8.1			0.01	2.18			
AC 1794	8.6				1.86		0.04	
AC 1795	8.7	0.06			0.94			
AC 1796	7.5				3.08			
AC 1797	7.2				3.34			
AC 1798	7.7			0.44	2.29		0.03	
AC 1799	8.2				2.14			
AC 1800	8.4	4.09			4.83			
AC 1801	8.2	0.78			8.80	0.01		0.01
AC 1802	8.5	0.39			3.67			
AC 1803	8.5	0.40			1.58			
AC 1804	7.7				3.28			
AC 1805	7.6				3.69			
AC 1806	7.8				2.77			
AC 1807	8.6	0.35			1.62			
AC 1808	8.8				1.89			
AC 1809	7.1				3.87			
AC 1810	6.7	0.34			4.76			
AC 1811	7.1			0.12	4.90			
AC 1812	5.8				3.10			
AC 1813	8.3				3.46			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-24-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042485.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1814	7.1	10.5	27.5	4190	1740	122	5.90	0.87	28.8	83.2	2.38
AC 1815	7.8	11.1	19.3	4020	1520	111	5.95	0.56	15.2	79.2	1.89
AC 1816	8.4	89.4	10.5	3550	1230	111	4.59	0.41	19.3	78.7	0.08
AC 1817	8.9	22.3	11.0	2960	1370	86.9	5.35	0.51	10.4	57.8	1.67
AC 1818	8.9	30.4	30.0	3570	2170	132	5.32	0.56	29.6	96.3	1.93
AC 1819	8.5	29.2	20.9	3830	3710	130	4.98	0.46	27.9	94.3	2.16
AC 1820	9.0	15.9	27.1	3420	2190	117	4.45	0.43	23.1	77.1	1.79
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1814	7.1	12.1	1.94							13.5	20.4
AC 1815	7.8	23.1			0.07					12.1	21.3
AC 1816	8.4	17.6	0.31							6.90	6.54
AC 1817	8.9	11.4	2.31							10.4	16.5
AC 1818	8.9	15.2	2.76						0.02	16.5	24.4
AC 1819	8.5	14.9	1.31		0.08					19.4	24.4
AC 1820	9.0	15.0	4.38						0.04	16.6	24.2
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1814	7.1	0.43			4.03			
AC 1815	7.8				2.87			
AC 1816	8.4	0.54			3.23			
AC 1817	8.9	0.62			2.51		0.24	
AC 1818	8.9	0.46			2.60			
AC 1819	8.5				2.14			
AC 1820	9.0				2.26			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-24-85 — DK2:042485.C13;3

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1821	7.3	2.29	28.2	4030	2480	134	4.58	0.42	27.1	100	1.99
AC 1822	8.1	67.3	27.6	3640	2610	138	3.06	0.60	29.0	83.9	2.11
AC 1823	7.1	2.66	39.1	3890	2670	123	5.80	0.63	25.9	98.1	2.
AC 1824	8.4	51.9	46.4	3930	4680	144	4.05	0.53	28.8	105	2.
AC 1825	7.4	31.5	28.3	3790	4450	140	4.18	0.46	31.1	105	2.22
AC 1826	8.3		25.6	3630	4520	134	3.94	0.74	45.2	95.5	2.10
AC 1827	6.4	51.2	26.7	4680	5470	148	5.31	0.59	26.4	129	3.46
AC 1828	6.8		19.2	4370	4720	111	4.27	0.42	28.2	107	2.88
AC 1829	8.2	1.58	8.47	711	6.09	8.12	2.70	0.11	4.88	14.6	0.04
AC 1830	7.8		23.0	4170	4140	122	4.65	0.48	22.7	166	2.35
AC 1831	8.7	38.8	22.9	4090	4830	160	4.04	0.52	13.6	93.7	2.14
AC 1832	7.0	40.7	27.1	5220	5200	198	6.44	0.64	39.2	186	3.54
AC 1833	7.8	60.1	22.7	3570	1380	134	3.22	0.60	13.1	56.1	1.57
AC 1834	8.7	20.0	14.5	4050	1580	163	3.21	0.58	34.6	73.6	1.66
AC 1835	8.4	41.3	18.7	4920	5860	240	3.67	0.46	21.8	112	2.46
AC 1836	7.2	40.1	15.9	4260	3520	128	4.20	0.31	14.7	88.5	2.90
AC 1837	7.4	11.9	13.4	4330	6870	159	4.20	0.55	21.9	155	2.83
AC 1838	8.1		6.57	2740	3150	80.9	4.14	0.41	16.6	88.7	2.40
AC 1839	7.1	13.9	13.0	4790	6390	138	3.81	0.28	20.0	132	2.24
AC 1840	9.1	6.18	12.9	5070	6040	134	3.30	0.38	20.4	121	2.19
AC 1841	8.2	6.86	13.9	6000	5240	193	2.93	0.32	25.0	120	2.03
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1821	7.3	13.8	0.33				0.44		0.17	16.8	29.1
AC 1822	8.1	12.6	5.30		0.87	0.28	0.54		0.07	15.0	22.1
AC 1823	7.1	13.5	0.25							18.3	24.1
AC 1824	8.4	17.1					0.82		0.12	25.9	30.8
AC 1825	7.4	18.2	1.31				0.45		0.12	21.8	27.9
AC 1826	8.3	20.1	3.81				1.07		1.41	22.1	28.9
AC 1827	6.4	24.3					0.35			32.7	40.0
AC 1828	6.8	15.6	2.18				0.18			23.2	33.7
AC 1829	8.2	0.33			1.12		0.14		0.02	0.25	0.11
AC 1830	7.8	12.4					0.26			27.9	30.1
AC 1831	8.7	14.7					0.19			22.8	33.2
AC 1832	7.0	17.7	0.98							34.4	4[illegible]
AC 1833	7.8	14.5	0.96		0.85	0.53	0.81			9.34	1[illegible]
AC 1834	8.7	13.7					0.85		0.04	13.7	23.8
AC 1835	8.4	14.7								30.4	39.8
AC 1836	7.2	10.5	0.63							25.0	34.5
AC 1837	7.4	12.2					0.13		0.02	38.0	42.0
AC 1838	8.1	7.66								26.6	30.5
AC 1839	7.1	9.78			0.15		0.82		0.29	33.4	39.4
AC 1840	9.1	9.82								30.3	34.1
AC 1841	8.2	9.96					1.02		0.06	29.2	32.5
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1821	7.3	0.41			2.56			
AC 1822	8.1	1.70			4.50			
AC 1823	7.1				3.19			
AC 1824	8.4				3.65			
AC 1825	7.4				2.90			
AC 1826	8.3				2.66			
AC 1827	6.4				5.33	0.00		
AC 1828	6.8				2.60			
AC 1829	8.2				6.50		0.31	0.00
AC 1830	7.8				1.97			
AC 1831	8.7				2.36			
AC 1832	7.0	0.45			2.66			
AC 1833	7.8	0.10			3.35			
AC 1834	8.7			0.11	2.00			
AC 1835	8.4	0.29			1.72			
AC 1836	7.2	0.29			3.02	0.01		
AC 1837	7.4				2.96			
AC 1838	8.1				1.13			
AC 1839	7.1				3.94			
AC 1840	9.1				3.21			
AC 1841	8.2				2.43			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS;1792-1984 DR. RUNDEL 4-24-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042485.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1842	6.5		19.3	6940	6070	237	4.17	0.54	41.1	152	2.47
AC 1843	6.9	3.24	19.2	6910	7030	241	4.09	0.26	23.1	153	3.02
AC 1844	8.6		5.44	969	14.4	4.41	2.05	0.02	3.83	6.68	
AC 1845	6.5		14.5	1.05%	7560	391	4.97	0.46	30.1	233	2.15
AC 1846	6.7		31.1	1.52%	8810	541	4.95	1.17	438	234	2.82
AC 1847-48	7.9	2.90	49.1	1.69%	9630	976	6.68	0.37	25.9	260	2.96
AC 1849-50	6.3		100	7700	3530	382	4.44	1.33	28.4	155	2.61
AC 1851-52	8.7	1.92	24.0	3940	2310	125	3.31	0.60	16.2	94.1	1.55
AC 1853-54	9.1	27.8	44.4	5300	3990	224	2.44	0.63	19.0	149	2.01
AC 1855	8.2		53.4	5420	5440	246	4.14	0.88	26.8	122	2.67
AC 1856	7.7	1.65	43.6	5030	5650	185	3.84	0.66	15.1	114	1.75
AC 1857	6.2		38.9	6130	6020	226	6.14	0.58	20.5	150	2.60
AC 1858	7.1		64.5	6010	6050	239	4.12	0.91	28.8	127	2.27
AC 1859	8.4	6.57	67.4	4760	6110	226	2.63	0.91	26.6	122	1.57
AC 1860	7.6		7.33	336	4.21	4.44	2.84	0.49	5.68	2.09	0.03
AC 1861	7.1	14.9	63.2	4910	5310	172	3.87	1.16	16.8	175	2.44
AC 1862	7.9	14.9	68.1	4650	5610	183	3.32	1.27	16.0	109	1.93
AC 1863	7.6		64.6	4310	5460	167	2.98	1.39	29.0	115	2.65
AC 1864	8.2	25.9	74.3	4320	5730	180	2.72	1.40	20.5	100	1.48
AC 1865	7.8		76.8	4640	2790	181	3.08	0.99	16.1	96.9	1.48
AC 1866	5.8		86.6	5950	5760	204	5.11	1.46	22.8	155	2.83
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1842	6.5	11.4					0.79		0.00	31.1	36.7
AC 1843	6.9	13.5					0.61			39.3	44.4
AC 1844	8.6	0.33								0.35	
AC 1845	6.5	12.9								50.8	51.8
AC 1846	6.7	24.4	12.0			0.85	42.7		221	50.9	56.1
AC 1847-48	7.9	13.3	6.12						0.21	52.1	60.1
AC 1849-50	6.3	16.4	9.76				2.11		0.04	28.4	37.0
AC 1851-52	8.7	7.35	2.54		0.32				0.02	13.1	17.1
AC 1853-54	9.1	13.4	2.31		0.03	0.05	0.74		0.01	29.5	33.2
AC 1855	8.2	13.5	3.08				0.39		0.09	27.4	33.6
AC 1856	7.7	11.7	2.60				0.35		0.04	28.2	31.5
AC 1857	6.2	12.0	0.34							33.0	37.4
AC 1858	7.1	14.2	2.94							29.4	32.8
AC 1859	8.4	14.3					0.91		0.13	33.1	33.5
AC 1860	7.6	3.07	7.98	0.05						0.27	0.03
AC 1861	7.1	12.8	5.76				0.63			38.5	37.4
AC 1862	7.9	17.4	6.27							29.1	29.3
AC 1863	7.6	22.7	5.63				0.00		0.09	27.8	32.5
AC 1864	8.2	17.9	11.4				0.16		0.11	28.3	28.5
AC 1865	7.8	15.4					0.13			21.5	27.0
AC 1866	5.8	18.6	3.52				0.13			31.2	36.0
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1842	6.5				2.77			
AC 1843	6.9			0.15	4.73	0.01		
AC 1844	8.6				6.32		0.37	
AC 1845	6.5	0.25			4.60			
AC 1846	6.7	0.01			2.48			
AC 1847-48	7.9	0.62			3.42			
AC 1849-50	6.3				3.68			
AC 1851-52	8.7	2.38			3.11			
AC 1853-54	9.1				3.29			
AC 1855	8.2	0.32			1.62			
AC 1856	7.7	1.56			3.99			
AC 1857	6.2				1.07			
AC 1858	7.1	0.47			1.28			
AC 1859	8.4				2.84			
AC 1860	7.6			0.45	7.75		0.21	
AC 1861	7.1				3.90	0.01		
AC 1862	7.9	0.87			2.72			
AC 1863	7.6	0.51			3.59			
AC 1864	8.2	0.42			3.11			
AC 1865	7.8				1.93			
AC 1866	5.8	0.20			3.22			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS;1792-1984 DR. RUNDEL 4-24-85 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042485.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1867	8.5	12.7	92.2	4920	4820	174	3.16	1.39	19.9	103	1.66
AC 1868	8.9	26.7	77.3	4370	5040	174	2.65	1.25	20.4	88.0	1.77
AC 1869	8.2	9.28	59.2	4430	4320	149	2.60	1.16	15.9	104	
AC 1870	8.6		83.2	4390	4700	188	3.51	1.52	24.0	121	2.03
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1867	8.5	16.0	4.00				0.19			27.0	27.4
AC 1868	8.9	17.0	5.85							24.4	26.2
AC 1869	8.2	13.0	3.04				0.39			23.4	25.5
AC 1870	8.6	17.1	4.92				0.36		0.06	28.5	28.8
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1867	8.5	0.12			1.63			
AC 1868	8.9	1.37			2.29			
AC 1869	8.2				0.98			
AC 1870	8.6				2.14			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-25-85 — DK2:042585.C13;1

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1871	8.6	1.10	58.8	4000	4250	142	6.19	1.44	15.8	80.6	1.75
AC 1872	7.5	29.0	72.6	4190	2920	189	5.13	1.25	22.5	77.7	1.17
AC 1873	8.7	30.1	68.1	3520	4520	133	5.89	1.35	16.6	83.0	2.23
AC 1874	9.0	16.7	59.6	3420	4510	148	6.03	1.48	22.6	81.2	1.61
AC 1875	7.4	31.6	116	5050	4590	158	7.77	1.84	26.0	98.0	1.88
AC 1876	7.9	16.3	91.7	3400	1840	115	6.98	1.49	19.7	66.3	1.57
AC 1877	8.9	39.6	164	6320	5920	305	7.57	1.43	31.3	131	2.03
AC 1878	9.0	22.4	21.0	3210	4460	133	4.71	0.89	17.4	107	1.47
AC 1879	8.0	10.4	14.9	2150	2890	93.3	5.36	0.84	15.7	95.9	1.50
AC 1880	5.4	21.6	10.3	3380	4140	139	8.14	1.07	23.4	163	2.18
AC 1881	8.8	15.0	11.3	2270	4050	109	3.99	0.96	19.0	117	1.42
AC 1882	5.8		10.9	3410	3170	135	8.36	1.04	28.5	120	2.36
AC 1883	6.1		8.58	2840	4250	81.5	7.37	1.27	25.5	135	1.97
AC 1884	6.6	24.1	11.8	3310	4230	108	6.54	0.87	17.9	112	2.12
AC 1885	7.3	4.88	15.1	2590	4740	131	7.25	1.09	27.3	101	1.95
AC 1886	7.0		10.6	2430	3940	92.1	5.67	1.02	25.1	99.2	1.82
AC 1887	7.4	23.9	13.7	2530	4130	117	4.96	1.08	27.1	134	1.59
AC 1888	7.5	19.9	10.9	2950	3650	111	8.31	1.31	32.2	168	2.27
AC 1889	7.5	24.6	8.76	2450	3140	71.1	6.04	0.81	19.2	98.4	2.07
AC 1890	6.3	7.32	12.2	2960	3870	120	8.57	1.06	35.6	160	2.44
AC 1891	8.3	12.2	11.4	3340	2550	127	5.82	1.34	37.6	86.0	1.48
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1871	8.6	12.0	11.5		0.05		0.11		0.07	20.5	24.9
AC 1872	7.5	12.8	16.2		0.14		1.49		0.23	19.2	23.8
AC 1873	8.7	12.9	21.7		0.24		0.02		0.16	20.7	24.2
AC 1874	9.0	15.3	12.4	0.06	0.19		1.59		0.98	22.1	25.8
AC 1875	7.4	20.5	15.2		1.88				0.34	20.6	26.0
AC 1876	7.9	14.6	19.9	0.57	0.82	0.30	2.15		0.16	12.2	19.2
AC 1877	8.9	25.3	25.7	0.62					0.33	34.9	36.2
AC 1878	9.0	15.3	4.59				0.57		0.12	22.1	25.7
AC 1879	8.0	14.5	4.98		0.29	0.18	2.02		0.08	19.2	25.0
AC 1880	5.4	20.9	10.6		1.04				0.16	22.2	25.1
AC 1881	8.8	19.6	10.1		0.81	0.06	1.14		0.14	26.1	26.8
AC 1882	5.8	19.9	8.35						0.01	20.0	26.4
AC 1883	6.1	16.5	16.2							24.7	24.5
AC 1884	6.6	18.1	17.4		0.86				0.12	23.5	26.4
AC 1885	7.3	22.4	14.6		0.02		0.66		0.25	25.1	29.1
AC 1886	7.0	20.3	8.93		0.35		0.20		0.03	22.5	23.9
AC 1887	7.4	23.0	11.9		1.01		1.02		0.14	28.0	26.6
AC 1888	7.5	30.2	9.36						0.03	23.7	23.9
AC 1889	7.5	18.2	16.8		0.39		0.76			21.7	23.1
AC 1890	6.3	25.9	13.2		1.58		1.00		0.10	23.0	26.1
AC 1891	8.3	23.6	16.8		0.04				0.19	16.5	22.6
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1871	8.6	0.78			3.05	0.00		
AC 1872	7.5				3.20			
AC 1873	8.7	0.48		1.23	3.28			
AC 1874	9.0				3.42			
AC 1875	7.4	0.20			2.75			
AC 1876	7.9				3.94			
AC 1877	8.9	1.12			3.36			
AC 1878	9.0				1.89			
AC 1879	8.0				3.06			
AC 1880	5.4	0.18			4.00			
AC 1881	8.8				2.75			
AC 1882	5.8	0.04			3.54			
AC 1883	6.1				1.95			
AC 1884	6.6				2.45			
AC 1885	7.3				2.79			
AC 1886	7.0				3.12			
AC 1887	7.4			0.06	2.69			
AC 1888	7.5				1.55			
AC 1889	7.5				2.88			
AC 1890	6.3				4.77			
AC 1891	8.3				1.90		0.00	
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS;1792-1984 DR. RUNDEL 4-25-85

VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042585.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1892	8.5	22.8	13.8	2930	3710	102	4.74	0.96	21.7	84.1	[illegible]
AC 1893	8.3		14.5	2720	2710	95.5	5.50	1.45	23.0	80.9	
AC 1894	8.8	10.4	14.2	2450	3620	101	4.12	1.16	19.6	86.4	[illegible]
AC 1895	8.7		18.1	2840	2310	122	4.35	0.93	20.1	75.0	1.19
AC 1896	7.1	13.2	17.8	3210	3560	128	5.87	0.78	17.4	87.5	1.42
AC 1897	8.2		1.25	927	30.6	6.13	4.01	0.14	2.78	9.30	
AC 1898	8.2		20.0	2800	2180	114	4.55	1.11	28.9	59.6	1.46
AC 1899	8.2	29.4	21.0	3070	2070	122	5.53	1.05	28.7	64.1	1.31
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1892	8.5	17.9	6.66		0.63		0.60		0.11	18.6	22.3
AC 1893	8.3	25.8	14.9		0.77		0.74		0.15	17.1	23.6
AC 1894	8.8	20.8	19.8		1.45	0.20	2.10		0.18	18.7	25.3
AC 1895	8.7	16.3	11.4		0.02		0.45		0.01	14.9	20.5
AC 1896	7.1	14.5	8.38		1.48		0.85		0.13	16.8	19.9
AC 1897	8.2	0.79	10.9		0.70					0.52	
AC 1898	8.2	22.1	6.19		1.24				0.11	12.9	18.0
AC 1899	8.2	14.8	9.53		1.15				0.10	12.3	18.8
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1892	8.5				3.11			
AC 1893	8.3				3.02			
AC 1894	8.8				3.78			
AC 1895	8.7				1.48			
AC 1896	7.1				3.72			
AC 1897	8.2				3.87		0.48	
AC 1898	8.2				2.57			
AC 1899	8.2				2.44			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS;1792-1984 DR. RUNDEL 4-25-85 — VALUES ARE % OR PPM (1% = 10;000PPM) — DK2:042585.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1900	8.6		28.4	3090	3730	124	3.23	1.25	38.1	81.2	1.58
AC 1901	8.5	13.6	26.3	2980	2540	132	3.55	0.99	27.3	89.0	1.42
AC 1902	8.3	24.6	25.0	2940	2740	130	4.89	1.22	27.7	89.1	1.41
AC 1903	7.6	1.56	27.0	2870	3690	116	3.25	0.98	24.6	98.5	1.97
AC 1904	8.6	17.4	23.8	3130	3570	122	3.20	0.87	20.8	86.1	1.71
AC 1905	9.0	14.3	20.1	2250	2430	102	2.36	0.65	16.1	75.4	1.10
AC 1906	7.9	5.42	11.3	2000	1790	89.3	2.50	0.48	10.8	72.1	1.09
AC 1907	7.7		17.6	2700	2450	101	2.63	0.86	17.7	95.4	1.15
AC 1908	8.5	21.6	6.15	1910	2050	78.1	2.33	0.37	11.5	71.6	0.73
AC 1909	8.4	56.5	16.1	1980	4240	106	3.04	0.70	21.4	104	1.79
AC 1910	8.5	34.6	12.9	2730	4080	102	1.29	0.57	15.9	90.6	1.37
AC 1911	7.6	37.5	27.0	2970	3070	121	2.38	1.06	30.1	97.1	1.40
AC 1912	8.7	47.8	10.9	2460	4500	103	1.60	0.47	17.9	[illegible]	1.39
AC 1913	8.6	60.5	23.8	2750	4940	143	1.42	0.72	25.8	103	1.01
AC 1914	7.8	67.5	20.0	3450	5570	165	2.28	0.85	37.7	126	1.68
AC 1915	7.9	45.8	24.0	3350	5280	146	2.41	0.94	42.0	102	1.47
AC 1916	7.7	126	33.0	3010	5970	183	1.74	0.95	27.0	112	1.05
AC 1917	6.5	169	28.5	2920	5160	154	3.30	0.91	25.7	240	1.77
AC 1918	8.2	83.5	32.9	3620	5650	196	2.31	1.19	47.0	124	1.25
AC 1919	8.7	62.3	27.2	3310	4810	164	2.16	0.95	45.5	111	0.98
AC 1920	7.5	59.3	29.4	3610	5130	153	2.67	1.08	41.1	122	1.37
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1900	8.6	19.1	11.3		1.72	0.27	2.20		0.23	18.6	21.3
AC 1901	8.5	14.0	9.54		0.21		0.52		0.18	15.7	20.8
AC 1902	8.3	16.3	16.9		0.10		2.31		0.28	16.3	21.5
AC 1903	7.6	14.5	14.1		0.72	0.33	1.78		0.21	19.4	25.2
AC 1904	8.6	14.6	8.35		0.40				0.21	17.5	22.5
AC 1905	9.0	14.0	11.7			0.12	1.12		0.05	15.8	20.2
AC 1906	7.9	7.97	2.62		0.40				0.04	11.8	16.7
AC 1907	7.7	7.64	7.60							16.3	19.6
AC 1908	8.5	5.95	2.06							13.5	16.5
AC 1909	8.4	8.65	9.51						0.02	19.9	23.9
AC 1910	8.5	8.11	0.62			0.01	0.44		0.13	19.9	22.2
AC 1911	7.6	11.2	14.4				0.16		0.21	20.6	25.3
AC 1912	8.7	5.96	5.62			0.19	0.45		0.19	22.2	24.3
AC 1913	8.6	9.41	15.4			0.29	1.24		0.32	24.4	28.5
AC 1914	7.8	12.4	14.5						0.34	29.4	30.4
AC 1915	7.9	13.3	21.8						0.39	25.3	30.3
AC 1916	7.7	13.9	27.7	0.63		0.54	2.62		0.53	28.5	34.6
AC 1917	6.5	9.26	20.1	0.14		0.02	0.66		0.15	42.9	35.6
AC 1918	8.2	17.9	28.2	0.22		0.02	0.88		0.50	28.2	31.5
AC 1919	8.7	11.4	17.3			0.16	2.18		3.01	23.9	26.6
AC 1920	7.5	14.4	17.4			0.45	1.28		0.56	29.4	31.3
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1900	8.6	1.39			2.86			
AC 1901	8.5	0.13			2.08			
AC 1902	8.3				2.49			
AC 1903	7.6	0.25			4.05			
AC 1904	8.6	0.63		0.44	2.99			
AC 1905	9.0	0.49			2.72			
AC 1906	7.9	0.61			2.01	0.01		
AC 1907	7.7	0.15			0.92			
AC 1908	8.5	0.14			0.40			
AC 1909	8.4	0.09			1.60			
AC 1910	8.5	0.07			2.76			
AC 1911	7.6				1.59			
AC 1912	8.7				2.12			
AC 1913	8.6	0.03			2.24			
AC 1914	7.8	0.43			2.29			
AC 1915	7.9	0.25			1.71			
AC 1916	7.7				2.77			
AC 1917	6.5				2.85			
AC 1918	8.2	0.09			2.79			
AC 1919	8.7	0.14			1.29			
AC 1920	7.5	0.15			3.74			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-25-85 — DK2:042585.C13;3

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1921	8.4	13.9	18.3	3170	5140	130	2.28	0.86	41.7	72.1	1.27
AC 1922	8.1	82.2	22.8	3730	5250	156	1.78	1.10	49.6	82.5	1.14
AC 1923	9.0	85.0	19.7	2970	5350	123	1.54	0.86	32.9	39.3	1.41
AC 1924	8.3	57.9	18.6	3300	4700	126	2.08	0.82	31.4	38.5	1.[illegible]
AC 1925	8.9	69.8	21.6	2860	5320	153	2.19	1.06	30.6	65.8	0.[illegible]
AC 1926	8.6	42.9	26.9	3580	6240	200	2.38	1.06	37.7	104	0.79
AC 1927	8.8	69.5	30.2	3150	5750	213	1.79	1.09	39.2	113	1.09
AC 1928	8.8	76.9	26.6	3020	6310	223	1.44	1.05	39.2	113	1.34
AC 1929	8.4	52.6	16.4	3140	4740	186	0.91	1.01	33.8	71.4	0.98
AC 1930	8.4	43.4	34.1	2570	6660	173	0.92	1.78	42.4	69.3	1.71
AC 1931	7.1	76.5	37.3	3010	6880	212	1.88	1.58	43.6	58.3	1.61
AC 1932	8.6	57.2	28.2	2610	5700	205	1.13	1.08	28.6	54.3	1.09
AC 1933	8.4	14.4	35.4	2860	4920	239	0.94	1.25	53.1	54.4	0.98
AC 1934	8.7		28.2	2780	4660	207	1.00	0.99	40.3	42.8	0.89
AC 1935	8.8	34.5	33.7	2920	4390	231	0.82	0.96	26.0	45.7	1.16
AC 1936	8.5	58.1	32.9	2980	5040	261	0.85	1.04	23.7	44.3	1.25
AC 1937	8.8	38.5	29.4	2620	4250	167	0.87	0.92	32.3	29.6	1.70
AC 1938	8.6	39.2	24.9	3050	4180	157	0.95	1.02	44.1	32.2	1.26
AC 1939	8.4	52.2	34.3	2680	4600	162	0.93	0.94	36.4	38.5	1.82
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1921	8.4	8.78	16.5						0.30	25.0	26.3
AC 1922	8.1	11.2	13.5				0.02		0.44	28.4	26.9
AC 1923	9.0	10.6	12.7				0.09		0.53	27.2	25.3
AC 1924	8.3	16.6	11.9						0.34	21.1	23.4
AC 1925	8.9	21.3	11.1				0.14		0.61	22.0	17.4
AC 1926	8.6	14.7	11.8	0.48			0.49		0.52	27.8	29.5
AC 1927	8.8	17.7	18.9			0.25	0.80		0.46	27.4	30.3
AC 1928	8.8	13.7	12.3			0.20	1.94		0.75	32.2	34.3
AC 1929	8.4	13.2	19.0	0.33		0.75	2.02		0.55	25.5	29.4
AC 1930	8.4	24.1	23.8	0.91		0.89	3.06		1.13	43.2	39.0
AC 1931	7.1	24.1	24.5	0.71		0.25	0.69		0.84	33.1	35.2
AC 1932	8.6	17.8	22.5	0.05		0.35	0.95		0.41	29.3	29.8
AC 1933	8.4	21.5	25.1	0.70		0.45	2.17		0.64	35.6	32.4
AC 1934	8.7	21.7	17.6	0.02		0.39	1.47		0.62	26.7	31.2
AC 1935	8.8	15.8	14.0	0.47		0.56	1.22		0.28	30.1	3[illegible]
AC 1936	8.5	18.1	8.54			0.42	1.06		0.36	29.5	29.[illegible]
AC 1937	8.8	15.0	15.3	0.13		0.32	0.39		0.54	23.1	25.3
AC 1938	8.6	19.6	13.9			0.03			0.67	20.6	23.1
AC 1939	8.4	16.2	13.0	0.28		0.57	2.55		0.75	24.3	25.3
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1921	8.4	0.23			1.31			
AC 1922	8.1	0.38			1.54			
AC 1923	9.0	0.38			2.02			
AC 1924	8.3	0.33			1.57			
AC 1925	8.9	0.30			2.36			
AC 1926	8.6	0.85			0.65			
AC 1927	8.8	1.04			2.34			
AC 1928	8.8				1.92			
AC 1929	8.4	0.21			2.25			
AC 1930	8.4	0.28			4.58			
AC 1931	7.1	0.82			2.18			
AC 1932	8.6	0.33			0.86			
AC 1933	8.4				1.43			
AC 1934	8.7	0.37			1.89			
AC 1935	8.8				1.10			
AC 1936	8.5	0.36			1.00			
AC 1937	8.8	0.59			1.66			
AC 1938	8.6	0.63			1.00			
AC 1939	8.4	0.12			2.89			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-26-84 — VALUES ARE % OR PPM (1% = 10,000PPM) — DK2:042685.C13;1

