

Supplementary Information

Contains supplementary background figures and tables for figures included in *No directional change in local vascular plant communities from 2007 to 2022 in Kangerluarsunnguaq (West Greenland)*. Document is generated from Quato R script enabling recreating of test and figures. Script is available on Zenodo.

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1 Current climate conditions

Data is available 2007 – 2022. 2008 is the first whole year of temperature data. Data available from <https://data.g-e-m.dk> (GEM 2026e, 2026c).

1.1 Temperature

Monthly mean temperature

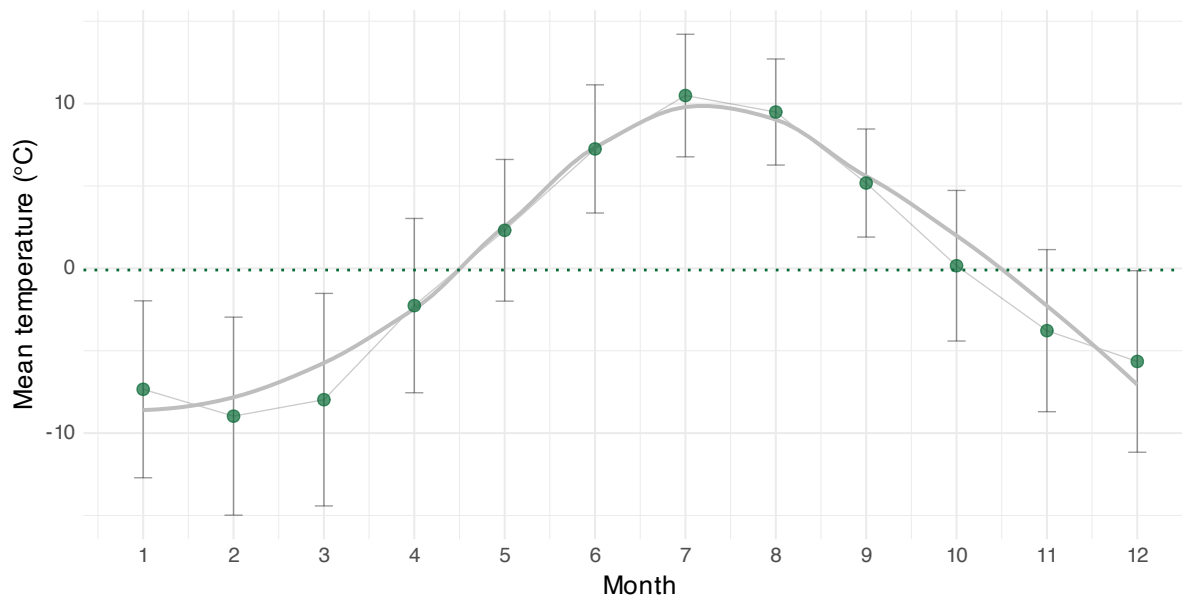


Figure 1: Mean temperature per month. Mean air temperature (°C) per month, based on data from 2007 to 2022. The dashed line represent yearly mean of -0.1°C.

The mean annual temperature is -0.1 °C. The warmest months are July (10.5 °C), August (9.5 °C), June (7.2 °C). The coldest months are January (-7.3 °C), March (-8 °C), February (-9 °C).

