

# Catchments of Plešné and Čertovo Lakes (Bohemian Forest) 2007-2022. Data set 3 - Chemical elements in the plant biomass<sup>1</sup>

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## Abstract

Selected chemical elements (C, N, P, Al, Fe, Ca, Mg, Mn, Na and K) were analysed as total content in plant (above-ground) biomass of herb layer in mountain Norway spruce forests. Five dominant species have specific (distinct) element content. Concentrations differ in both catchments. Locality of the sampling has significant impact on some concentrations, probably as result of accumulation of the element in soil. Total element content in the *Vaccinium myrtillus* biomass must be calculated regarding to share green and woody biomass parts because concentrations in these compartments are highly different.

**Keywords:** bark beetle, chemical elements, forest vegetation, plant biomass, stand regeneration, succession, Šumava Mts.

The aim of this text is to collect data on the content of selected chemical elements in the (mainly) above-ground plant biomass of the herb layer in mountain Norway spruce (*Picea abies*) forests. Such data are not yet commonly available in the literature. This work follows on from a previous publication (SVOBODA ET AL. 2006).

## Methods

The herb-layer biomass was collected at top-vegetation-season from permanent plots and several supplementary plots within the catchments of Plešné Lake and Čertovo Lake at Šumava Mts. (= Bohemian Forest) in several years (2007, 2008, 2014), see MATĚJKA (2011, 2015, 2022). First comparing data was obtained in 2004 (SVOBODA ET AL. 2006; only mixture samples from whole two catchments were processed).

The single species herb-layer above-ground biomass samples dried at 80 °C were coarsely ground in a shear mill. A small part of the total final sample was finely ground using a ball mill at the Faculty of Sciences of JČU in České Budějovice.

Further analyses took place at the Czech Geology Survey at Prague: the sample was decomposed with mixture HF + HNO<sub>3</sub> + H<sub>2</sub>SO<sub>4</sub> (200 °C, 2 h digestion), followed by FAAS (Flame Atomic Absorption Spectrometer) determination of Al, Fe, Ca, Mg, Mn, Na and K.

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Total content of P (phosphomolybdenate blue method), N and C (using a C-N analyser) were determined from a finely ground sample at the Hydrobiological Institute AS CR in České Budějovice.

To ensure the accuracy of the measurements, the analyses were performed repeatedly and blinded, and the results were compared.

## Results

All data are collected in Table 1. It is possible that data from 2004 are with methodological flaw because results are partly different. Average concentrations are summarized in Table 2. Both grasses (*A. flexuosa* and *C. villosa*) have similar element content. Partly different is *Luzula sylvatica* with higher Ca, Mg, K and P concentrations. Very distinct concentrations are found in *Vaccinium myrtillus*. This small shrub has different composition of green and woody part of the biomass (namely by Ca, Mg and K), that content of element would be different according to population development stage.

Both catchments are distinct, e.g. low content Ca, high Al and Fe in Čertovo Lake. There are differences in the element content within the catchment as visible from figs. 1-3 with example of Plešné Lake. Whereas Al shows approximately even content, Ca varies between 7.79 and 11.3 g.kg<sup>-1</sup>, probably regarding to the element accumulation in the soil depending on the terrain configuration. High P content was revealed in plots with young population of *Vaccinium myrtillus* (mainly in PJ3).