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1940	8.2	91.8	52.6	3620	4340	165	6.53	1.30	54.9	48.4	1.16
AC 1941	8.5	91.0	45.8	2550	2640	135	3.34	1.05	38.8	41.9	0.02
AC 1942	8.1	5.97	11.3	1180	177	30.7	3.93	0.53	14.0	15.8	
AC 1943	8.5	97.6	42.9	2840	4620	132	3.82	1.44	41.8	48.5	0.95
AC 1944	9.0	110	41.7	2630	4680	168	4.34	1.28	43.4	59.1	1.39
AC 1945	8.7	137	43.0	3020	5350	159	6.26	1.34	54.5	60.0	1.72
AC 1946	8.8	102	31.8	2630	5400	113	4.63	0.80	26.2	52.3	1.10
AC 1947	7.3	102	48.8	3110	6790	131	6.26	1.23	51.3	59.2	1.00
AC 1948	8.6	125	58.9	2510	5810	98.1	4.93	1.34	34.7	50.9	1.03
AC 1949	6.0	153	58.3	3130	6710	88.9	10.5	1.66	61.3	84.0	1.88
AC 1950	7.6	125	61.2	3190	5460	96.3	5.72	0.99	41.1	68.0	1.28
AC 1951	8.6	140	47.0	2500	4720	81.2	5.11	0.97	42.8	46.3	1.22
AC 1952	8.0	90.0	41.8	2550	4910	68.1	6.49	1.02	47.1	36.5	1.16
AC 1953	8.0	154	67.3	30	4820	103	3.71	1.01	50.1	33.1	1.69
AC 1954	7.7	7.48	8.28	460	115	10.5	3.38	0.18	7.04	6.72	0.00
AC 1955	8.7	244	84.1	3030	4820	111	4.18	1.10	50.5	33.3	1.69
AC 1956	7.9	147	66.9	2970	4380	87.6	3.63	1.09	36.7	31.9	1.26
AC 1957	8.1	195	105	3400	4430	94.4	4.18	0.91	42.9	27.6	1.10
AC 1958	7.5	179	73.9	3120	4570	85.2	4.79	0.85	31.1	28.1	1.17
AC 1959	7.5	172	102	3290	4470	105	4.38	1.21	55.4	32.7	1.39
AC 1960	8.3	166	94.6	3130	4100	85.3	3.68	0.82	46.1	25.7	1.42
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1940	8.2	20.8	19.3				0.78		0.78	20.7	23.3
AC 1941	8.5	19.1	10.8			0.09	1.12		0.69	15.3	14.5
AC 1942	8.1	3.24	0.51		0.97				0.18	0.97	0.56
AC 1943	8.5	19.5	14.0				0.63		0.47	27.4	26.3
AC 1944	9.0	15.0	14.9			0.26	1.01		0.67	24.8	29.8
AC 1945	8.7	13.6	20.3						0.75	26.1	29.0
AC 1946	8.8	8.58	8.12						0.29	24.7	26.5
AC 1947	7.3	14.6	11.3						1.69	30.2	28.7
AC 1948	8.6	15.5	8.78		0.35		0.63		0.69	31.0	29.0
AC 1949	6.0	19.3	20.7				0.61		0.71	49.2	35.8
AC 1950	7.6	14.8	12.1				0.28		0.62	25.9	26.9
AC 1951	8.6	15.5	11.9		0.18				0.68	24.9	25.7
AC 1952	8.0	20.1	12.0				0.85		0.87	25.0	24.8
AC 1953	8.0	19.3	12.9		0.11	0.00	0.53		0.96	20.7	20.2
AC 1954	7.7	1.00			1.16				0.05	0.65	0.14
AC 1955	8.7	16.5	18.2				0.06		0.99	22.3	24.1
AC 1956	7.9	14.5	7.36				0.42		0.75	23.7	22.9
AC 1957	8.1	14.5	8.83			0.00	0.89		0.61	19.2	20.9
AC 1958	7.5	11.5	5.83				0.73		0.31	20.8	21.7
AC 1959	7.5	20.4	20.9				0.72		0.66	22.7	23.6
AC 1960	8.3	13.9	11.5				0.26		0.66	20.2	21.1
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1940	8.2	0.34			2.47			
AC 1941	8.5	0.21			4.24			
AC 1942	8.1				4.49			
AC 1943	8.5				3.33			
AC 1944	9.0			0.05	3.36			
AC 1945	8.7				0.66			
AC 1946	8.8	0.39			1.24			
AC 1947	7.3	0.24			1.49			
AC 1948	8.6	0.05			3.82			
AC 1949	6.0	0.28			4.22			
AC 1950	7.6	0.36			2.32			
AC 1951	8.6	0.49			2.26			
AC 1952	8.0				2.33			
AC 1953	8.0				2.38			
AC 1954	7.7				4.81			
AC 1955	8.7				0.97			
AC 1956	7.9				3.01			
AC 1957	8.1				1.88			
AC 1958	7.5				3.61			
AC 1959	7.5				3.04			
AC 1960	8.3				1.36			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS;1792-1984 — DR. RUNDEL 4-26-84 — DK2:042685.C13;1

VALUES ARE % OR PPM (1% = 10,000PPM)

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1961	7.7	247	180	4530	3890	91.6	5.98	1.03	56.7	28.2	1.77
AC 1962	6.9	39.6	49.5	1760	207	14.6	5.27	0.59	16.6	9.77	0.0[illegible]
AC 1963	7.9	192	642	7020	4240	63.2	5.89	1.14	69.6	24.6	1.[illegible]
AC 1964	7.5	290	1470	1.01%	6960	405	7.78	1.86	71.5	60.5	9.5[illegible]
AC 1965-66	8.6	164	76.7	2320	4210	135	5.11	2.22	93.4	32.3	5.30
AC 1967	9.0	171	26.3	1890	2460	46.6	4.66	0.89	39.1	24.2	1.44
AC 1968	8.8	163	29.5	2150	2280	59.1	4.87	0.98	48.2	19.8	1.65
AC 1969	5.9	369	54.9	3010	3720	74.9	8.88	1.47	68.2	37.7	2.59
AC 1970	8.9	227	27.9	2120	1990	66.9	4.01	1.14	54.5	16.7	1.27
AC 1971-72	8.1	340	38.2	2570	2480	58.1	4.79	1.34	76.3	20.5	1.83
AC 1973	7.1	368	36.1	2790	3130	51.0	4.95	1.15	78.0	18.8	1.51
AC 1974	7.6	295	40.1	3060	1670	56.3	5.89	1.25	77.2	12.5	1.29
AC 1975	5.7	372	37.2	2170	2000	46.8	8.62	1.32	67.5	17.1	2.53
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1961	7.7	18.7	18.3		0.21	0.30	0.87		1.23	18.4	21.7
AC 1962	6.9	5.45	8.13		0.82				0.16	1.52	0.74
AC 1963	7.9	25.5	26.8			0.16	1.18		1.17	24.6	21.5
AC 1964	7.5	73.9	48.3				3.54		1.37	35.1	39.5
AC 1965-66	8.6	32.1	41.8				1.22		1.18	21.0	19.8
AC 1967	9.0	10.6	11.6		0.22				0.38	13.2	13.4
AC 1968	8.8	11.5	10.3						0.37	14.2	16.3
AC 1969	5.9	19.3	21.6						0.44	24.2	20.5
AC 1970	8.9	9.44	9.95		0.07		0.18		1.41	12.0	13.3
AC 1971-72	8.1	14.8	20.5				0.61		0.91	15.3	14.3
AC 1973	7.1	16.7	22.4		0.16	0.27	1.14		0.96	14.4	13.2
AC 1974	7.6	16.0	24.5		0.29		0.53		1.29	11.2	13.9
AC 1975	5.7	21.2	28.5		0.69	0.60	1.17	0.50	0.51	12.9	14.6
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1961	7.7				3.40			
AC 1962	6.9				4.79			
AC 1963	7.9			0.05	3.18			
AC 1964	7.5	0.15			3.16			
AC 1965-66	8.6	0.35			0.77			
AC 1967	9.0	0.11			2.20			
AC 1968	8.8				1.53			
AC 1969	5.9			0.62	3.63			
AC 1970	8.9				1.83			
AC 1971-72	8.1				1.67			
AC 1973	7.1				2.56			
AC 1974	7.6				2.60			
AC 1975	5.7			1.06	7.60			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

CONCENTRATION IN DRY TISSUE — SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-26-85
VALUES ARE % OR PPM (1% = 10,000PPM)

DK2:042685.C13;3

	WEIGHT	1 P	2 NA	3 K	4 CA	5 MG	6 ZN	7 CU	8 FE	9 MN	10 B
AC 1976	6.5	261	52.2	3190	2070	63.7	6.56	1.87	127	23.0	2.22
AC 1977	8.2	312	50.1	2600	1700	63.3	2.91	1.53	94.1	18.8	1.26
AC 1978	8.9	348	48.7	2520	803	63.1	3.35	1.39	82.9	17.1	1.07
AC 1979	8.2	565	43.6	2430	741	49.4	2.60	1.01	42.1	15.6	1.50
AC 1980	6.5	730	35.5	3100	556	48.6	2.19	1.19	72.9	18.7	2.03
AC 1981	8.1	430	59.8	2490	329	46.5	1.70	1.28	77.4	15.0	1.37
AC 1982	8.4	504	66.9	2500	271	52.6	1.47	1.66	72.5	17.0	1.14
AC 1983	8.6	635	60.6	3580	218	53.4	2.23	1.65	94.6	15.2	0.92
AC 1984	8.4	23.0	9.35	755	2.20	1.31	0.83	0.12	3.11	1.02	
UPPER LIMIT		10.0%	20.0%	20.0%	20.0%	5.00%	10.0%	1000	1.50%	5.00%	3000
LOWER LIMIT		50.0	1.00	150	1.00	50.0	5.00	0.20	0.60	0.10	1.00

	WEIGHT	11 AL	12 SI	13 TI	14 V	15 CO	16 NI	17 MO	18 CR	19 SR	20 BA
AC 1976	6.5	23.1	36.6		0.16	0.45	0.59		1.50	12.2	14.2
AC 1977	8.2	18.7	31.0		0.25	0.87	1.72		1.48	10.6	12.6
AC 1978	8.9	16.6	33.0	0.23					1.42	6.74	9.89
AC 1979	8.2	11.5	21.1		0.53	0.25	0.33		0.85	6.84	8.55
AC 1980	6.5	13.5	27.8	0.03	1.62				1.30	6.35	9.37
AC 1981	8.1	11.7	22.0		0.70	0.54	1.02		1.57	5.34	10.8
AC 1982	8.4	12.5	23.0		0.59	0.76	1.51		1.61	4.60	9.89
AC 1983	8.6	13.2	25.4	0.05	0.37		0.64		3.51	4.54	9.64
AC 1984	8.4	0.88							0.01	0.00	0.04
UPPER LIMIT		3.00%	10.0%	2.00%	500	2000	2000	2000	300	1000	2000
LOWER LIMIT		1.00	1.00	0.50	1.00	1.50	0.50	0.20	0.20	0.20	0.20

	WEIGHT	21 LI	22 AG	23 SN	24 PB	25 BE	26 CD	27 AS
AC 1976	6.5	0.23	0.02		2.24			
AC 1977	8.2		0.03	0.08	2.73			
AC 1978	8.9	0.54			2.78			
AC 1979	8.2	0.49			3.57			
AC 1980	6.5	0.47			3.34			
AC 1981	8.1	0.27	0.00		3.59			
AC 1982	8.4		0.02		3.71			
AC 1983	8.6	0.18			2.36			
AC 1984	8.4				2.93			
UPPER LIMIT		2000	100	100	3000	1.00%	1.10%	1.00%
LOWER LIMIT		0.30	0.10	0.30	1.00	0.20	3.00	1.00

APPENDIX II

Appendix I Regressions based on 12 individuals of Abies concolor and 11 of Abies magnifica in Sequoia National Forest. Regressions are of the form $\ln y = A + B \ln X$. The intercept A has been adjusted so that the antiln Y is corrected for bias due to use of ln-ln regression. The correction is of the form $A = A' + (\ln \frac{SEE^2}{2})$. SEE is the standard error of estimate in arithmetric units. SD is the standard deviation of Y in ln units. r is the coefficient of correlation for the logarithmic regression. CF is the factor by which antiln Y has been increased by incorporating the correction factor for ln-ln bias. Current twig and leaf production equations are the same as those for current twig and leaf dry weight. The proportion of current twigs and leaves only is 54.6% for A. concolor, 68.4% for A. magnifica.

Dimensions Y	On DBH, x (cm) A concolor	A magnifica	A concolor	A magnifica
Tree height, (cm)				
A	4.40671	4.63140		
B	0.89743	0.80628		
r	0.959	0.837		
SD	0.69769	0.33192		
SEE	1.2411	1.2227		
CF	1.024	1.020		
Stem volume (cm^3)			On stem parabolic volume y (cm^3)	
A	4.22124	3.76073	0.98862	0.02554
B	2.6954	2.7817	0.93047	0.99559
r	0.994	0.973	0.999	0.994
SD	2.0214	0.98493	2.0214	0.98493
SEE	1.2643	1.2881	1.1174	1.1262
CF	1.028	1.033	1.006	1.007

Stem wood volume (cm^3)

A	3.91409	3.49889	0.65042	-0.28427
B	2.7158	2.7821	0.93786	0.99867
r	0.994	0.968	0.999	0.992
SD	2.0375	0.98958	2.0375	0.98958
SEE	1.2771	1.3149	1.1213	1.1439
CF	1.030	1.038	1.007	1.009

Surface area, y (cm^2)

Stem surface			On stem conic surface, x (cm)	
A	5.57214	5.25596	0.99803	0.06693
B	1.7744	1.8262	0.93741	1.0149
r	0.987	0.948	0.998	0.991
SD	1.3413	0.66348	1.3413	0.66348
SEE	1.2722	1.2634	1.0854	1.1014
CF	1.209	1.028	1.003	1.005

Branch surface, y

A	7.33819	3.93677	3.20389	-1.45574
B	1.9041	2.5848	0.95172	1.2866
r	0.960	0.934	0.919	0.875
SD	1.4792	0.95298	1.4792	0.95298
SEE	1.5745	1.4568	1.8927	1.6655
CF	1.108	1.073	1.225	1.139

Leaf surface, projected			On sapwood x-sec area, x (cm^2)	
A	6.92947	3.03073	-0.82053	0.86724
B	1.8855	2.9309	0.94351	0.99422
r	0.954	0.934	0.968	0.905
SD	1.4733	1.0803	1.4733	1.0803
SEE	1.6190	1.5309	1.5018	1.6619
CF	1.123	1.095	1.086	1.137

Leaf surface, all-sided

A	7.74507	3.91023	-0.00517	1.74687
B	1.8855	2.9310	0.94351	0.99422

r	0.954	0.934	0.968	0.905
SD	1.4733	1.0803	1.4733	1.0803
SEE	1.6190	1.5305	1.5018	1.6619
CF	1.123	1.095	1.086	1.137

Mass, y (g)

Stem wood dry weight

A	3.11845	2.55249	-0.13498	-1.23065
B	2.7011	2.7821	0.93316	0.99865
r	0.994	0.968	0.999	0.992
SD	2.0272	0.98957	2.0272	0.98957
SEE	1.2848	1.3150	1.1175	1.1441
CF	1.032	1.038	1.006	1.009

Stem bark dry weight

A	2.36182	1.46053	-0.75628	-2.17775
B	2.6201	2.8468	0.90326	1.0076
r	0.994	0.945	0.997	0.955
SD	1.9664	1.0378	1.9664	1.0378
SEE	1.2747	1.4570	1.1925	1.4068
CF	1.030	1.073	1.016	1.060

Stem sapwood dry weight

A	2.64305	2.83836	-0.82754	-1.19097
B	2.9002	2.7857	1.0007	1.0148
r	0.994	0.909	0.998	0.945
SD	2.1767	1.0555	2.1767	1.0555
SEE	1.3097	1.6266	1.1844	1.4626
CF	1.037	1.125	1.014	1.075

Live branch wood and bark, dry weight

A	2.82853	-1.82353	0.46801	-5.30124
B	2.3418	3.5210	0.78467	1.1842
r	0.926	0.937	0.938	0.900
SD	1.8150	1.2935	1.8150	1.2935

SEE	1.7187	1.6456	1.9919	1.8639
CF	1.156	1.132	1.268	1.214

Current twigs and leaves, dry weight

A	4.47181	2.65541	3.17376	0.67998
B	1.3140	1.6110	0.43735	0.56509
r	0.935	0.839	0.905	0.841
SD	1.0482	0.66098	1.0482	0.66098
SEE	1.5035	1.4877	1.6287	1.4854
CF	1.087	1.082	1.126	1.081

