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Decadal and long-term boreal soil carbon and nitrogen sequestration rates across a variety of ecosystems

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Supplemental Material

Table S1. ^{210}Pb ages for surface horizons for each profile, using both the CRS and CF:CS models. Errors are only shown for the CRS model as this is the model used in this study. Dates within square brackets have errors larger than the age difference between that horizon's age and the age of the intervals above, and therefore not considered valid. Depths with asterisks are mineral soil. BZBS = black spruce, BZWB = shrub, BZGR = tussock grass, BZEC = sedge, and BZRM = rich fen.

Sample	Basal Depth (cm)	^{210}Pb (dpm g^{-1})	+/-	^{226}Ra (dpm g^{-1})	+/-	Dry mass (g cm^{-2})	CRS basal date	+/- (yrs)	CF:CS basal date
BZBS 4	1	26.1	2.0	2.6	0.3	0.01	2005	0.1	2005
	5	24.1	1.1	0.7	0.1	0.04	2002	0.3	2002
	10	18.7	1.2	0.0	0.1	0.15	1990	1.4	1992
	15	8.7	0.8	0.5	0.1	0.50	1956	7	1956
	19	4.7	1.2	1.2	0.2	0.32	1928	20	1933
	22	2.4	0.6	0.9	0.1	0.48	[1863]	[144]	1898
BZBS 5	2	22.2	1.6	1.8	0.2	0.02	2005	0.2	2004
	5	23.0	1.2	0.4	0.1	0.12	1992	1.2	1992
	12.5	11.5	0.9	0.5	0.1	0.45	1945	10.2	1949
	16.5	2.9	1.0	0.9	0.2	0.44	1881	112	1906
BZBS 6	1	22.6	1.6	2.0	0.3	0.01	2006	0.0	2005
	3	37.6	1.7	1.4	0.1	0.02	2004	0.1	2004
	6	38.4	2.4	1.2	0.3	0.06	2000	0.4	1999
	9	10.4	0.8	0.5	0.1	0.21	1995	0.6	1984
	16	19.4	1.2	0.9	0.1	0.70	1936	9	1932
	18	1.9	0.3	0.6	0.1	0.34	[1871]	[299]	1907
BZWB 1	2	14.8	2.1	1.8	0.4	0.02	2005	0.2	2005
	4.5	13.6	1.5	0.9	0.3	0.10	2001	0.7	2002
	8.5	8.9	0.8	0.5	0.1	0.32	1988	1.9	1990
	12.5	6.1	0.7	0.4	0.1	0.44	1970	4.6	1973
	17.5	3.2	0.6	0.5	0.1	0.65	1946	12	1949
	22.5	2.3	0.5	1.1	0.1	1.20	[1881]	[91]	1905
BZWB 2	1	19.0	1.3	0.4	0.2	0.03	2003	0.4	2004
	6	8.2	1.0	0.9	0.2	0.45	1975	6.0	1975
	9	5.0	0.6	0.7	0.1	0.33	1941	17	1953
	12	3.4	0.5	0.9	0.1	0.27	[1877]	[129]	1936

BZWB 3	1	22.0	1.9	3.6	0.3	0.04	2005	0.2	n.d.
	6	6.8	0.8	0.8	0.1	0.55	1998	1.0	n.d.
	11	2.4	0.7	0.4	0.1	0.75	1994	1.7	n.d.
	16	3.8	0.8	0.8	0.2	0.40	1991	2.0	n.d.
	21	7.5	0.9	0.8	0.2	0.30	1985	2.2	n.d.
	26	6.3	0.9	0.4	0.2	0.40	1976	2.9	n.d.
	31	7.9	0.9	0.1	0.2	0.50	1951	7.0	n.d.
	36	8.1	0.9	0.3	0.2	0.40	1867	50	n.d.
BZGR 1	3	12.9	0.8	0.6	0.1	0.21	1999	0.8	2001
	7	4.9	0.5	0.5	0.1	0.32	1994	1.1	1994
	11.5	5.0	0.6	0.8	0.1	1.22	1968	6.1	1966
	14	4.8	0.4	1.3	0.1	0.73	1935	16.9	1950
	18*	2.2	0.3	1.4	0.1	1.60	[1871]	[131.4]	1914
BZGR 2	5	8.0	0.8	0.9	0.1	0.40	2000	0.7	2001
	8	7.6	0.7	0.7	0.1	0.51	1992	1.3	1994
	10	5.3	0.6	0.8	0.1	0.36	1987	1.5	1989
	12	3.0	0.5	0.5	0.1	0.40	1983	1.6	1983
	14	5.2	0.6	0.7	0.1	0.44	1975	2.2	1977
	16	4.9	0.4	1.0	0.1	0.66	1960	3.5	1968
	18	3.0	0.4	1.6	0.1	0.96	1943	6.5	1955
	20*	3.0	0.4	1.6	0.1	1.20	1909	23.4	1938
	22*	2.4	0.4	1.7	0.1	1.12	[1844]	[177]	1923
BZGR 3	5.5	6.9	0.6	0.3	0.1	0.39	1990	1.2	1989
	16	5.3	0.8	1.0	0.2	0.84	1986	3.7	1983.
	30	4.5	0.7	0.2	0.1	0.84	1964	9.1	1967
	35	3.2	0.5	0.3	0.1	0.35	1952	12	1961
	41	1.3	0.5	0.4	0.1	0.78	1941	17	1946
	54*	1.1	0.5	0.5	0.1	2.73	[1877]	[156]	1895
BZEC 1	4	7.7	0.8	1.0	0.1	0.52	1978	5.0	1977
	7	3.8	0.5	0.7	0.1	0.57	1937	20	1946
	9	2.0	0.3	0.9	0.1	0.44	[1872]	[166]	1922
BZEC 2	3	14.6	1.0	0.4	0.1	0.27	1995	1.1	1995
	7	11.1	0.9	1.1	0.1	0.56	1967	5.0	1972
	16	3.2	0.4	0.9	0.1	1.53	1902	38	1910