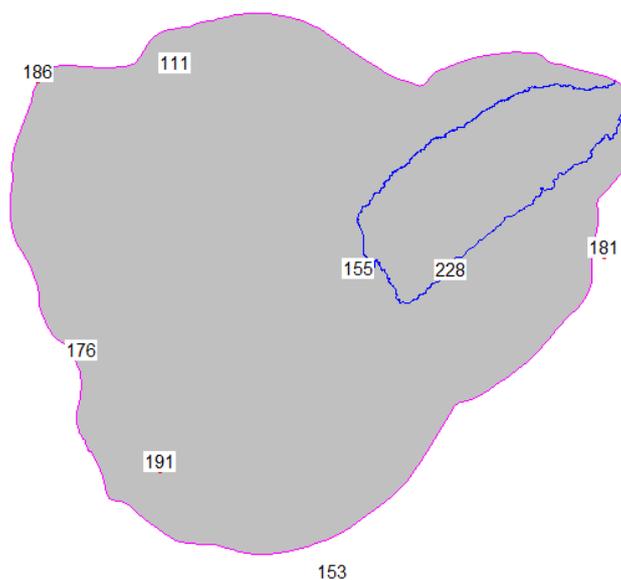


Fig. 1. Average content of Al (mg.kg<sup>-1</sup>) in green part of the aboveground biomass of *Vaccinium myrtillus* in the Plešné Lake catchment at 2007.

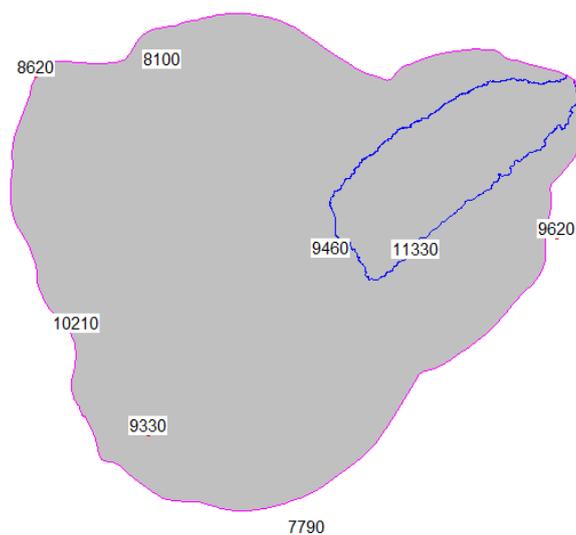


Fig. 2. Average content of Ca ( $\text{mg.kg}^{-1}$ ) in green part of the aboveground biomass of *Vaccinium myrtillus* in the Plešné Lake catchment at 2007.

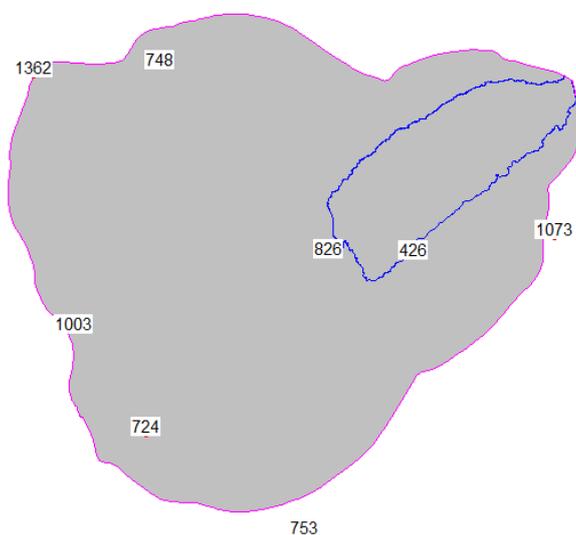


Fig. 3. Average content of P ( $\text{mg.kg}^{-1}$ ) in green part of the aboveground biomass of *Vaccinium myrtillus* in the Plešné Lake catchment at 2007.

## Literature

- Matějka K. (2011): Vegetace v povodí Plešného a Čertova jezera v letech 2007–2010. URL: <https://www.infodatasys.cz/proj002/results2010.pdf>
- Matějka K. (2015): Disturbance-induced changes in the plant biomass in forests near Plešné and Čertovo Lakes. - Journal of Forest Science, 61: 156-168. DOI: [10.17221/109/2014-JFS](https://doi.org/10.17221/109/2014-JFS)
- Matějka K. (2022): Catchments of Plešné and Čertovo Lakes (Bohemian Forest) 2007-2021. Data set 2 - Plant biomass.
- Svoboda M., Matějka K., Kopáček J. (2006): Biomass and element pools of understory vegetation in the catchments of Čertovo Lake and Plešné Lake in the Bohemian Forest. - Biologia, Bratislava, 61(Suppl. 20): S509-S521.