Current and older leaves dry weight

A	3.81947	-0.12667	1.93555	-3.16996
B	1.8855	2.9308	0.63007	0.99418
r	0.954	0.934	0.928	0.905
SD	1.4733	1.0802	1.4733	1.0802
SEE	1.6189	1.5306	1.8252	1.6618
CF	1.123	1.095	1.198	1.137

Total aboveground mass

A	4.36982	2.61856	1.45087	-1.08411
B	2.5043	2.9121	0.86016	1.0295
r	0.997	0.981	0.996	0.990
SD	1.8738	1.0225	1.8738	1.0225
SEE	1.1830	1.2470	1.2016	1.1723
CF	1.014	1.025	1.017	1.013

	On DBH, x (cm)		On stem parabolic volume, x (cm^3)		On stem wood parabolic volume annual increment (cm^3/yr)	
	A. concolor	A. magnifica	A. concolor	A. magnifica	A. concolor	A. magnifica
Net production, x (g/yr)						
Stem wood production						
A	1.44979	1.60616	-1.16634	-0.93019	-1.06180	-0.53954
B	2.1726	2.1768	0.75077	0.75523	1.0340	0.98170
r	0.930	0.627	0.935	0.622	0.994	0.995
SD	1.7415	1.9149	1.7415	1.1949	1.7415	1.1949
SEE	2.0129	2.7975	1.9635	2.8148	1.2314	1.1385
CF	1.277	1.697	1.255	1.708	1.022	1.008
Stem bark production						
A	0.67501	0.21110	-1.80511	-2.18297	-1.63388	0.69372
B	2.0896	2.2418	0.72016	0.76417	0.98717	0.79085
r	0.933	0.764	0.936	0.743	0.990	0.948
SD	1.6701	1.0109	1.6701	1.0109	1.6701	1.0109
SEE	1.9315	2.0576	1.9081	2.1119	1.3203	1.4290
CF	1.242	1.297	1.232	1.322	1.035	1.066
Live branch wood and bark production						
A	2.5044	-2.16239	0.70744	-5.31191	1.37974	0.45853
B	1.7388	2.8842	0.58414	0.98786	0.76077	0.84983
r	0.943	0.857	0.921	0.838	0.926	0.888
SD	1.3757	1.1593	1.3757	1.1593	1.3757	1.1593
SEE	1.6542	1.9368	1.7968	2.0128	1.7675	1.8032
CF	1.135	1.244	1.187	1.277	1.176	1.190
Older leaf production						
A	-0.62264	-4.67337	-2.6226	-7.76758	-1.44007	0.25582
B	1.9914	3.0027	0.66623	1.0172	0.83536	0.70287
r	0.958	0.937	0.933	0.907	0.902	0.772
SD	1.5501	1.1035	1.5501	1.1035	1.5501	1.1035
SEE	1.6267	1.5308	1.8461	1.6737	2.0799	2.1729
CF	1.125	1.095	1.207	1.142	1.307	1.351

Total aboveground production

A	4.31370	1.90079	2.44735	-0.72449	2.77544	2.19563
B	1.6860	2.2787	0.57343	0.78875	0.77315	0.81971
r	0.958	0.764	0.948	0.755	0.987	0.966
SD	1.3119	1.0276	1.3119	1.0276	1.3119	1.0276
SEE	1.5074	2.0835	1.5777	2.1070	1.2643	1.3401
CF	1.088	1.309	1.109	1.320	1.028	1.044

APPENDIX III. Seasonal change in foliar concentrations of nutrients at Log Creek during 1984.

K CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			22700.00	10666.66	8550.00		
ABIES CONCOLOR		10766.66	12533.33	14166.66	11733.33	13100.00	11233.33
ABIES MAGNIFICA		30466.66	12166.66	14700.00	15400.00	12600.00	12966.66
SEQUOIADENDRON GIGANTEUM		21400.00	18966.66	14666.66	15333.33	12433.33	14100.00
CEANOTHUS CORDULATUS	16800.00		14866.66	6376.66	7216.66		
CORYLUS CORNUTA	18266.66		11300.00	8566.66	6893.33		
CORNUS STOLONIFERA	14433.33		9976.66	8010.00	7480.00		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	18066.66	11033.33	18433.33	12800.00	12966.66	14066.66	9980.00
ARCTOSTAPHYLOS PATULA	17333.33	9456.66	11733.33	10700.00	10090.00	9593.33	8206.66
QUERCUS KELLOGGII	10196.66	9863.33	12866.66	5003.33	4680.00	11600.00	9133.33

HERBS	JULY 26
LUPINUS LATIFOLIUS	17333.33
ATHYRIUM FILIX-FEMINA	27266.66
PTERIDIUM AQUILINUM	23700.00
HIERACEUM ALBIFLORUM	29866.66
OSMORHIZA CHILENSIS	25800.00
ADENOCAULON BICOLOR	36100.00
PYROLA PICTA A	16333.33
PYROLA PICTA B	20033.33
PTEROSPORA ANDROMEDEA	15633.33

MG CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			1573.33	647.67	607.00		
ABIES CONCOLOR		205.67	345.67	1623.33	1533.33	1156.67	1290.00
ABIES MAGNIFICA		1773.33	173.33	1200.00	1220.00	991.67	1170.00
SEQUOIADENDRON GIGANTEUM		2803.33	3083.33	2093.33	2026.67	2186.67	2120.00
CEANOTHUS CORDULATUS	2140.00		2856.67	1058.33	855.00		
CORYLUS CORNUTA	4683.33		832.67	1663.33	1370.00		
CORNUS STOLONIFERA	2703.33		477.67	1360.00	1586.67		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	1296.67	248.00	1646.67	856.00	854.67	864.33	1213.33
ARCTOSTAPHYLOS PATULA	1776.67	233.00	2123.33	1320.00	1303.33	1180.00	1153.33
QUERCUS KELLOGGII	2913.33	375.67	2960.00	914.33	922.33	1620.00	1120.00

HERBS	JULY 26
LUPINUS LATIFOLIUS	4843.33
ATHYRIUM FILIX-FEMINA	8016.66
PTERIDIUM AQUILINUM	2973.33
HIERACEUM ALBIFLORUM	2710.00
OSMORHIZA CHILENSIS	3503.33
ADENOCAULON BICOLOR	3343.33
PYROLA PICTA A	2366.67
PYROLA PICTA B	2740.00
PTEROSPORA ANDROMEDEA	289.67

CA CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			1643.33	496.33	460.00		
ABIES CONCOLOR		563.67	1250.00	11933.33	12700.00	10410.00	10833.33
ABIES MAGNIFICA		2316.67	384.33	8793.33	10050.00	7506.66	7826.66
SEQUOIADENDRON GIGANTEUM		10216.66	12133.33	9950.00	11633.33	11166.66	12833.33
CEANOTHUS CORDULATUS	13133.33		13566.66	6376.66	2173.33		
CORYLUS CORNUTA	21133.33		2206.67	15333.33	12366.66		
CORNUS STOLONIFERA	20466.66		2396.67	18100.00	22866.66		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	333.00	243.67	681.33	548.00	459.00	523.00	726.00
ARCTOSTAPHYLOS PATULA	4253.33	701.33	11633.33	7010.00	6383.33	6346.66	6046.66
QUERCUS KELLOGGII	9336.66	847.00	12700.00	4406.66	6986.66	11466.66	10200.00

HERBS	JULY 26
LUPINUS LATIFOLIUS	21233.33
ATHYRIUM FILIX-FEMINA	4990.00
PTERIDIUM AQUILINUM	4763.33
HIERACEUM ALBIFLORUM	12433.33
OSMORHIZA CHILENSIS	27933.33
ADENOCAULON BICOLOR	14966.66
PYROLA PICTA A	7973.33
PYROLA PICTA B	17566.66
PTEROSPORA ANDROMEDEA	267.00

NA CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			118.37	5.16	7.25		
ABIES CONCOLOR		1.17	17.10	8.65	4.25	7.23	5.30
ABIES MAGNIFICA		21.43	0.0	7.93	4.40	2.53	5.50
SEQUOIADENDRON GIGANTEUM		15.20	19.17	1.62	2.18	0.0	7.32
CEANOTHUS CORDULATUS	85.83		38.90	8.80	13.40		
CORYLUS CORNUTA	287.67		27.07	22.80	22.70		
CORNUS STOLONIFERA	55.67		7.84	10.25	13.37		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	9.12	0.57	16.17	7.55	8.81	19.30	1.32
ARCTOSTAPHYLOS PATULA	27.27	5.39	21.43	8.65	8.74	13.63	10.81
QUERCUS KELLOGGII	47.97	15.83	61.70	10.35	11.10	82.30	38.23

HERBS	JULY 26
LUPINUS LATIFOLIUS	47.57
ATHYRIUM FILIX-FEMINA	311.33
PTERIDIUM AQUILINUM	51.13
HIERACEUM ALBIFLORUM	507.33
OSMORHIZA CHILENSIS	36.50
ADENOCAULON BICOLOR	37.10
PYROLA PICTA A	35.10
PYROLA PICTA B	85.17
PTEROSPORA ANDROMEDEA	12.27

MN CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			126.67	55.60	42.50		
ABIES CONCOLOR		21.53	43.23	218.67	242.00	205.33	239.33
ABIES MAGNIFICA		166.00	17.77	434.67	352.00	166.00	305.00
SEQUOIADENDRON GIGANTEUM		251.33	286.00	293.67	385.00	147.67	283.00
CEANOTHUS CORDULATUS	238.33	.	186.33	76.60	73.93		
CORYLUS CORNUTA	459.67		29.00	262.00	90.13		
CORNUS STOLONIFERA	79.90		2.99	21.47	15.37		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	147.00	38.97	212.33	89.73	57.17	51.03	254.67
ARCTOSTAPHYLOS PATULA	26.37	0.67	44.37	18.80	17.80	12.83	20.57
QUERCUS KELLOGGII	379.33	44.73	481.67	119.57	166.00	271.33	144.00

HERBS	JULY 26
LUPINUS LATIFOLIUS	125.00
ATHYRIUM FILIX-FEMINA	105.57
PTERIDIUM AQUILINUM	116.13
HIERACEUM ALBIFLORUM	162.67
OSMORHIZA CHILENSIS	111.67
ADENOCAULON BICOLOR	34.27
PYROLA PICTA A	52.87
PYROLA PICTA B	62.80
PTEROSPORA ANDROMEDEA	0.0

AL CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			402.67	66.47	58.67		
ABIES CONCOLOR		14.43	24.63	146.00	88.77	160.33	92.83
ABIES MAGNIFICA		133.33	15.17	213.33	110.00	86.70	110.67
SEQUOIADENDRON GIGANTEUM		12.43	20.03	6.57	15.67	4.13	10.80
CEANOTHUS CORDULATUS	293.33		136.00	24.60	41.47		
CORYLUS CORNUTA	1256.67		32.63	226.00	155.67		
CORNUS STOLONIFERA	254.33		11.07	67.93	123.07		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	79.83	10.39	120.67	87.87	67.83	111.83	115.33
ARCTOSTAPHYLOS RATULA	62.60	11.37	116.30	32.07	38.37	51.37	36.03
QUERCUS KELLOGGII	157.00	19.43	299.33	61.00	75.93	446.33	181.67

HERBS	JULY 26
LUPINUS LATIFOLIUS	136.43
ATHYRIUM FILIX-FEMINA	328.33
PTERIDIUM AQUILINUM	77.83
HIERACEUM ALBIFLORUM	340.67
OSMORHIZA CHILENSIS	74.03
ADENOCAULON BICOLOR	58.57
PYROLA PICTA A	151.00
PYROLA PICTA B	165.67
PTEROSPORA ANDROMEDEA	10.35

FE CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			87.77	40.80	38.27		
ABIES CONCOLOR		0.0	11.62	57.87	46.23	58.37	46.80
ABIES MAGNIFICA		70.83	0.0	78.20	44.93	38.67	51.53
SEQUOIADENDRON GIGANTEUM		82.70	81.23	45.60	59.43	36.97	46.53
CEANOTHUS CORDULATUS	290.33		215.33	64.50	82.30		
CORYLUS CORNUTA	753.33		39.07	200.00	138.67		
CORNUS STOLONIFERA	212.33		18.83	87.60	112.83		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	39.10	0.0	74.77	56.63	46.20	112.00	102.87
ARCTOSTAPHYLOS PATULA	125.33	7.38	109.00	74.53	67.60	77.47	69.73
QUERCUS KELLOGGII	218.00	31.50	285.67	114.13	113.00	313.67	214.00

HERBS	JULY 26
LUPINUS LATIFOLIUS	145.00
ATHYRIUM FILIX-FEMINA	305.00
PTERIDIUM AQUILINUM	167.67
HIERACEUM ALBIFLORUM	260.67
OSMORHIZA CHILENSIS	110.67
ADENOCAULON BICOLOR	118.00
PYROLA PICTA A	97.83
PYROLA PICTA B	159.00
PTEROSPORA ANDROMEDEA	9.66

SI CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			831.33	434.00	442.33		
ABIES CONCOLOR		64.67	130.00	298.33	256.00	348.33	303.67
ABIES MAGNIFICA		76.90	34.13	510.67	192.00	168.33	251.33
SEQUOIADENDRON GIGANTEUM		233.67	205.00	244.00	311.33	109.30	434.33
CEANOTHUS CORDULATUS	1069.33		572.33	452.00	744.67		
CORYLUS CORNUTA	2336.67		211.33	1793.33	1503.33		
CORNUS STOLONIFERA	814.00		136.67	1040.33	1356.67		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	57.10	20.10	288.67	260.67	164.33	464.67	617.33
ARCTOSTAPHYLOS PATULA	301.67	125.33	438.00	325.67	443.67	317.00	659.33
QUERCUS KELLOGGII	589.00	240.67	933.67	904.67	1008.00	1596.67	968.33

HERBS	JULY 26
LUPINUS LATIFOLIUS	514.00
ATHYRIUM FILIX-FEMINA	11200.00
PTERIDIUM AQUILINUM	7063.33
HIERACEUM ALBIFLORUM	993.67
OSMORHIZA CHILENSIS	412.67
ADENOCAULON BICOLOR	315.33
PYROLA PICTA A	353.33
PYROLA PICTA B	3023.33
PTEROSPORA ANDROMEDEA	85.73

ZN CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			17.67	20.53	18.87		
ABIES CONCOLOR		3.82	6.13	25.80	18.47	21.00	13.53
ABIES MAGNIFICA		31.33	6.87	19.97	27.50	19.73	21.00
SEQUOIADENDRON GIGANTEUM		17.63	14.30	17.30	13.07	17.97	13.40
CEANOTHUS CORDULATUS	14.57		10.51	13.90	15.57		
CORYLUS CORNUTA	19.17		0.49	22.90	18.23		
CORNUS STOLONIFERA	12.73		0.47	15.47	13.20		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	24.87	14.53	21.53	19.60	18.60	19.13	16.23
ARCTOSTAPHYLOS PATULA	21.47	5.04	14.47	15.83	15.33	13.13	10.76
QUERCUS KELLOGGII	15.40	4.53	16.77	19.80	15.43	29.20	15.17