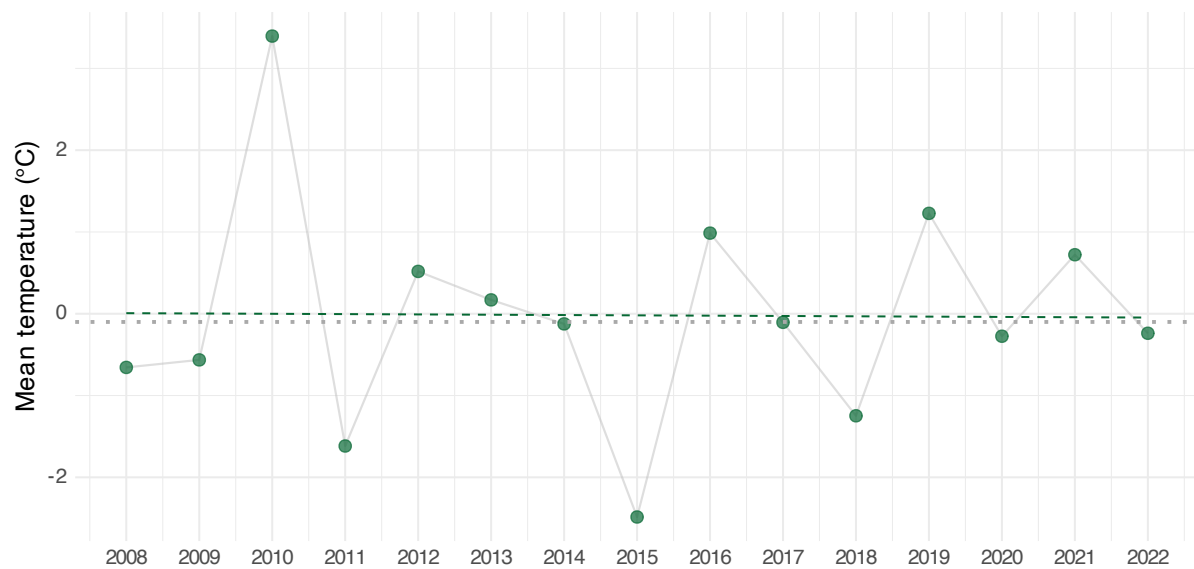
Yearly mean temperature

Figure 2: Mean annual air temperature per year (°C) from 2008 to 2022 in Kangerluassunguaq. Data from 2007 is excluded because data is only from October, November and December. Gray dotted line indicate over all mean of -0.1003°C. Dashed line is model prediction.

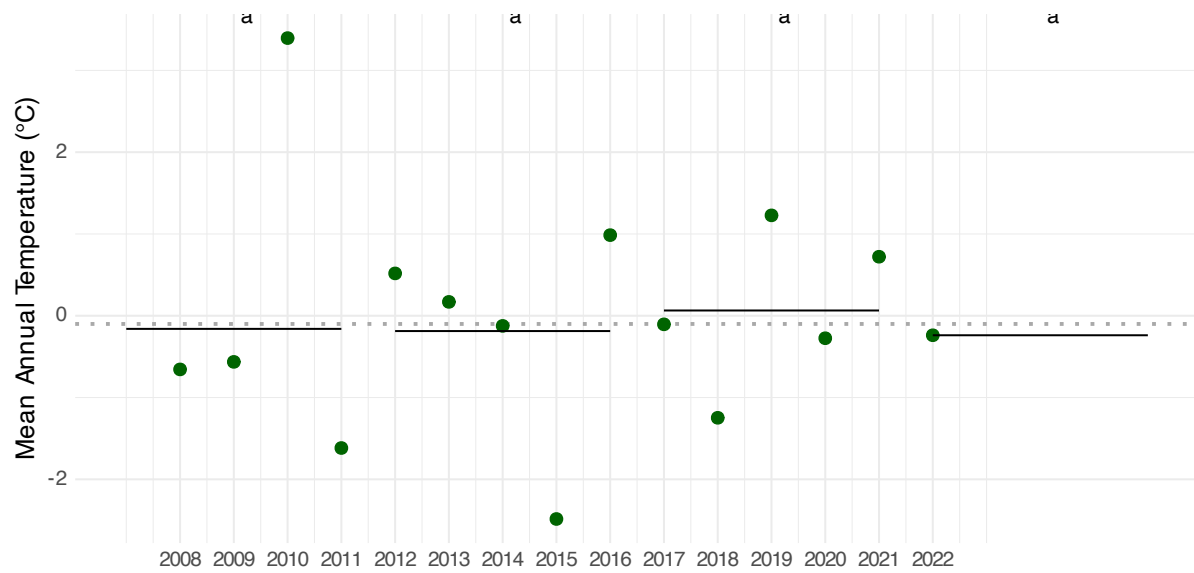
Five year intervals of temperature

Figure 3: Five year intervals in temperature means. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display .

1.2 Precipitation

Data available from <https://data.g-e-m.dk> (GEM 2026c).

The mean annual precipitation is 886.15 mm.

The months with the most precipitation are September (138.64 mm), October (99.38 mm), August (98.28 mm), which account for 336.3 mm or 38 % of the yearly precipitation.

The months with the least precipitation are May (51.51 mm), February (37.62 mm), March (36.44 mm).

