# 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
[illegible] DRY TISSUE    VALUES ARE % OR PPM    (1% = 10,000PPM)    DK2:042285.C13;1

| | WEIGHT | 1 F | 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[illegible] |
| 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[illegible] |
| 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 | | | | 4.26 | | | 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
VALUES ARE % OR PPM    (1% = 10,000PPM)    DK2:042285.C13;1

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | P | NA | K | CA | MG | ZN | CU | FE | MN | 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 | 1.66 |
| 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 |

| | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | AL | SI | TI | V | CO | NI | MO | CR | SR | 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 | 2.36 | 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 |

| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|
| | WEIGHT | LI | AG | SN | PB | BE | CD | 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
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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.[illegible] |
| 1890 | 7.8 | | 24.9 | 969 | 1570 | 220 | 0.06 | 0.44 | 41.3 | 85.6 | 1.[illegible] |
| 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 | 12.6 | 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 | 0.46 |
| 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 | [illegible] |
| 1899 | 7.7 | 27.7 | 18.9 | 0.19 | | 1.46 | 0.41 | | 0.74 | 26.1 | [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 | | 2.26 | | | |
| 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

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | P | NA | K | CA | MG | ZN | CU | FE | MN | 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 |

| | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | AL | SI | TI | V | CO | NI | MO | CR | SR | 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 |

| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|
| | WEIGHT | LI | AG | SN | PB | BE | CD | 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 | 8.4 | 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 SEQUOIA NATIONAL PARK AC-RINGS,1857-1984 DR. RUNDEL 4-23-85
IN DRY TISSUE 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
VALUES ARE % OR PPM    (1% = 10,000PPM)    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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | [illegible] |
| 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 | 78.5 | 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 | 987 | 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    DR. RUNDEL    4-23-85
VALUES ARE % OR PPM    (1% = 10,000PPM)    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    DK2:042485.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 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. [illegible] |
| 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 | 8.6 | 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 [illegible] |
| AC 1803 | 8.5 | 12.4 | | | | | | | 0.03 | 13.9 | 2. |
| AC 1804 | 7.7 | 13.7 | | | 0.29 | | | | | 14.8 | 14. [illegible] |
| 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 SEQUOIA NATIONAL PARK AC-2 RINGS,1792-1984 DR. RUNDEL 4-24-85

IN DRY TISSUE 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 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.[illegible] |
| AC 1824 | 8.4 | 51.9 | 46.4 | 3930 | 4680 | 144 | 4.05 | 0.53 | 28.8 | 105 | 2.[illegible] |
| 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 | [illegible] | 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 | 26.1 |
| 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 | [illegible] |
| AC 1833 | 7.8 | 14.5 | 0.96 | | 0.85 | 0.53 | 0.81 | | | 9.34 | [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 | 1.12 | 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% | 20.0% | 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

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 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 | 1.97 |
| 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 | | | | 3.84 | | | |
| 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

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | P | NA | K | CA | MG | ZN | CU | FE | MN | B |
| AC 1892 | 8.5 | 22.8 | 13.8 | 2930 | 3710 | 102 | 4.74 | 0.96 | 21.7 | 84.1 | 1.44 |
| 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 |

| | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WEIGHT | AL | SI | TI | V | CO | NI | MO | CR | SR | 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 |

| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|
| | WEIGHT | LI | AG | SN | PB | BE | CD | 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].3 | 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.C1;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. |
| AC 1925 | 8.9 | 69.8 | 21.6 | 2860 | 5320 | 153 | 2.19 | 1.06 | 30.6 | 65.8 | 0. |
| 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 | [illegible] |
| AC 1936 | 8.5 | 18.1 | 8.54 | | | 0.42 | 1.06 | | 0.36 | 29.5 | [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 |

| | 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 | [illegible]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

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 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 $A = A' + \left(\frac{\ln SEE^2}{2}\right)$. SEE is the standard error of estimate in arithmetic 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.

| | On DBH, x (cm) | | | |
|---|---|---|---|---|
| Dimensions Y | 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 | 0.69768 | 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 | 1.74667 |
| 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 | 1.6268 | 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 | 0.906 |
| 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 | 1.330 | 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 |
| HIERAGEUM 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 | 45.50 | | |
| 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 PATULA | 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.[illegible]5 | 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 |
| ADENOCAULON 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 PATULA | 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 $45^{\circ}$ 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.