HERBS	JULY 26
LUPINUS LATIFOLIUS	14.47
ATHYRIUM FILIX-FEMINA	13.73
PTERIDIUM AQUILINUM	11.71
HIERACEUM ALBIFLORUM	15.00
OSMORHIZA CHILENSIS	7.61
ADENOCAULON BICOLOR.	7.95
PYROLA PICTA A	13.77
PYROLA PICTA B	9.49
PTEROSPORA ANDROMEDEA	15.53

TI CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			2.60	1.70	2.30		
ABIES CONCOLOR		0.0	0.0	1.32	0.51	2.09	0.97
ABIES MAGNIFICA		1.31	0.0	2.36	0.54	0.22	0.82
SEQUOIADENDRON GIGANTEUM		1.24	1.99	0.40	1.39	0.0	1.27
CEANOTHUS CORDULATUS	12.67		9.16	3.30	5.25		
CORYLUS CORNUTA	54.70		0.0	17.80	14.87		
CORNUS STOLONIFERA	10.53		0.0	4.93	7.66		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	0.0	0.0	1.45	2.72	0.76	2.85	1.82
ARCTOSTAPHYLOS PATULA	2.14	0.0	5.10	2.72	2.43	3.07	2.05
QUERCUS KELLOGGII	5.04	0.0	11.28	5.71	7.29	25.90	11.89

HERBS	JULY 26
LUPINUS LATIFOLIUS	7.51
ATHYRIUM FILIX-FEMINA	19.60
PTERIDIUM AQUILINUM	13.43
HIERACEUM ALBIFLORUM	29.53
OSMORHIZA CHILENSIS	2.38
ADENOCAULON BICOLOR	8.52
PYROLA PICTA A	8.00
PYROLA PICTA B	13.83
PTEROSPORA ANDROMEDEA	0.0

CU CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			7.81	3.04	2.69		
ABIES CONCOLOR		1.19	3.07	4.67	3.20	4.17	2.53
ABIES MAGNIFICA		11.73	1.53	5.36	6.13	3.60	4.00
SEQUOIADENDRON GIGANTEUM		10.93	9.51	5.75	5.20	4.68	3.79
CEANOTHUS CORDULATUS	6.80		7.72	3.05	2.25		•
CORYLUS CORNUTA	16.83		2.54	5.56	5.19		
CORNUS STOLONIFERA	4.18		0.64	2.55	2.12		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	4.95	1.49	5.94	2.48	2.40	2.22	1.79
ARCTOSTAPHYLOS PATULA	6.60	0.71	3.26	2.05	2.33	1.79	1.66
QUERCUS KELLOGGII	9.16	3.00	10.24	3.45	3.13	7.00	3.63

HERBS	JULY 26
LUPINUS LATIFOLIUS	3.38
ATHYRIUM FILIX-FEMINA	9.91
PTERIDIUM AQUILINUM	5.29
HIERACEUM ALBIFLORUM	12.57
OSMORHIZA CHILENSIS	4.40
ADENOGAULON BICOLOR	6.32
PYROLA PICTA A	6.84
PYROLA PICTA B	5.29
PTEROSPORA ANDROMEDEA	0.31

B CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			28.47	22.87	16.90		
ABIES CONCOLOR		6.13	7.42	18.67	24.67	28.53	20.93
ABIES MAGNIFICA		24.50	7.09	36.90	39.57	23.83	24.13
SEQUOIADENDRON GIGANTEUM		39.70	36.70	39.40	41.23	34.97	38.33
CEANOTHUS CORDULATUS	28.90		43.70	25.70	40.87		
CORYLUS CORNUTA	40.17		15.97	44.57	43.27		
CORNUS STOLONIFERA	21.53		4.88	10.83	9.78		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	9.22	4.93	19.13	12.07	13.37	15.77	17.10
ARCTOSTAPHYLOS PATULA	17.23	6.36	17.33	21.63	11.25	19.33	8.23
QUERCUS KELLOGGII	22.73	13.57	41.20	62.97	58.03	61.67	50.47

HERBS	JULY 26
LUPINUS LATIFOLIUS	23.10
ATHYRIUM FILIX-FEMINA	22.87
PTERIDIUM AQUILINUM	32.80
HIERACEUM ALBIFLORUM	36.27
OSMORHIZA CHILENSIS	14.97
ADENOCAULON BICOLOR	29.10
PYROLA PICTA A	24.53
PYROLA PICTA B	39.07
PTEROSPORA ANDROMEDEA	2.79

V CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			0.0	0.0	0.0		
ABIES CONCOLOR		8.60	8.29	0.94	1.16	1.08	1.32
ABIES MAGNIFICA		0.0	9.62	0.08	0.84	1.39	1.50
SEQUOIADENDRON GIGANTEUM		0.0	0.0	0.01	0.0	0.24	0.36
CEANOTHUS CORDULATUS	0.90		0.09	0.0	0.0		
CORYLUS CORNUTA	0.29		8.13	1.27	0.0		
CORNUS STOLONIFERA	1.39		8.92	0.46	0.60		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	1.16	9.63	1.37	0.0	0.0	0.0	1.17
ARCTOSTAPHYLOS RATULA	1.05	10.36	0.41	0.0	0.0	0.0	0.0
QUERCUS KELLOGGII	1.96	9.59	1.12	0.07	0.0	0.0	0.0

HERBS	JULY 26
LUPINUS LATIFOLIUS	0.0
ATHYRIUM FILIX-FEMINA	0.0
PTERIDIUM AQUILINUM	0.0
HIERACEUM ALBIFLORUM	0.0
OSMORHIZA CHILENSIS	0.0
ADENOCAULON BICOLOR	0.0
PYROLA PICTA A	0.0
PYROLA PICTA B	0.0
PTEROSPORA ANDROMEDEA	8.29

SR CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			3.33	2.24	3.31		
ABIES CONCOLOR		3.85	6.03	126.33	119.00	110.33	92.73
ABIES MAGNIFICA		11.77	2.41	52.67	41.83	31.80	36.20
SEQUOIADENDRON GIGANTEUM		81.93	98.63	198.00	211.33	207.67	298.67
CEANOTHUS CORDULATUS	93.40		120.67	78.20	52.10		
CORYLUS CORNUTA	169.33		11.07	179.67	122.67		
CORNUS STOLONIFERA	134.67		10.67	237.33	304.00		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	0.65	1.97	1.99	2.60	1.92	3.00	3.06
ARCTOSTAPHYLOS PATULA	23.60	3.60	81.43	59.50	39.17	43.73	35.93
QUERCUS KELLOGGII	30.27	3.27	40.67	26.97	36.50	52.23	36.80

HERBS	JULY 26
LUPINUS LATIFOLIUS	152.00
ATHYRIUM FILIX-FEMINA	95.27
PTERIDIUM AQUILINUM	170.33
HIERACEUM ALBIFLORUM	65.97
OSMORHIZA CHILENSIS	161.00
ADENOCAULON BICOLOR	103.07
PYROLA PICTA A	62.20
PYROLA PICTA B	102.37
PTEROSPORA ANDROMEDEA	2.14

BA CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			3.50	1.54	2.02		
ABIES CONCOLOR		8.80	20.30	91.13	117.67	85.07	86.70
ABIES MAGNIFICA		6.87	0.49	14.50	13.93	13.23	13.17
SEQUOIADENDRON GIGANTEUM		11.17	15.07	26.60	24.73	37.03	36.77
CEANOTHUS CORDULATUS	34.83		44.70	32.40	17.30		
CORYLUS CORNUTA	109.00		16.43	73.23	80.40		
CORNUS STOLONIFERA	33.07		7.08	37.07	48.73		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	0.72	0.0	2.07	1.97	1.88	3.37	2.43
ARCTOSTAPHYLOS PATULA	49.27	14.40	85.80	80.23	72.87	60.10	44.57
QUERCUS KELLOGGII	29.70	5.78	46.30	14.97	20.73	35.73	24.77

HERBS	JULY 26
LUPINUS LATIFOLIUS	62.17
ATHYRIUM FILIX-FEMINA	268.00
PTERIDIUM AQUILINUM	208.67
HIERACEUM ALBIFLORUM	33.23
OSMORHIZA CHILENSIS	59.40
ADENOCAULON BICOLOR	39.50
PYROLA PICTA A	47.07
PYROLA PICTA B	106.80
PTEROSPORA ANDROMEDEA	0.68

LI CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			0.52	0.10	0.00		
ABIES CONCOLOR		6.39	7.56	1.03	0.95	1.01	0.73
ABIES MAGNIFICA		0.91	4.42	0.48	0.79	0.46	0.52
SEQUOIADENDRON GIGANTEUM		0.79	0.97	0.86	0.73	0.81	0.80
CEANOTHUS CORDULATUS	1.12		0.85	1.09	0.56		
CORYLUS CORNUTA	1.75		14.97	1.75	1.67		
CORNUS STOLONIFERA	2.34		13.23	2.14	2.79		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	0.36	1.59	0.68	0.93	0.90	0.74	0.74
ARCTOSTAPHYLOS PATULA	0.87	5.81	0.79	1.03	1.03	0.93	1.07
QUERCUS KELLOGGII	0.85	6.30	1.18	0.86	1.16	1.51	1.33

HERBS	JULY 26
LUPINUS LATIFOLIUS	3.65
ATHYRIUM FILIX-FEMINA	25.47
PTERIDIUM AQUILINUM	1.28
HIERACEUM ALBIFLORUM	1.77
OSMORHIZA CHILENSIS	3.40
ADENOCAULON BICOLOR	2.18
PYROLA PICTA A	1.46
PYROLA PICTA B	2.80
PTEROSPORA ANDROMEDEA	2.36

PB CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			5.49	8.44	9.33		
ABIES CONCOLOR		7.09	10.99	4.11	1.93	3.61	2.43
ABIES MAGNIFICA		3.88	4.74	4.71	5.15	3.21	3.48
SEQUOIADENDRON GIGANTEUM		5.22	5.50	2.42	0.98	0.42	4.38
CEANOTHUS CORDULATUS	7.31		7.61	11.37	12.63		
CORYLUS CORNUTA	9.36		56.77	12.93	10.49		
CORNUS STOLONIFERA	13.13		24.07	10.02	11.73		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	4.38	3.89	4.35	0.0	0.03	0.02	1.22
ARCTOSTAPHYLOS PATULA	5.35	14.83	6.57	1.36	0.77	1.56	1.10
QUERCUS KELLOGGII	8.70	35.67	8.99	7.89	6.39	4.07	2.41

HERBS	JULY 26
LUPINUS LATIFOLIUS	7.67
ATHYRIUM FILIX-FEMINA	13.53
PTERIDIUM AQUILINUM	9.31
HIERACEUM ALBIFLORUM	10.59
OSMORHIZA CHILENSIS	8.34
ADENOCAULON BICOLOR	8.61
PYROLA PICTA A	7.35
PYROLA PICTA B	9.91
PTEROSPORA ANDROMEDEA	9.82

CD CONCENTRATION IN NEW FOLIAGE (PPM)
AT LOG CREEK, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 26	JULY 3	JULY 9	JULY 31	AUG 15	AUG 28	SEPT 4
PINUS LAMBERTIANA			1.54	0.49	0.58		
ABIES CONCOLOR		0.0	0.0	0.51	0.36	0.63	0.33
ABIES MAGNIFICA		0.46	0.0	0.98	0.05	0.28	0.36
SEQUOIADENDRON GIGANTEUM		0.01	0.0	0.0	0.0	0.0	0.0
CEANOTHUS CORDULATUS	1.69		0.50	0.0	0.11		
CORYLUS CORNUTA	4.99		0.0	1.17	1.08		
CORNUS STOLONIFERA	0.89		0.0	0.21	0.74		

	JUNE 28	JULY 2	JULY 10	AUG 3	AUG 13	AUG 27	SEPT 19
PINUS JEFFREYI	0.76	0.0	0.91	0.64	0.52	0.86	0.73
ARCTOSTAPHYLOS PATULA	0.27	0.0	0.49	0.0	0.14	0.02	0.02
QUERCUS KELLOGGII	0.81	0.0	1.46	0.37	0.69	2.00	0.87

HERBS	JULY 26
LUPINUS LATIFOLIUS	0.74
ATHYRIUM FILIX-FEMINA	2.07
PTERIDIUM AQUILINUM	0.36
HIERACEUM ALBIFLORUM	1.52
OSMORHIZA CHILENSIS	0.50
ADENOCAULON BICOLOR	0.23
PYROLA PICTA A	0.44
PYROLA PICTA B	0.86
PTEROSPORA ANDROMEDEA	0.0

APPENDIX IV

The Plane Intercept Method

The plane intercept method is a way of measuring newly-produced roots in the field during a known interval. A series of screens of appropriate mesh size is inserted in the soil. At harvest the number of penetrations by roots through the plane of the screens can provide an estimate of length of new root produced during the time the screens were in the ground. The theory and a number of refinements to the method were treated in detail in the original proposal. A review of some of the important details, and new information gathered during this and related projects, will be summarized here.

Preparation of the screen "planes": The size of the mesh openings should be matched reasonably well to the diameter of the new growing root tips. If too small, roots may be turned aside rather than penetrate the screen. If too large, they may be easily dislodged in withdrawal or during subsequent handling of the screens. The potential problems of mesh size did not materialize, however, and the system seems to be rather flexible in this regard. More serious difficulties arose from unexpected sources. Quality sievecloth is expensive and difficult to obtain at times. We were able to locate only one national supplier, and on one occasion had to wait several months for a shipment. Nylon, the least expensive material for quality sievecloth, absorbed the phenol used in staining mycorrhizal hyphae and became unpleasant to work with. Fiberglass window screen worked well for roots in spite of its large mesh size, but apparently has a coating that supports the growth of fungi. Testing finally indicated polyester as the material of choice because of its strength and resistance to chemicals.

Installation: Insertion of the screens into the soil has turned out to be one of the most challenging aspects of developing the technique. The simplest method, which was successful when the soil was moist, was a two-step procedure of making a slit in the soil with a long, narrow blade, then doubling the screen around the blade, re-inserting it into the slit in the soil, and withdrawing the blade. As the soil dried out, and as the method was used in other soils, it became clear that this simple approach would only work in the most favorable circumstances. The method that has been successful in the widest variety of conditions involves a tool consisting of two plates (Figure 17). A wider lower plate accepts most of the stress of driving the assembly into the soil, while an upper plate protects the screen from tearing and holds it in place as it moves downward through the soil. The upper plate is removed from the soil first, and rails on each side of the screen guide a tab on the upper plate over the screen. The successful installation if the screen is sensitive to the width of the tab, the angle at which it is bent, and the placement of the side rails. The assembly is driven into the soil with a series of slide hammers made from galvanized pipe. The slide hammers keep the exposed portion of the insertion tool from bending, and must cover most of its length. This means two or three slide hammers of different lengths are used during the insertion of each screen. The repeated blows on the insertion tool quickly put it out of business if it is made from inferior steel. We found that a machine shop was unwilling to use steel of the required quality and had to fabricate them ourselves from machetes and large saw blades.

Disturbance effects: The observation of below ground processes necessarily requires disturbance to the system. We would argue that the relatively minor disturbance generated by inserting the screens represents is one of the method's strengths. However, any roots in the path of the insertion tool are severed. Removing root apices is known to result in the appearance of laterals that would not have grown on an uncut root. Because of this potential problem, an elaborate sampling schedule was devised that involved harvesting an extra set of screens after each insertion. The first count was to be subtracted from the second, and the difference used to calculate production. We now believe that any error introduced by cutting the roots is minimal or non-existent. The roots cut during insertion would not have been represented at that plane in the soil because their growing tips were already somewhere else. Any new laterals that arise as a result of cutting those roots will be oriented on average at right angles to the original root axis, meaning most would not pass through the screen. All of these arguments are academic, however, as they are overwhelmed by the distinct seasonality of root growth. In this and other studies using the plane intercept technique it has become clear that root growth rate changes so rapidly with season and abiotic factors that it is meaningless to subtract a value found during one period from that found during another period. We thus dismiss the compensation period as worse than useless: it directs resources away from the main sample, introduces unnecessary complexity into the schedule, and may lead to serious underestimates of production.