**Table 1.** Content of chemical elements in plant aboveground (if not mentioned another) biomass in chatchments of Plešné (P) and Čertovo (C) Lake.

Catchment	Plot <sup>1)</sup>	Species	Category <sup>2)</sup>	Year	Al	Fe	Ca	Mg	Mn	Na	K	P	N	C
					[mg.kg <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]								
C	all	<i>Athyrium distentifolium</i>	fine roots	2004	4481.23	1874.90	3260.27	1402.67	98.50	159.89	922.64	896.35	16.99	518.97
P	all	<i>Athyrium distentifolium</i>	fine roots	2004	5379.28	1358.20	2867.33	966.46	61.62	652.45	1516.65	1142.86	17.45	514.70
C	all	<i>Athyrium distentifolium</i>		2004	86.26	89.02	3328.56	2590.16	517.46	11.68	35954.01	2776.55	28.65	475.22
P	all	<i>Athyrium distentifolium</i>		2004	111.49	100.41	2839.29	1826.33	334.24	15.82	31952.38	4197.69	29.94	490.17
C	all	<i>Avenella flexuosa</i>	fine roots	2004	1933.79	1159.72	2781.81	712.48	67.63	187.34	1320.35	806.59	14.19	521.51
P	all	<i>Avenella flexuosa</i>	fine roots	2004	2236.63	681.56	2262.88	452.92	53.18	337.49	1309.79	809.99	13.93	514.77
C	all	<i>Avenella flexuosa</i>		2004	131.72	131.80	967.60	1174.78	221.56	22.42	15477.06	1918.08	23.31	483.58
C	CU	<i>Avenella flexuosa</i>		2007	42.80	65.33	790.00	989.80	184.11	34.51	11030.00	1225.52	19.36	442.53
C	CU	<i>Avenella flexuosa</i>		2008	38.64	79.73	680.00	920.00	186.89	47.62	14290.00	1492.52	23.02	446.12
P	all	<i>Avenella flexuosa</i>		2004	112.35	110.30	1026.32	1090.61	282.22	21.63	13764.67	1826.80	20.06	481.12
P	P20	<i>Avenella flexuosa</i>		2014	30.88	43.29	830.00	566.29	213.60	28.84	8540.00	1156.24		
P	PJ3	<i>Avenella flexuosa</i>		2008	32.45	52.56	1200.00	1088.96	382.43	52.97	15040.00	2107.51	20.09	441.90
P	PJ3	<i>Avenella flexuosa</i>		2014	64.93	125.64	1050.00	742.75	241.12	42.74	9360.00	1418.99		
P	PJ4	<i>Avenella flexuosa</i>		2007	52.83	75.97	1260.00	880.00	338.25	34.62	15980.00	1641.33	19.00	442.51
P	PJ4	<i>Avenella flexuosa</i>		2008	39.15	63.72	1080.00	1020.00	443.74	35.55	15710.00	1514.18	20.77	438.12
P	PJ4	<i>Avenella flexuosa</i>		2014	52.00	66.47	1300.00	811.22	236.26	52.93	7480.00	1100.28		
P	X5	<i>Avenella flexuosa</i>		2014	30.92	41.80	1200.00	608.69	170.84	41.94	6430.00	804.93		
C	all	<i>Calamagrostis villosa</i>	fine roots	2004	3298.57	1770.41	2665.47	645.83	101.14	182.95	1226.44	864.11	13.25	510.79
P	all	<i>Calamagrostis villosa</i>	fine roots	2004	3910.54	1299.89	2272.50	514.80	74.94	492.81	1746.13	1103.35	14.34	507.02
C	all	<i>Calamagrostis villosa</i>		2004	60.03	96.11	1079.50	870.24	296.28	10.94	16775.87	1871.31	21.78	479.45
C	CU	<i>Calamagrostis villosa</i>		2007	64.55	93.32	1350.00	663.28	148.01	47.32	13080.00	1061.07	20.56	434.57
C	CU	<i>Calamagrostis villosa</i>		2008	59.26	81.47	1040.00	630.00	166.97	45.25	13210.00	790.66	19.92	437.33
P	all	<i>Calamagrostis villosa</i>		2004	51.37	93.38	1336.56	897.83	390.22	9.49	17572.42	2298.35	22.45	466.34
P	P20	<i>Calamagrostis villosa</i>		2014	57.18	69.71	1980.00	910.00	418.05	26.31	6980.00	1238.26		
P	PJ3	<i>Calamagrostis villosa</i>		2007	44.33	74.60	1680.00	770.00	349.76	32.94	14880.00	1902.75	18.07	434.73
P	PJ3	<i>Calamagrostis villosa</i>		2008	41.77	83.37	1750.00	810.00	173.51	38.65	18030.00	2141.30	22.35	442.91
P	PJ3	<i>Calamagrostis villosa</i>		2014	43.78	70.15	1280.00	668.36	281.94	30.14	9000.00	1290.24		
P	X5	<i>Calamagrostis villosa</i>		2014	45.10	51.39	1510.00	553.43	190.33	35.21	8360.00	1306.50		
P	X6	<i>Calamagrostis villosa</i>		2014	32.18	59.18	1450.00	660.00	481.22	24.34	11630.00	1533.50		
C	all	<i>Luzula sylvatica</i>	fine roots	2004	2740.62	2307.88	3237.78	805.32	107.24	224.24	1059.92	958.48	14.13	507.69
P	all	<i>Luzula sylvatica</i>	fine roots	2004	2965.97	1093.32	2888.78	504.91	112.62	247.30	1366.49	1027.21	13.20	530.63
C	all	<i>Luzula sylvatica</i>		2004	136.47	113.48	1132.28	1871.66	351.66	35.45	21834.91	2588.11	21.05	471.53
P	all	<i>Luzula sylvatica</i>		2004	319.25	191.78	2173.67	1648.39	326.99	49.98	21355.10	2448.85	20.06	478.87
P	PJ3	<i>Luzula sylvatica</i>		2007	49.61	107.41	1990.00	1480.00	409.50	35.67	19970.00	1994.86	18.69	444.66
P	PJ3	<i>Luzula sylvatica</i>		2008	27.12	53.90	1540.00	1700.00	437.37	49.00	22250.00	3065.28	19.77	439.63