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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 |

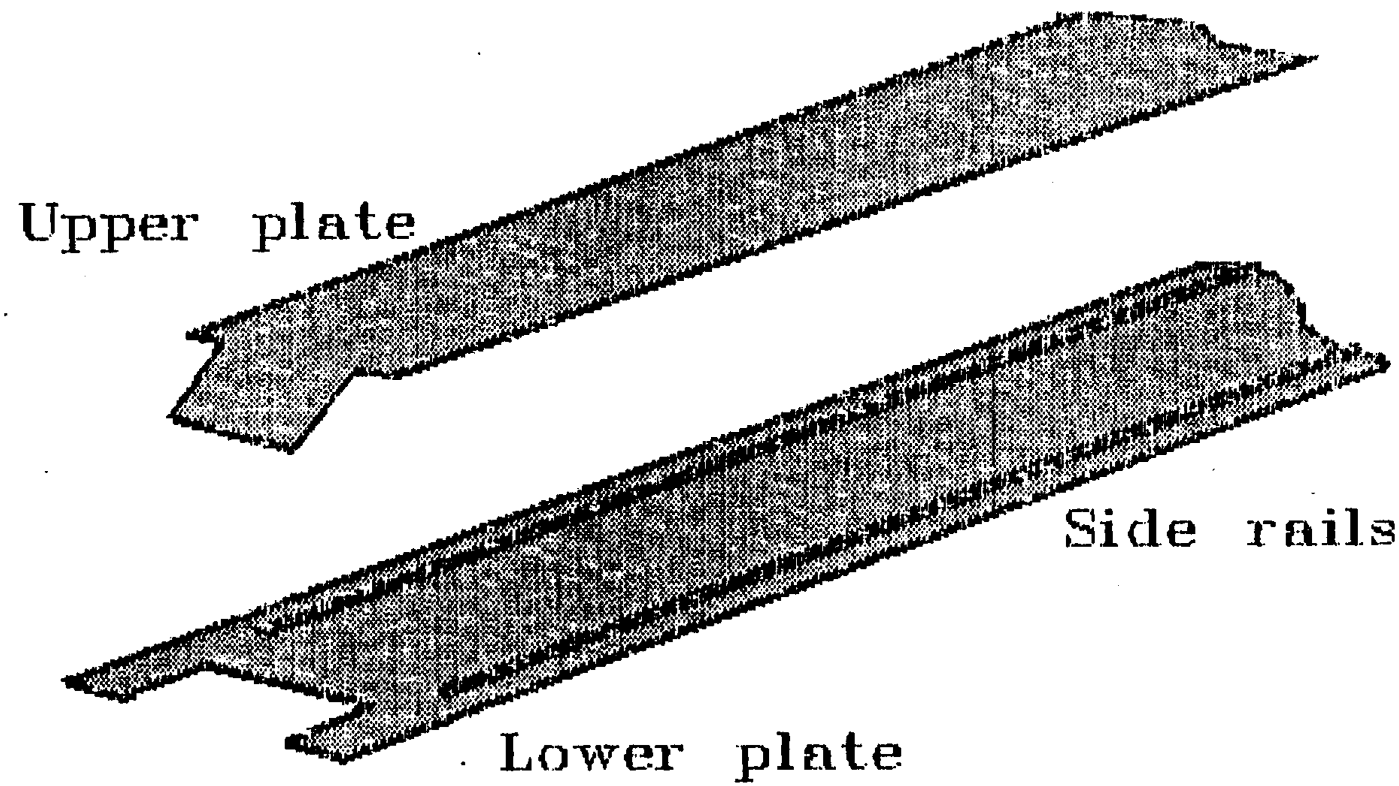


Figure 17. Screen insertion tool

VEGETATION PROCESS STUDIES
EMERALD LAKE,
SEQUOIA NATIONAL PARK

VOLUME 1B

Contract Number A3-097-32

24 May 1984-23 August 1985
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FINAL CONTRACT REPORT
Prepared for
CALIFORNIA AIR RESOURCES BOARD