Collection of screens: Withdrawal of the screens from the soil was another anticipated difficulty that failed to materialize.The roots adhere rather well to the screens, and we are convinced that the great majority of the roots that penetrated each screen are represented in the intercept counts. Attempts to cut roots near the screen before removing it ended in damage to the screen, dislodging of at least as many roots as would have been lost without cutting, and more extensive disturbance to the plots than was necessary. An experiment was carried out in Fall of 1984, at a different study site, to specifically test for loss of roots during screen withdrawal (Table 28). Half of a large set of screens was withdrawn in the manner used during most of the study. The other half was excavated carefully with a shovel. The lack of a significant difference in root intercepts supports my belief that withdrawal without cutting preserves most or all root intercepts.This may depend to some extent upon the characteristics of the roots under study and perhaps on the texture of the soil.

Calculations and conversion to biomass: The plane intercept method was derived from a principle of geometric probability that allows estimation of the total length of lines per cubic volume from the number of intersections of the lines per unit area of a face of the cubic volume. Baldwin et al. (1971) discussed the determination of root length in embedded soil blocks, the application that suggested this method for determining productivity. The calculations are the same: the probable length per unit volume of soil is estimated by 2 multiplied by the number of intercepts per unit area. The screens are inserted in the soil at a 45° angle, randomly oriented with respect to each other, to approximate the condition that non-randomly oriented lines can be estimated by averaging the intercept counts at three mutually perpendicular faces of the cubic soil volume.

The data provided by the calculation are length, and must be converted to weight. In this study a data set from the fall, 1984, cores provided the basis for the conversion factors.

Accuracy: The accuracy of any method can only be judged when the true value is known. This was done for the plane intercept technique in two laboratory experiments reported in the original proposal, where excellent agreement with the known value was obtained in both experiments. In the field, the true value is not known, and the comparison is made with an estimate of unknown accuracy.The discussion of the results must rest on theoretical considerations.

LITERATURE CITED

Baldwin, J.P., P.B. Tinker, and F.H.C. Marriott. 1971. The measurement of length and distribution of onion roots in the field and laboratory. Journal of Applied Ecology 8:543-554.

Table 28
COMPARISON OF TWO PLANE WITHDRAWAL METHODS

	Dug with soil intact	Withdrawn from surface-
Mean no. intercepts	4.9	5.3
95% conf. interval	3.7-6.1	4.4-6.2
Sample size	180	170

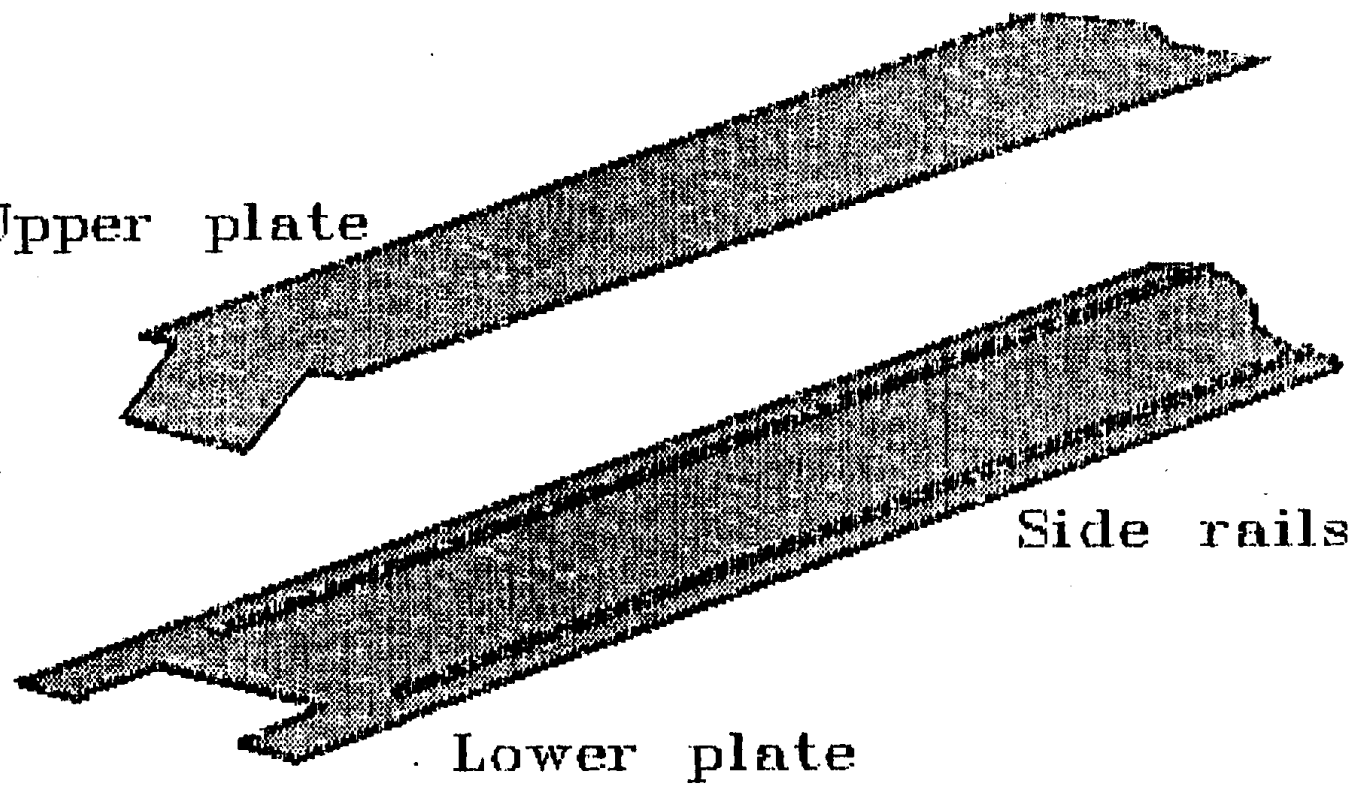

Figure 17. Screen insertion tool

VEGETATION PROCESS STUDIES
EMERALD LAKE,
SEQUOIA NATIONAL PARK

VOLUME 1B

Contract Number A3-097-32

24 May 1984-23 August 1985
Date of Report: March 1, 1986
Revised August 1, 1987

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FINAL CONTRACT REPORT
Prepared for
CALIFORNIA AIR RESOURCES BOARD

TABLE OF CONTENTS

ABSTRACT	2
ACKNOWLEDGEMENTS	2
DISCLAIMER	2
SUMMARY AND CONCLUSIONS	3
RECOMMENDATIONS	4
INTRODUCTION	5
Project objectives	5
Study area	6
LITERATURE CITED	9
STAND DATA AND DYNAMICS	10
TREE RING ANALYSIS	11
ABOVE-GROUND BIOMASS AND PRODUCTION	13
NUTRIENT POOLS	15
APPENDIX	18

ABSTRACT

These investigations were undertaken to supply baseline data about ecosystem processes that might be affected by acid deposition and air pollution. The project encompasses seven subtopics: stand data and dynamics, tree ring analysis, above ground biomass and production for several species, and analytical work related to nutrient pools.

Field studies delineating and describing the floristic and ecological structures of the major plant communities of the Emerald Lake Basin are in progress, but not yet completed. Current data bases on tree population structure are available from National Park Service studies. Tree-ring chemical analyses of samples collected by Arizona State University are also in progress. Appropriate regression equations have been selected from the literature to estimate above-ground production and biomass in tree species. These equations will be applied to total tree census data collected in the second year of the project.

Comparative data on tissue concentrations of nitrogen, phosphorus, cations and trace elements have been collected for dominant woody species in the Emerald Lake Basin. Despite the skeletal soils and acidic pH characteristic of the Emerald Lake Basin, foliar nutrient levels tended to be as high or higher than those of woody species from Log Creek in Giant Forest. No unusually high or low concentrations of cations or potentially toxic trace metals were found.

ACKNOWLEDGEMENTS

We acknowledge with thanks the continuing cooperation and logistic support of the staff of Sequoia and Kings Canyon National Parks, particularly Dr. David Parsons and Thomas Stohlgren. This support has been an essential element in the success of our research program. Our work could not have been carried out without the field assistance of a number of individuals.

This report was submitted in fulfillment of ARB contract number A3-097-32, "Vegetation Process Studies," by the Laboratory of Biomedical and Environmental Sciences, University of California, Los Angeles, under the sponsorship of the California Air Resources Board. Work was completed as of 23 August, 1985.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

SUMMARY AND CONCLUSIONS

The short and long-term effects of acid deposition are thought to be one of the most critical environmental issues of the day. California has a great deal at risk in the losses to forest resources that potentially could result from acid deposition and other forms of pollution in the next few years. Evaluation of this risk and development of a plan for managing the resources is properly a matter of high priority for responsible State agencies. The present study is part of an integrated watershed study, the most appropriate approach toward developing the required understanding of the influences of acid deposition in the Sierra Nevada. The work described in this report provides one element in a group of interrelated, continuing projects on the effects of acid deposition in Sequoia National Park.

During this research we have felt strongly that the most important areas for study are baseline values of above- and below-ground production. Future efforts by the staff of the Air Resources Board and cooperating scientists to develop mass flow budgets for phosphorus, nitrogen, aluminum, cations and trace elements through terrestrial ecosystems within the watershed will depend on a data base of production studies.

RECOMMENDATIONS

It has been stressed throughout the communications of this project that the collection of baseline data is intrinsically a long-term task. Some of the most important measurements, especially above- and below-ground production, can be quite variable from year to year. An example is evident in this first year of work. The conventional soil core method for determining below-ground production, when used only over one or two growing seasons, leaves doubt about whether the estimated production rates are artifacts of year-to-year variations in standing crop. The quality of future research and regulatory policy will depend strongly on the accuracy and representative nature of the data being generated now. The data base will be in an increasingly stronger position as more years of data are collected.

The biological effects of acid deposition and pollution may be expressed in ways that are not anticipated by the rather limited database generated by these early studies. Other kinds of data are required for fullest utilization and interpretation of the baseline production estimates:

Nitrogen fixation is a vital ecosystem process that is known to be sensitive to pH and toxic materials. Both leguminous and non-leguminous nitrogen fixation should be quantified, and the responses to pollutants studied.

The pollution responses of the primary producer species should be studied under controlled, greenhouse conditions.

The response to pollutants of decomposition, which like other important ecosystem processes is mediated by sensitive microorganisms, should be studied. The dynamics of litterfall are an important component of decomposition processes.

Mass flow budgets of nutrient and toxic elements should be prepared as an aid in understanding the potential effects of perturbation at the ecosystem and watershed levels.

Meeting these objectives will require extensive integration of past, present and future research by many workers. The integration of our biomass and productivity data, and related nutrient pool and flux sizes, with other elements of the Integrated Watershed study will be a critical task for the overall success of this project.

A final concern we raise here is the difficulty in establishing causality for any biological effects of reduced productivity which we may find by the end of our project (or on a longer time scale). Regulatory policy related to pollution effects on natural ecosystems requires a clear link between cause and effect. The challenge will be to separate potential effects of acid deposition from effects of oxidant pollutants. The present structure of the Integrated Watershed study is not adequate to establish the nature of such links.

INTRODUCTION

This report covers the first year of work on vegetation processes at Sequoia National Park, carried out between July 1 1984 and July 1 1985. Our work was undertaken as a study of the base level processes of growth and nutrient dynamics that may be influenced in coming years by acid deposition. This is part of a continuing project, and the first year's findings are difficult to interpret fully if isolated from the continuing work. For this reason, frequent reference will be made to aspects of the project that are still under study.

Detrimental effects have been documented elsewhere, and have been described in reviews and symposia by Mudd and Kozlowski (1975), Hutchinson and Havas (1980), Miller (1980), and Smith (1981). The impacts of air pollution and acid deposition on forest growth is emerging as on of the most significant environmental issues of the decade. Of the economic losses to be suffered from acid deposition in this country, the forest industry in the Eastern United States is expected to bear a substantially larger share than agriculture (Crocker and Regens 1985). The effects will be felt as both localized mortality and loss of wood production, perhaps as much as 5%.

Although experimental work to date has been primarily in Europe and the Eastern United States, acid deposition has been shown to occur in California (Lawson and Wendt 1982). The Sierra Nevada lie in the path of pollutant-laden air from major metropolitan areas, and include the most sensitive regions of California. Past effects of acid deposition on terrestrial processes in the granitic soils of the Sierra Nevada cannot be assessed because of a lack of relevant baseline data. However, there is ample reason to expect future effects on tree growth and vigor, phenology, soil chemistry, soil microbiology, and nutrient cycling processes (Alexander 1980, McColl 1981b, Hutchinson and Havas 1980).

Understanding and documentation of both the short and long-term effects of acid deposition is an essential goal of the State of California. A broad ecosystem study in the form of an integrated watershed study is the most appropriate approach toward this goal, and will provide a basis for future evaluation of the influences of acid deposition in the Sierra Nevada.The work described in this report provides one element in a group of interrelated projects on the effects of acid deposition in Sequoia National Park.

Project objectives

The goal of this project has been the determination of both above- and below-ground production as a data base against which future changes may be assessed. The research reported here has centered a small headwater drainage within the watershed of the Marble Fork of the Kaweah river. This subalpine site (Emerald Lake) has only scattered vegetation and skeletal soils with little organic matter content to adsorb atmospheric inputs of nitrate or sulfur.

The objectives of this study are as follows:

1. Species/Community Studies

a. Vegetation. Collection and integration of existing vegetation studies of the Emerald Lake site, as well as comparable sites outside these drainages, from a large data base assembled by independent researchers at UCLA, San Jose State University, and UC Berkeley, as well as by National Park Service Staff. These studies were to include quantitative interpretations of understory coverage and species diversities for all groups of vascular plants.

2. Tree Growth

a. Tree rings. Analysis of sample cores from dominant tree species at Emerald Lake; analysis of tree ring materials to identify potentially toxic trace elements which might be related to annual growth response.

b. Above-ground production. Examination of published regressions for estimating net annual above ground production in dominant trees.

During this research we have felt strongly that the most important areas for study are baseline values of above- and below-ground production.Future efforts by the staff of the Air Resources Board and cooperating scientists to develop mass flow budgets for nitrogen, sulfur, phosphorus, and aluminum through terrestrial ecosystems within the watershed will depend on a data base of production studies.

Study area

This study is being carried out in cooperation with the National Park Service. The park is an International Biosphere Reserve, and the National Park Service specifically provides research areas for cooperative work. National Park Service personnel carry out related research activities under their own funding, and help coordinate outside and Park Service researchers. This coordination strengthens the total program and minimizes duplication of effort. The park has been the site of an acid rain monitoring station for the National Atmospheric Deposition Program (NADP) since 1980. The NADP station, located at Giant Forest, has established that summer pH values are normally below 5.0, and occasionally can drop as low as 3.5. Summer and fall storms usually carry less precipitation than winter storms, when the pH is usually between 4.5 and 5.5. Nitrate is thought to be more significant, relative to sulfate, at Sequoia National Park than in the Northeastern U.S.