Catchment Plot	Species	Category	Year	Al	Fe	Ca	Mg	Mn	Na	K	P	N	C	
				[mg.kg <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]								
P	PJ3	<i>Luzula sylvatica</i>		2014	44.50	50.38	1500.00	1402.49	408.11	68.33	14710.00	1707.05		
P	X6	<i>Luzula sylvatica</i>		2014	35.01	61.78	2070.00	1000.00	512.31	40.34	19960.00	2171.43		
C	all	<i>Vaccinium myrtillus</i>	ABG-A	2004	158.00	75.78	5085.94	860.49	1007.56	22.32	3453.87	823.50	10.45	512.63
P	all	<i>Vaccinium myrtillus</i>	ABG-A	2004	192.35	77.12	5493.81	975.89	653.76	26.71	3997.49	904.56	10.53	511.78
C	all	<i>Vaccinium myrtillus</i>	ABG-L	2004	186.15	100.30	6306.11	1962.24	770.40	13.82	9143.14	1529.14	20.85	504.04
P	all	<i>Vaccinium myrtillus</i>	ABG-L	2004	176.05	88.74	7039.74	2043.18	538.39	10.81	9951.42	1691.69	21.29	505.92
C	all	<i>Vaccinium myrtillus</i>	fine roots	2004	1675.96	988.32	2418.15	553.59	215.47	111.45	1025.35	667.24	11.42	526.54
P	all	<i>Vaccinium myrtillus</i>	fine roots	2004	1154.57	510.61	3013.42	618.56	190.52	183.21	883.74	579.64	10.35	506.75
C	CL	<i>Vaccinium myrtillus</i>	green	2007	177.52	56.92	9200.00	1409.27	623.45	41.18	5320.00	1144.76	13.70	472.87
C	CL	<i>Vaccinium myrtillus</i>	green	2008	168.97	45.59	8260.00	1418.43	875.23	40.33	5310.00	843.02	13.14	473.68
P	P19	<i>Vaccinium myrtillus</i>	green	2007	152.77	46.98	7790.00	1093.64	488.91	46.62	4780.00	753.29	12.83	476.33
P	P19	<i>Vaccinium myrtillus</i>	green	2008	129.41	42.24	6860.00	1076.01	415.06	48.01	5240.00	863.83	13.86	482.98
P	P19	<i>Vaccinium myrtillus</i>	green	2014	198.32	49.59	9470.00	1158.21	539.77	46.50	3970.00	723.92		
P	P20	<i>Vaccinium myrtillus</i>	green	2014	190.97	48.47	9330.00	1587.40	570.19	43.14	3960.00	723.71		
P	PJ3	<i>Vaccinium myrtillus</i>	green	2007	186.43	66.79	8620.00	1513.58	887.15	35.15	5290.00	1362.22	14.82	470.34
P	PJ3	<i>Vaccinium myrtillus</i>	green	2008	140.33	51.36	6730.00	1142.57	542.06	39.83	5270.00	1303.50	14.73	481.66
P	PJ4	<i>Vaccinium myrtillus</i>	green	2007	181.03	59.85	9620.00	1628.41	635.04	31.40	5520.00	1072.77	16.16	471.87
P	PJ4	<i>Vaccinium myrtillus</i>	green	2008	167.58	54.68	7970.00	1085.01	387.74	41.57	5990.00	1263.08	13.93	471.89