TABLE OF CONTENTS

## 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

# 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.

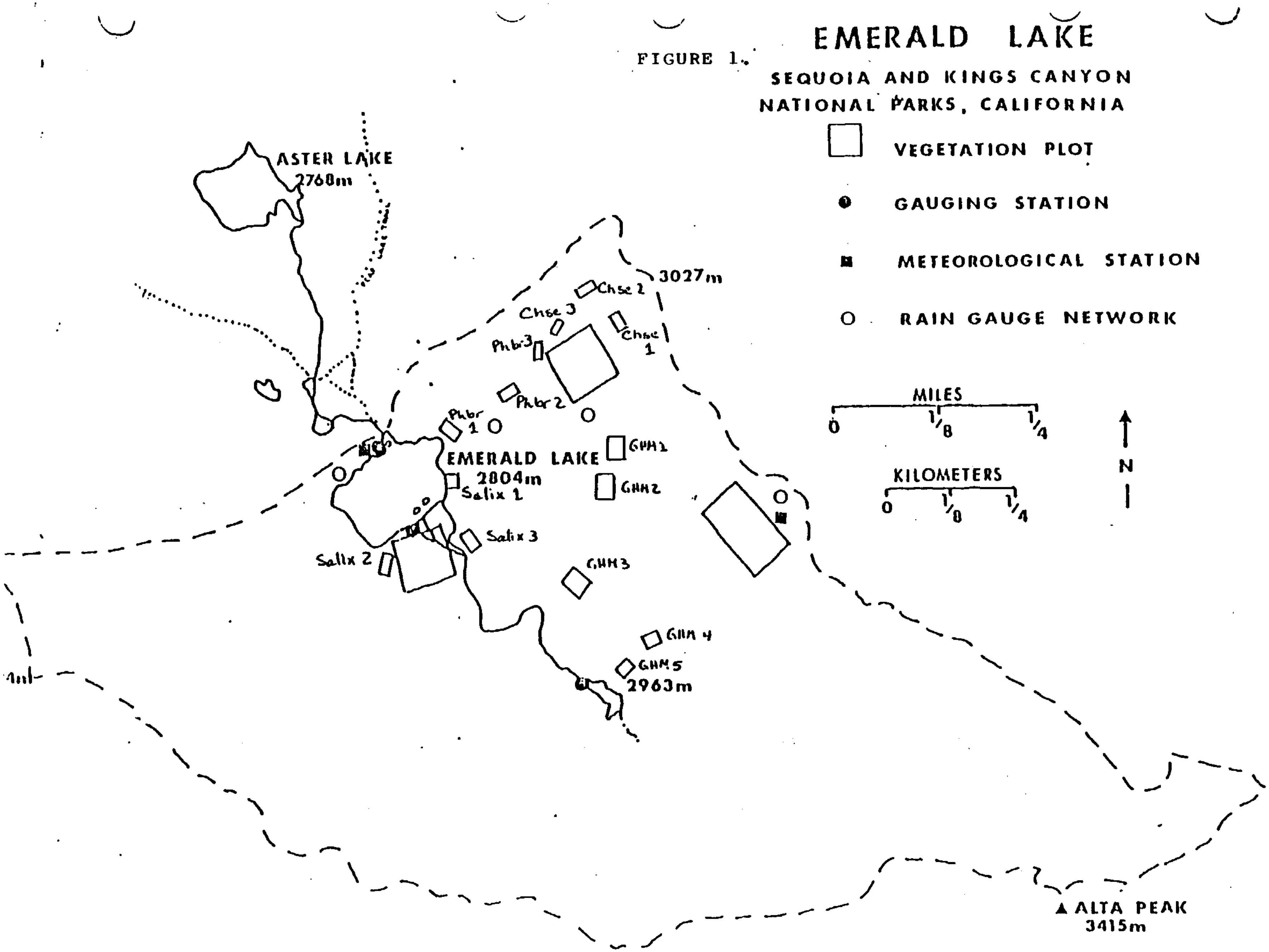


FIGURE 1.

Figure courtesy of U.S. National Park Service

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## 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.

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## 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.

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## 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 5. 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 CONTORIA 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 | 3899.33 | 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 | 1.58 | 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 |