Emerald Lake at 2800 m elevation is the subalpine site used by this and related studies. It occupies a granitic drainage about 125 ha in size. Vegetation is sparse and much of the basin is exposed granite. Coniferous trees occur in scattered clumps. The species include *Pinus contorta* var. *murrayana* (lodgepole pine), *P. monticola* (western white pine), *P. jeffreyi* (Jeffrey pine), and *P. balfouriana* (foxtail pine). Locally common shrubs are *Phyllodoce breweri*, *Chrysolepis sempervirons*, and *Salix orestera*. The Emerald Lake watershed, shown in Figure 1 prepared by the National Park Service, includes permanent vegetation plots, a gauging station. rain gauges, and a meteorological station.

Most of the terrain at Emerald Lake consists of variously jointed exposures of granodiorite. Most of the soils have formed in localized regions defined by rock joints. All have a cryic temperature regime and sandy or or coarse-loamy textures. Most are classified as lithic cryumbrepts and entic cryumbrepts.

Soil depths to underlying rock range from 10 to 50 cm. Late Spring to Fall access is on foot or horseback by way of an 8 km hiking trail, while winter access is limited to skiing. The Pear Lake cabin, located 1 km away, is available for occasional winter use.

FIGURE 1.

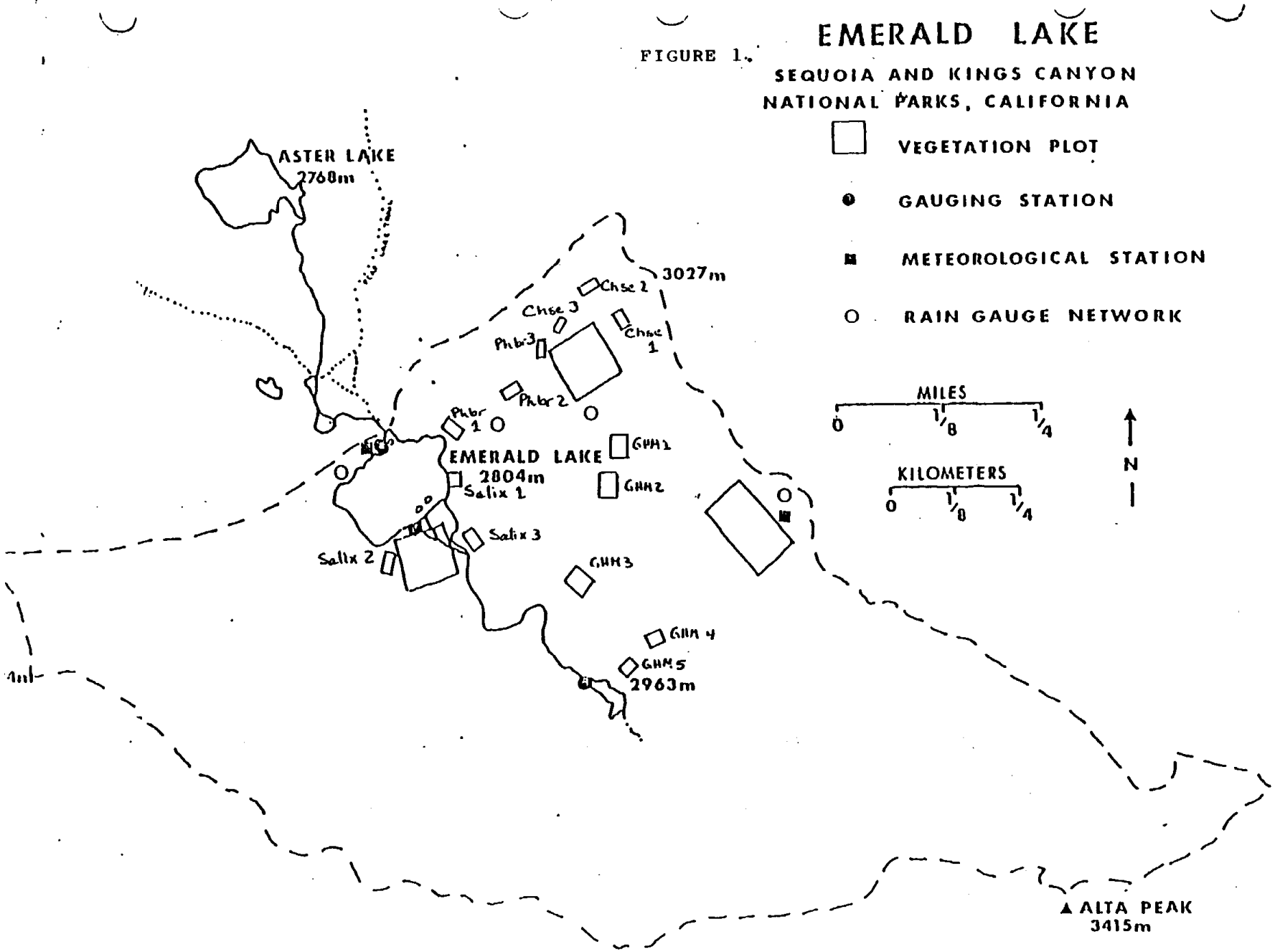

Figure courtesy of U.S. National Park Service

LITERATURE CITED

Alexander, M. 1980. Effects of acidity on microorganisms and microbial processes in soil. In T.C. Hutchinson and M. Havas. Effects of Acid precipitation on terrestrial ecosystems. Plenum Press, N.Y. pp. 363-374.

Crocker, T.D., and J.L. Regens. 1985. Acid deposition control and benefit-cost analysis: its prospects and limits. Environ. Sci. Technol. 19:112-116.

Hutchinson, T.C., and M. Havas. 1980. Effects of Acid precipitation on terrestrial ecosystems. Plenum Press, N.Y. pp. 363-374.

Lawson, D.R., and J.G. Wendt. 1982. Acid deposition in California. Society of Automotive Engineers SAE Tech. Paper Series No. 821246. 19 pp.

McColl, J.G. 1981. Effects of acid rain on plants and soils in California. Final report to California Air Resources Board. Contract A8-136-31.

Miller, P.R. (tech. coord.) 1980. Proceedings of symposium on effects of air pollutants on mediterranean and temperate forest ecosystems. USDA Forest Service Gen. Tech. Report PSW-43. 256 pp.

Mudd, J.B., and T.T. Kozlowski. 1975. Responses of plants to air pollution. Academic Press, N.Y. 383 pp.

Smith, W.H. 1981. Air pollution and forests.Springer-Verlag, N.Y.

STAND DATA AND DYNAMICS

The primary objective for this portion of the work was to collect data from the above activities and from older data bases, such as those summarized by Rundel et al. (1977), and prepare an updated, detailed description of the vegetation types under study. The final summaries of the data can be expressed in the following form for most stands:

a) distribution of dbh (diameter at breast height) classes for each tree species

b) demographic data on tree population structure

c) relative assessments of tree baselines

d) quantitative assessments of understory coverage

Both small 0.1 ha and 1.0 ha or larger permanent reference stands have been established by the National Park Service in key forest communities (see Figure 1). Every tree in these plots has been tagged, mapped, and measured for dbh and vigor. Shrubs, herbs, and litter accumulation were recorded in subplots. These stands are planned to be periodically resampled by the National Park Service, providing a basis for evaluation of long term growth, mortality, and demography.

The data contributing to these analyses were for the most part generated by NPS personnel. While it is within the scope of this project to summarize all sources of existing data, the different schedules and short term objectives of NPS researchers make it inappropriate to include their database in our present analysis. The data generated through NPS and other efforts is an important component of the summaries, and must await publication of each unit of research according to the schedules of the individual research efforts.

LITERATURE CITED

Rundel, P.W., D.J. Parsons, and D.T. Gordon. 1977. Mountain and subalpine vegetation of the Sierra Nevada and Cascade ranges. In M. Barbour and J. Major (eds.) Terrestrial vegetation of California. J. Wiley and Sons, N.Y.

TREE RING ANALYSIS

Multivariate regression analyses have proved to be a useful technique in dendroclimatology to describe the growth responses of trees to specific environmental variables (Fritts 1977). The general approach has been to study tree rings in relation to variables in historical records of temperature and precipitation with the assumption that other environmental factors remain the same. The problems of adding possible variables in atmospheric pollutants to these types of multivariate analyses is that long-term records of pollutant levels are generally not available. The approach in such studies has been to assume that if relationships of tree-growth to climate (i.e. temperature and precipitation) differ from an established pattern, then some other environmental variable, such as pollutant level, must be changing. Extreme caution must be used in statistical design of these approaches, since autocorrelation of rings with previous-year's growth can complicate interpretations.

Dendrochronological analyses have proved particularly effective in assessing the effects of point-source pollution on tree growth. Fox and Nash (1980) utilized tree-ring analyses to investigate the growth response of Larix occidentalis (western larch) to SO_2 emissions from a lead-zinc smelter at Trail, British Columbia. Their study benefitted from a good documentation of SO_2 emissions in space and time since smelter activities began in 1896 and thus was able to examine the interrelationships of air pollution, climate, and tree growth.

Nonpoint-source pollutants such as ozone, NO_x, or acid deposition (in the broad sense) are much more difficult to deal with in tree-ring studies because of the lack of long-term records. Dendrochronological approaches can be used, however, as an indirect method of assessing the effects of hypothetical changes in levels of atmospheric pollutants. Ashby and Fritts (1972) used this approach to suggest that decreases in tree growth near LaPorte, Indiana, during the 1940's may have been attributable to air pollution. Other examples of this approach are studies by Strand (1980) in Norway, Roman and Raynall (1980) and Puckett (1982) in New York, and Johnson et al. (1981) in New Jersey. These more recent studies have all documented characteristic decreases in tree-growth over the past two and one-half decades which were not attributable to drought, fire, pests, and oxidant air pollutants. They suggest that this change in growth patterns could be the result of physiological stress induced by components of acid deposition. Cogsbill (1977), however, was unable to find any indication of regional effects in a broad tree-ring study in the Northeastern United States.

Ongoing tree-ring studies by the staff of Oak Ridge National Laboratory in the Great Smoky Mountains National Park (Baes and McLaughlin 1984) have demonstrated that trace elements in tree rings can provide evidence of recent and historical air pollution. These tree-ring analyses have revealed decreased growth and greatly increased concentrations of Fe, Al, Cd, Cu, Ti, and Zn in rings formed during the last 20-25 years in relation to values for the previous half century. These increased concentrations of trace elements, in some cases approaching toxic levels, result from increased solubilization of soil elements as well as from anthropogenic origins. The interpretation of trace metal patterns in tree rings rests on the critical assumption that lateral translocation subsequent to initial incorporation into xylem tissues does not

occur. Recent studies with Pinus virginiana and Abies balsamea suggest that this assumption appears to be valid (Hagan in Baes and McLaughlin 1984), although this evidence has not been critically assessed.

The objectives for this portion of the work were to work with the Arizona State Researchers, who have been developing a tree-ring chronology from which possible pollutant effects on growth can be recognized. The chronology is being developed from sample cores from three dominant tree species in the Emerald Lake area- Pinus contorta var. murrayana, P. monticola, and P. balfouriana. The other objective was to analyze tree rings for concentrations of potentially toxic trace elements which might be indicative of inputs of atmospheric pollutants to this system. In addition to the subalpine tree-ring studies, we have also analyzed cores from Abies concolor and A. magnifica at Giant Forest to test for any long-term trends in trace element concentrations in woody rings. Because the tree-ring material for the subalpine species was received from Arizona State at the end of this funding period, we will report the results of these analyses in a separate progress report.

LITERATURE CITED

Ashby, W.C., and H.C. Fritts. 1972. Tree growth, air pollution, and climate near LaPorte, Indiana. Bull. Amer. Meteor. Soc.53:246-251.

Baes, C.F., and S.B. McLaughlin. 1984. Trace elements in tree rings: evidence of recent and historical air pollution. Science 224:494-497.

Cogbill, C.V. 1977. Effect of acid precipitation on tree growth in Eastern North America. Water, Air, and Soil Pollution 8:89-93.

Fox, C.A., and T.M. Nash. 1980. The effect of air pollution on western larch as detected by tree-ring analysis. p.234 in: P.R. Miller (ed.) Effects of air pollutants on mediterranean and temperate forest ecosystems. USDA Forest Service Gen. Tech. Rep. PSW-43.

Fritts, H.C. 1977. Tree rings and climate. Academic Press.

Johnson, A.H., T.C. Siccama, D. Wang, R.J. Turner, and T.H. Barringer.1981. Recent changes in patterns of tree growth rate in the New Jersey Pinelands: a possible effect of acid rain. J. Envir. Quality 10:427-430.

Puckett, L.J. 1982. Acid rain, air pollution, and tree growth in Southeastern New York. J. Envir. Quality 11:376-381.

Roman, J.R., and D.J. Raynall. 1980. Effects of acid precipitation on tree growth. pp. 427-433 in: Actual and potential effects of acid precipitation on a forest ecosystem in the Adirondack Mountains. New York State Energy Res. and Energy Dev. Auth. Rep. No. 80-28.

Strand, L. 1980. Acid precipitation and regional tree-ring analysis. Norwegian Council for Scientific and Industrial Research. SNSF Project, Internal Report 73180.

ABOVE-GROUND BIOMASS AND PRODUCTION

Equations exist in the literature for biomass of some of the Emerald Lake species. They are useful in that they take into account the form of the tree species, and supply a basis for at least an approximate estimate of biomass. We were able to find no suitable regression equations for some of the species. In these cases we attempted to find equations for species with similar form. Of course, the use of such equations is complicated not only by problems of geographic area, but by whatever differences in form exist between the species of interest and the species for which the regression was intended. Some equations for conifer species of interest to this project are presented in Table 1, based largely on data summarized by Goltz et al. (1979).

Production regressions exist for some conifer species, but production is more dependent than biomass on site characteristics, and the equations based on other geographic areas are unlikely to provide satisfactory estimates in our study area. Biomass estimates can be made at intervals, however, and production estimated from biomass increments.

We are utilizing a set of dimensional analysis data from comparable or identical species in the Pacific Northwest or Rocky Mountains (Table 1). These existing regressions (see Gholz et al. 1979) which substitute Chamaecyparis/Thuja for Calocedrus, Pinus ponderosa for P. jeffreyi, and P. monophylla for P. balfouriana (this will be checked with data for P. albicaulis- see below) and old growth Pseudotsuga menzeisii for Sequoiadendron giganteum. Some data on biomass distribution with branches of Sequoiadendron has been collected by T. Stohlgren of the National Park Service.

During the current year we have been working with the National Park Service to make parabolic volume measurements of conifers in the Emerald Lake watershed. We now have a complete census of stem diameters for all conifers in the basin, and the National Park Service is measuring parabolic stem volumes on a subset of these.

Dimensional data on woody biomass fractions of Pinus contorta var. murrayana (as well as P. albicaulis and Tsuga mertensiana) in the Sierra Nevada were presented by Davilla (1976). He presented equations for estimating stem, bark, and branch dry weight from measurements of either DBH, parabolic volume, or conic stem area. These equations will be useful for calculating above-ground biomass for the Emerald Lake watershed (with the estimation of foliage biomass), but they are not very helpful in making estimates of productivity.

LITERATURE CITED

Gholz, H.L., C.C. Grier, A.G. Campbell, and A.T. Brown. 1979.Equations for estimating biomass and leaf area of plants in the pacific northwest. Oregon State University School of Forestry Research Paper 41. 39 pp.