P	PJ4	<i>Vaccinium myrtillus</i>	green	2014	215.77	53.55	11140.00	1410.14	486.06	38.89	3830.00	1043.59		
P	X2	<i>Vaccinium myrtillus</i>	green	2014	175.99	80.42	10210.00	1190.00	887.52	36.47	4140.00	1002.52		
P	X3	<i>Vaccinium myrtillus</i>	green	2014	154.55	37.17	9460.00	1353.11	469.23	36.67	3730.00	825.76		
P	X4	<i>Vaccinium myrtillus</i>	green	2014	227.76	38.77	11330.00	1268.59	495.06	42.96	4070.00	426.33		
P	X5	<i>Vaccinium myrtillus</i>	green	2014	110.81	31.86	8100.00	1224.16	548.30	30.69	2760.00	748.14		
C	all	<i>Vaccinium myrtillus</i>	wood	2004	170.17	97.12	2221.48	343.77	609.87	8.02	1479.09	428.77	6.54	509.85
C	CL	<i>Vaccinium myrtillus</i>	wood	2007	136.20	45.20	2260.00	408.40	305.48	40.27	1720.00	493.27	9.14	437.66
C	CL	<i>Vaccinium myrtillus</i>	wood	2008	125.99	37.43	2440.00	410.72	505.94	28.53	1710.00	352.20	5.87	479.45
P	all	<i>Vaccinium myrtillus</i>	wood	2004	185.85	97.34	2565.15	437.49	497.85	12.62	1817.37	485.70	7.20	513.92
P	P19	<i>Vaccinium myrtillus</i>	wood	2007	167.41	53.62	3000.00	432.73	536.65	34.89	1410.00	373.39	6.86	481.24
P	P19	<i>Vaccinium myrtillus</i>	wood	2008	129.61	42.66	3190.00	463.05	365.93	47.49	1870.00	431.04	6.83	479.83
P	PJ3	<i>Vaccinium myrtillus</i>	wood	2007	144.84	50.52	2610.00	414.45	521.31	34.45	1870.00	720.80	7.17	477.12
P	PJ3	<i>Vaccinium myrtillus</i>	wood	2008	106.92	32.95	1850.00	362.41	445.19	28.83	2110.00	746.35	7.55	484.36
P	PJ4	<i>Vaccinium myrtillus</i>	wood	2007	141.14	40.57	2960.00	383.85	359.80	31.13	1870.00	698.09	8.06	478.00
P	PJ4	<i>Vaccinium myrtillus</i>	wood	2008	141.34	38.37	2880.00	446.27	299.27	35.32	2160.00	738.66	8.02	479.69
P	X3	<i>Vaccinium myrtillus</i>	wood	2014	142.60	53.10	1780.00	339.63	350.63	31.13	1550.00	400.59		
P	X4	<i>Vaccinium myrtillus</i>	wood	2014	148.31	44.01	1550.00	356.45	262.10	29.60	1490.00	699.61		
P	P19	<i>Vaccinium vitis-idaea</i>		2007	113.06	103.43	3560.00	837.72	272.76	43.94	4390.00	661.02	7.14	525.73
P	P19	<i>Vaccinium vitis-idaea</i>		2008	137.88	94.50	3610.00	862.70	282.77	47.02	4480.00	758.62	10.18	487.21