BZEC 3	4	12.3	1.0	1.2	0.2	0.20	2001	0.6	2001
	7	12.5	0.9	1.0	0.1	0.48	1982	2.4	1988
	11	12.0	0.7	0.4	0.1	0.28	1960	4.7	1980
	15.5	4.7	0.7	1.0	0.1	0.90	1896	40	1956
BZMR 1	2	5.6	0.4	0.1	0.1	0.12	2004	0.2	2001
	5	18.1	1.2	0.4	0.1	0.21	1990	1.3	1992
	10	9.3	0.7	0.4	0.1	0.35	1972	2.9	1978
	18	4.1	0.5	0.6	0.1	0.80	1933	13	1944
	32	1.0	0.6	0.4	0.1	1.54	[1869]	[127]	1880
BZMR 2	2.5	16.3	0.8	0.9	0.1	0.35	1977	3	1982
	10	4.7	0.6	0.4	0.1	0.45	1950.1	8.4	1951
	15	3.0	0.4	1.1	0.1	0.50	1915.2	27	1917
	20	1.3	0.4	0.5	0.1	0.55	[1851.0]	[208]	1880
BZMR 3	3	n.d	-	n.d	-	n.d.	2001.7	0.2	1989
	5	18.0	1.1	1.2	0.2	0.14	1991.6	1.0	1990
	7	15.0	1.9	1.3	0.3	0.16	1978.1	2.5	1980
	11	6.4	0.9	0.7	0.2	0.36	1956.9	5.8	1957
	13	5.9	1.0	1.3	0.2	0.20	1938.8	9.6	1945
	15	3.4	0.6	1.1	0.1	0.20	1922.7	15	1932
	17	2.3	0.5	1.1	0.1	0.22	[1907.7]	[23]	1918
	19	3.2	1.1	1.4	0.2	0.24	[1843.5]	[193]	1903

Table S2. ^{14}C raw and calibrated data. Negative values indicate ages younger than 1950 (present). These dates were calculated using CALIBomb with intercal13 and the NHZ1 bomb curve extension. All other dates were calibrated using CALIB 7.0, IntCal04 curve. Minimum and maximum ages are estimates using two sigma. Because ages are presented as cal BP, age at the time of sampling equals 2006-(1950-cal BP age).

Profile	Depth (cm)	Lab Number	Description	Fraction Modern	FM Error	Age	Age error	Min age (cal BP)	Max age (cal BP)
Shrub-1 (BZWB 1)	8.5	WW9508	Deciduous leaves of various sizes	1.15	0.0041	>Modern	-	-39.88	-42.89
	12.5	WW9509	Deciduous leaves of various sizes	1.05	0.0031	>Modern	-	-6.58	-7.30
	22.5	WW9526	Bulk soil with roots picked out	0.97	0.0034	225	30	145 267	214 309
	27	WW9527	Bulk soil with roots picked out	0.92	0.0027	695	25	646	683
Sedge-1 (BZEC 1)	7	WW9522	Seeds	0.99	0.0052	55	45	-5	-5
	15	WW9513	Bulk soil with roots picked out	0.91	0.0032	750	30	664	727
	17	WW9514	Bulk soil with roots picked out	0.90	0.0026	865	45	725	800
Rich Fen-2 (BZMR 2)	10	WW9523	Moss leaves and seeds	0.98	0.0042	130	35	56 172	151 278
	15	WW9524	Moss leaves and seeds	0.99	0.0035	100	30	15	145
	20	WW9525	Moss leaves and seeds	0.99	0.0043	115	35	11	150
	72	WW9511	Bulk soil with roots picked out	0.86	0.0025	1225	25	1068	1187
	79	WW9512	Bulk soil with roots picked out	0.84	0.0024	1435	25	1297	1371

Table S3. Results from the sensitivity analysis to determine the potential impact of different ages for the black spruce ecosystem. Long-term C accumulation rates using different ages for the black spruce ecosystem were compared to accumulation rates of the three other non-fen ecosystems (shrub, tussock grass, and sedge) and, separately, the rich fen ecosystem. Only when the black spruce ecosystem is 200 years old does its long-term C accumulation rate differ significantly from the non-fen ecosystems and become similar to the rich fen ecosystem. The long-term C accumulation rate for the black spruce ecosystem found in the manuscript is 8 +/- gC m^{-2} yr^{-1}, based on an age of 780 yrs (see Section 3.2 for more information).

Selected age of black spruce ecosystem	**Long-term C accumulation rate using that age (gC m^{-2} y^{-1})**	**Are black spruce long-term C accumulation rates significantly different when compared to:**	
		Non-fen ecosystems (p-value)?	**Rich-fen ecosystem (p-value)?**
200 yrs	32 +/- 5	Yes (0.031)	No (0.045)
300 yrs	22 +/- 3	No (0.30)	Yes (0.003)
500 yrs	13 +/- 2	No (0.45)	Yes (0.0006)
1000 yrs	6 +/- 1	No (0.16)	Yes (0.0003)
1400 yrs	5 +/- 1	No (0.11)	Yes (0.0002)
1600 yrs	4 +/- 1	No (0.09)	Yes (0.0002)

Figure S1. C:N relationships averaged by site for the surface organic soil (≤ 20 cm, panel 1) and deep organic soil (>20 cm, panel 2). Letters indicate significant differences (Tukey multiple comparison of means).