Miller, E.L., R.O. Meeuwig, and J.D. Budy. 1981. Biomass of singleleaf pinyon and Utah juniper. USDA Forest Service Intermountain Forest and Range Experiment Station Res. Paper INT-273. 18 pp.

Table 1
REGRESSION EQUATIONS FOR ESTIMATING
BIOMASS OF SELECTED CONIFEROUS SPECIES

X= DBH in cm
Total above-ground biomass is sum of components given

Species	A	B	authority
P. balfouriana based on			
P. edulis			
(Y=ln DBH. C= crown dia in M and S=# stems breast height)			
Miller et al. 1981			
-1.423	1.241	0.347*lnC-0.274lnS	
P. contorta var. *murrayana* based on			
P. contorta			Gholz at al. 1979
foliage	-3.6187	1.8362	
branches	-4.6004	2.3533	
stem	-2.9849	2.4287	
P. jeffreyi based on			
P. ponderosa			Gholz at al. 1979
foliage	-4.2612	2.0967	
branches	-5.3855	2.7185	
stem	-4.4907	2.7587	
bark	-4.2063	2.2312	
P. monticola based on *P. lambertiana*			

NUTRIENT POOLS

During 1984-85, we collected preliminary data on concentrations of various nutrients and trace elements in tissues of dominant woody species from the Emerald Lake Watershed. Our focus in these analyses has been to collect appropriate nutrient and trace element data relevant to hypothesized effects of acid deposition on forest trees. At this stage our data has focused on nutrient concentrations, with calculations of pool sizes, an ongoing project this year.

Sampling and Methods

A data set for nutrients and trace elements was collected from dominant wood species at the Emerald Lake site in October 1980.The National Park Service staff collected samples of the same nine tissue types from six dominant species in the watershed and analyzed these for total nitrogen and phosphorus. Our analyses were made on new foliage samples collected on seven dates over the summer and fall of 1984 from five of these species. Again, we used optical emission spectroscopy for analysis, with each sample replicated three times.

Nitrogen and phosphorus concentrations in tissue pools at Emerald Lake are shown in Tables 2 and 3. Despite the more skeletal soils at this site, foliar nutrient levels in these species were as high or higher than those in Log Creek species. The highest foliar nitrogen levels occurred, as expected, in Salix orestera, the only deciduous species studied.

The major portion of nutrient studies at Emerald Lake are part of our 1985-86 work plan. We will thus discuss these data in more detail in our project report next year. We present an appendix of nutrient and trace element analyses for new foliage of dominant species at Emerald Lake with minimal discussion. The pattern of change is variable. No unusually high or low concentrations of cations or potentially toxic trace metals were found.

Table 2. Nitrogen concentrations (mg g^{-1} dry wt.) in tissue parts of dominant woody species at the Emerald Lake site, Sequoia National Park. Values are for pooled samples collected from ten individuals of each species in October 1983, by the Sequoia National Park staff.

	Heartwood	Sapwood	Bark	Branchwood	Old stems	Current stems	Old needles/ leaves	Current needles/ leaves	Reproductive tissues
Pinus contorta ssp. *murrayana*	ND	ND	ND	3.7	6.6	13.4	11.8	12.6	ND
Pinus monticola	1.0	1.5	2.5	3.0	6.3	12.0	11.3	11.1	ND
Abies magnifica	ND	ND	ND	2.8	5.5	11.8	10.3	13.0	ND
Salix orestera	-	-	-	5.3	10.5	15.8	-	19.3	12.7
Chrysolepis sempervirens	-	-	-	3.7	8.0	12.3	13.7	15.4	ND
Phyllodoce breweri	-	-	-	5.0	6.5	12.6	10.6	14.1	12.3

Table 3. Phosphorus concentrations (mg g^{-1} dry st.) in tissue parts of dominant woody species at the Emerald Lake site, Sequoia National Park. Values are for pooled samples collected from ten individuals of each species in October 1983, by the Sequoia National Park staff

	Heartwood	Sapwood	Bark	Branchwood	Old stems	Current stems	Old needles/ leaves	Current needles/ leaves	Reproductive tissues
Pinus contorta ssp. *murrayana*	ND	ND	ND	0.8	1.2	2.0	1.2	2.0	ND
Pinus monticola	0.6	0.8	0.7	1.0	0.9	2.2	1.8	2.0	ND
Abies magnifica	ND	ND	ND	1.0	0.7	2.9	1.6	1.8	ND
Salix orestera	-	-	-	0.9	1.3	1.5	-	1.7	1.6
Chrysolepis sempervirens	-	-	-	1.0	0.3	1.4	1.4	2.0	ND
Phyllodoce breweri	-	-	-	1.0	1.3	2.0	1.4	1.8	2.1

APPENDIX: Seasonal change in concentration of foliar nutrients at Emerald Lake during 1984.

K CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	9746.66	7043.33	17300.00	10263.33	7800.00	10073.33	
PINUS CONTORTA SSP. MURRAYANA			6676.66	6733.33		6186.66	
PYLLODOCE BREWERI	13766.66	5660.00	12833.33	9280.00	9460.00	8340.00	
CHRYSOLEPSIS SEMPERVIRENS			16433.33	11366.66	14333.33	9140.00	6216.66
SALIX ORESTERA (MALE)	13033.33	10766.66	18766.66	11900.00	10113.33	10966.66	10140.00
SALIX ORESTERA (FEMALE)	15200.00	9256.66	8926.66	11333.33	9693.33	10033.33	8510.00

MG CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	905.33	535.67	1866.67	903.33	727.33	872.67	
PINUS CONTORTA SSP. MURRAYANA			440.00	589.00		562.00	
PYLLODOCE BREWERI	1290.00	620.33	1723.33	1363.33	1580.00	1336.67	
CHRYSOLEPSIS SEMPERVIRENS			2323.33	1210.00	986.33	801.67	781.33
SALIX ORESTERA (MALE)	1260.00	900.67	2896.67	1493.33	1190.00	1483.33	1656.67
SALIX ORESTERA (FEMALE)	1328.67	769.67	1157.33	937.33	979.00	1180.00	1843.33

CA CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	445.00	328.67	3780.00	1109.00	795.67	1850.00	
PINUS CONTORTA SSP. MURRAYANA			288.00	378.33		188.00	
PYLLODOCE BREWERI	2750.00	773.33	3386.67	3646.67	4283.33	4783.33	
CHRYSOLEPSIS SEMPERVIRENS			5673.33	5360.00	5166.66	7073.33	8073.33
SALIX ORESTERA (MALE)	1120.33	1470.00	10273.33	4633.33	3895.33	4413.33	9280.00
SALIX ORESTERA (FEMALE)	3613.33	1636.67	1816.67	1540.00	2123.33	2243.33	10543.33

NA CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	11.84	4.61	55.30	11.25	10.45	10.70	
PINUS CONTORTA SSP. MURRAYANA			1.91	5.19		6.37	
PYLLODOCE BREWERI	40.53	6.16	111.33	58.37	196.47	73.47	
CHRYSOLEPSIS SEMPERVIRENS			98.53	99.70	42.17	15.60	14.17
SALIX ORESTERA (MALE)	49.63	6.80	25.83	21.50	22.33	11.57	23.70
SALIX ORESTERA (FEMALE)	29.27	9.32	6.07	22.47	19.72	16.70	316.00

MN CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	95.17	101.07	477.00	191.33	125.33	184.67	
PINUS CONTORTA SSP. MURRAYANA			146.57	152.00		111.00	
PYLLODOCE BREWERI	109.67	79.77	274.67	346.33	433.00	352.33	
CHRYSOLEPSIS SEMPERVIRENS			529.00	432.33	555.67	803.33	1079.33
SALIX ORESTERA (MALE)	129.17	109.20	274.33	249.67	222.33	248.33	529.00
SALIX ORESTERA (FEMALE)	175.00	159.33	138.93	186.33	99.20	288.00	632.67

AL CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	51.87	17.27	262.67	104.13	54.67	148.40	
PINUS CONTORTA SSP. MURRAYANA			41.93	67.63		84.10	
PYLLODOCE BREWERI	61.07	13.87	266.00	180.67	225.33	196.00	
CHRYSOLEPSIS SEMPERVIRENS			158.40	307.67	94.73	45.23	40.20
SALIX ORESTERA (MALE)	14.40	11.09	23.73	16.37	18.43	36.40	110.80
SALIX ORESTERA (FEMALE)	30.17	14.57	15.40	8.57	9.53	20.53	173.00

FE CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	32.33	16.33	64.60	60.93	38.10	68.37	
PINUS CONTORTA SSP. MURRAYANA			32.17	34.57		57.87	
PYLLODOCE BREWERI	76.85	35.10	224.00	241.67	181.67	143.33	
CHRYSOLEPSIS SEMPERVIRENS			157.00	224.00	128.00	105.83	103.17
SALIX ORESTERA (MALE)	72.07	48.67	124.67	84.07	68.30	68.60	155.00
SALIX ORESTERA (FEMALE)	115.23	61.20	60.37	61.93	50.03	80.43	218.00

ZN CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	29.83	34.00	30.77	22.57	18.77	21.83	•
PINUS CONTORTA SSP. MURRAYANA			32.87	21.87		11.36	
PYLLODOCE BREWERI	20.70	20.90	21.10	11.03	13.93	13.20	
CHRYSOLEPSIS SEMPERVIRENS			26.27	21.20	12.53	12.70	9.62
SALIX ORESTERA (MALE)	34.97	65.43	31.77	56.50	38.53	46.77	52.50
SALIX ORESTERA (FEMALE)	50.83	60.60	54.40	32.03	31.67	22.20	57.67

CU CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	6.81	3.51	9.38	5.29	4.74	4.99	
PINUS CONTORTA SSP. MURRAYANA			2.31	3.34		3.10	
PYLLODOCE BREWERI	10.57	3.84	7.23	5.41	6.39	5.16	
CHRYSOLEPSIS SEMPERVIRENS			21.47	13.90	12.70	8.71	8.19
SALIX ORESTERA (MALE)	11.80	6.19	7.90	7.79	6.88	7.92	6.58
SALIX ORESTERA (FEMALE)	8.52	5.84	5.72	6.45	3.21	6.62	5.28

B CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	26.00	20.17	27.73	21.50	18.50	16.40	
PINUS CONTORTA SSP. MURRAYANA			15.00	12.80		18.60	
PYLLODOCE BREWERI	12.37	17.60	18.93	14.03	14.93	15.07	
CHRYSOLEPSIS SEMPERVIRENS			32.63	29.63	31.43	31.07	23.80
SALIX ORESTERA (MALE)	10.31	18.60	25.23	20.93	28.63	41.10	24.50
SALIX ORESTERA (FEMALE)	10.90	12.07	15.83	15.47	36.37	24.00	33.17

SI CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	63.13	75.07	317.00	82.43	84.00	139.50	
PINUS CONTORTA SSP. MURRAYANA			47.10	25.57		58.37	
PYLLODOCE BREWERI	473.00	290.67	1343.33	1414.00	2326.67	1453.33	
CHRYSOLEPSIS SEMPERVIRENS			2273.67	1756.67	602.67	426.00	417.33
SALIX ORESTERA (MALE)	145.67	242.00	200.67	137.33	175.00	223.33	651.00
SALIX ORESTERA (FEMALE)	250.00	310.33	304.67	66.33	123.00	133.33	811.33

TI CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	0.05	0.0	0.49	0.52	1.56	2.04	
PINUS CONTORTA SSP. MURRAYANA			0.94	0.05		1.21	
PYLLODOCE BREWERI	2.01	1.05	6.27	7.77	9.05	6.11	
CHRYSOLEPSIS SEMPERVIRENS			3.50	11.28	5.76	5.00	4.33
SALIX ORESTERA (MALE)	2.23	0.73	0.62	0.49	2.15	2.81	8.18
SALIX ORESTERA (FEMALE)	2.17	1.05	0.62	0.37	0.87	1.25	11.00

V CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	0.0	0.0	1.07	0.75	0.0	0.55	
PINUS CONTORTA SSP. MURRAYANA			0.58	0.0		0.0	
PYLLODOCE BREWERI	0.03	0.14	1.86	0.29	0.38	0.49	
CHRYSOLEPSIS SEMPERVIRENS			0.50	0.0	0.0	0.28	0.54
SALIX ORESTERA (MALE)	0.0	0.33	0.92	1.34	0.03	0.08	0.17
SALIX ORESTERA (FEMALE)	1.17	0.0	0.44	0.16	0.0	0.0	0.16

SR CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	2.08	1.68	5.08	2.56	2.76	6.67	
PINUS CONTORTA SSP. MURRAYANA			1.43	0.99		0.0	
PYLLODOCE BREWERI	7.24	7.35	7.31	9.38	12.33	12.67	
CHRYSOLEPSIS SEMPERVIRENS			7.27	4.65	6.43	11.17	17.47
SALIX ORESTERA (MALE)	5.09	23.40	37.63	20.33	14.40	34.10	51.73
SALIX ORESTERA (FEMALE)	14.21	25.53	30.40	13.20	13.20	17.77	66.03

BA CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	1.50	0.54	6.04	2.27	2.23	4.54	
PINUS CONTORTA SSP. MURRAYANA			0.42	0.45		0.49	
PYLLODOCE BREWERI	15.67	17.07	38.83	34.57	41.97	43.33	
CHRYSOLEPSIS SEMPERVIRENS			12.83	9.61	11.93	8.63	12.57
SALIX ORESTERA (MALE)	1.57	9.55	10.95	10.04	5.10	17.97	17.53
SALIX ORESTERA (FEMALE)	6.40	6.94	10.13	3.73	6.55	4.74	17.60

LI CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	0.55	0.0	0.72	0.49	0.81	0.74	
PINUS CONTORTA SSP. MURRAYANA			0.22	0.34		0.44	
PYLLODOCE BREWERI	0.22	0.37	0.81	0.0	0.17	0.11	
CHRYSOLEPSIS SEMPERVIRENS			0.69	0.02	0.0	0.69	0.15
SALIX ORESTERA (MALE)	0.63	0.71	1.46	1.22	1.21	1.86	0.12
SALIX ORESTERA (FEMALE)	0.75	0.69	0.93	1.01	0.96	1.05	0.28

PB CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	5.63	9.12	8.07	7.86	5.18	6.47	
PINUS CONTORTA SSP. MURRAYANA			6.92	6.92		3.70	
PYLLODOCE BREWERI	1.21	7.59	9.42	2.99	5.49	4.42	
CHRYSOLEPSIS SEMPERVIRENS			9.37	3.77	1.79	4.56	5.08
SALIX ORESTERA (MALE)	10.53	11.10	7.69	15.00	9.13	6.63	4.58
SALIX ORESTERA (FEMALE)	13.97	14.07	8.39	13.43	9.45	8.67	5.30

CD CONCENTRATION IN NEW FOLIAGE (PPM)
AT EMERALD LAKE, SEQUOIA NATIONAL PARK, DURING 1984

	JUNE 9	JUNE 21	JULY 6	JULY 23	AUG 7	AUG 21	OCT 4
PINUS MONTICOLA	0.0	0.0	0.70	0.21	0.02	0.18	
PINUS CONTORTA SSP. MURRAYANA			0.11	0.38		0.54	
PYLLODOCE BREWERI	0.07	0.0	0.90	0.43	0.91	1.05	
CHRYSOLEPSIS SEMPERVIRENS			0.92	1.63	0.31	0.36	0.16
SALIX ORESTERA (MALE)	0.0	0.0	0.0	0.0	0.0	0.0	0.60
SALIX ORESTERA (FEMALE)	0.0	0.0	0.0	0.0	0.0	0.0	0.97