Catchment Plot	Species	Category	Year	Al	Fe	Ca	Mg	Mn	Na	K	P	N	C
				[mg.kg <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]								
P	P19	<i>Vaccinium vitis-idaea</i>	2008	131.74	93.01	3610.00	855.72	301.33	48.89	4600.00			
P	P19	<i>Vaccinium vitis-idaea</i>	2014	122.35	53.12	5100.00	973.28	330.45	35.14	3000.00	599.13		
P	P19	<i>Vaccinium vitis-idaea</i>	2014	115.09	55.43	5110.00	971.47	335.46	33.93	3150.00			
P	X3	<i>Vaccinium vitis-idaea</i>	2014	109.20	54.92	4270.00	934.11	243.92	32.77	3160.00	679.76		
P	X3	<i>Vaccinium vitis-idaea</i>	2014	111.68	51.64	4260.00	924.75	242.01	35.02	3040.00			

Comments:

<sup>1)</sup> all - mixture sample through all plots in the catchment

<sup>2)</sup> total aboveground biomass except cases

- fine root - belowground biomass from soil cores to depth approximately 10 cm (only at 2004; see Svoboda et al. 2006)

- wood - woody part of shoots

- green - green (annual) part of shoots (green branches with leaves)

- ABG-A - annual green branches without leaves (only at 2004)

- ABG-L - leaves (only at 2004)

**Table 2.** Average content of chemical elements in plant aboveground biomass in both catchments 2007-2014.

		Al	Fe	Ca	Mg	Mn	Na	K	P	N	C
		[mg.kg <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]	[mg.g <sup>-1</sup> ]							
<i>Avenella flexuosa</i>		42.7	68.3	1043	848	266	41.30	11540	1385	20.45	442.2
<i>Calamagrostis villosa</i>		48.5	72.9	1505	708	276	35.02	11896	1408	20.23	437.4
<i>Luzula sylvatica</i>		39.1	68.4	1775	1396	442	48.34	19222	2235	19.23	442.1
<i>Vaccinium myrtillus</i>	green	171.9	50.9	8939	1304	590	39.96	4612	940	14.15	475.2
<i>Vaccinium myrtillus</i>	wood	138.4	43.8	2452	402	395	34.16	1776	565	7.44	474.7
<i>Vaccinium vitis-idaea</i>		120.1	72.3	4217	909	287	39.53	3689	675	8.66	506.5