Monthly mean precipitation

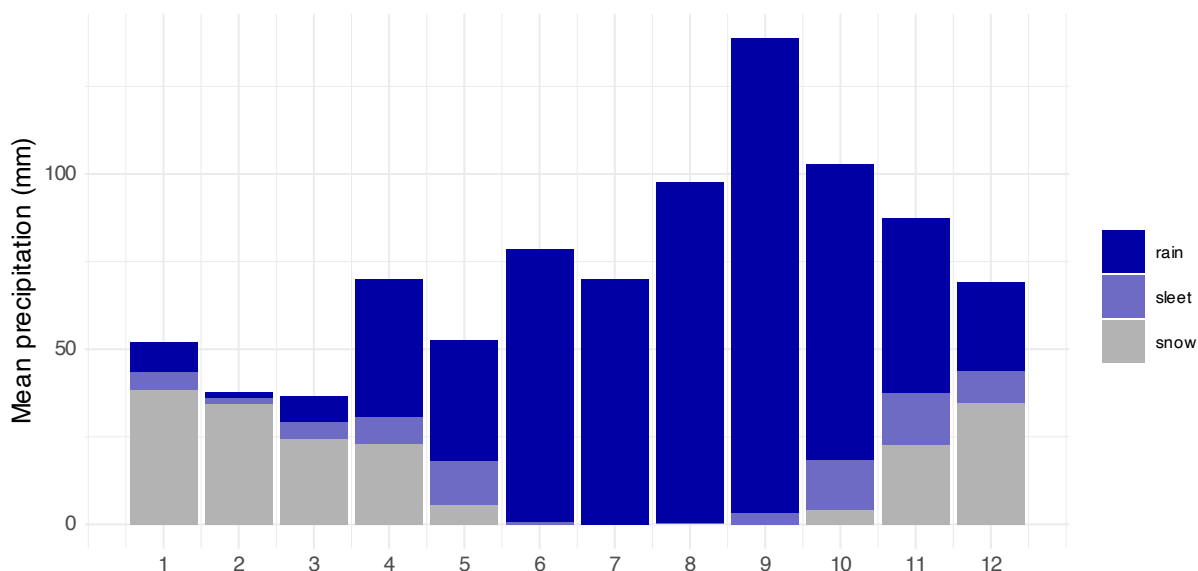


Figure 4: Mean precipitation type per month. Mean monthly distribution of types of precipitation (mm). Totals based on data from 2007 to 2024 (requires join with temperature data which it only available till 2022). Sleet is defined as precipitation that fell when temperatures were between -1°C and 1°C .

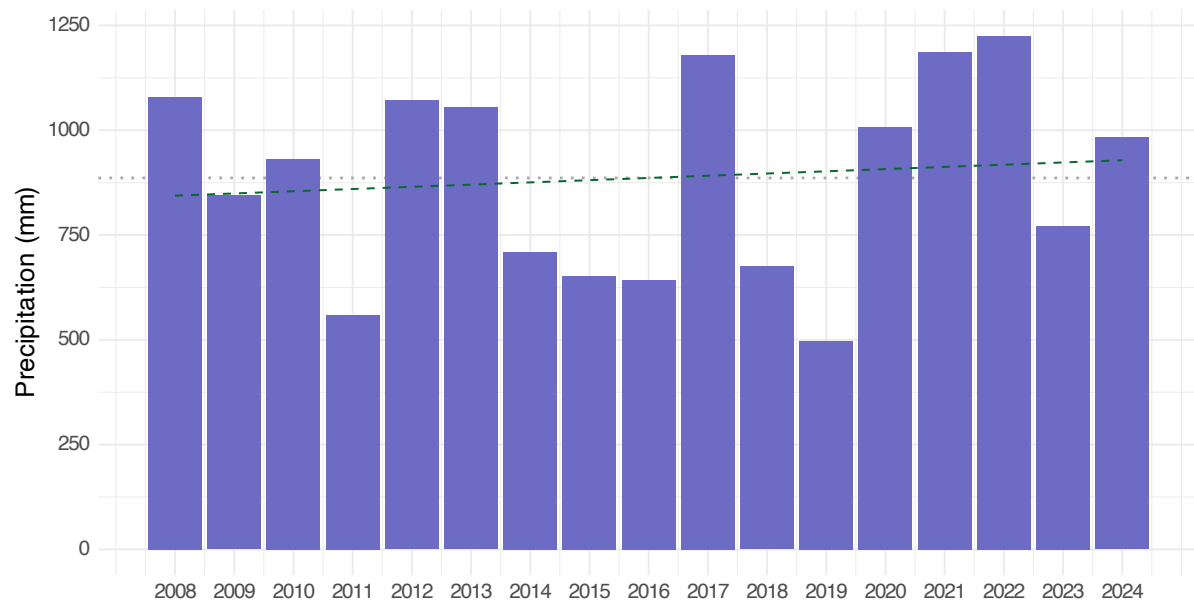
Yearly mean precipitation

Figure 5: Mean yearly precipitation (mm) from 2008 to 2024. Data from 2007 is excluded because it was only from May - December. Blue dashed line indicate over all mean of 886.15 mm. Dashed line represent model prediction.

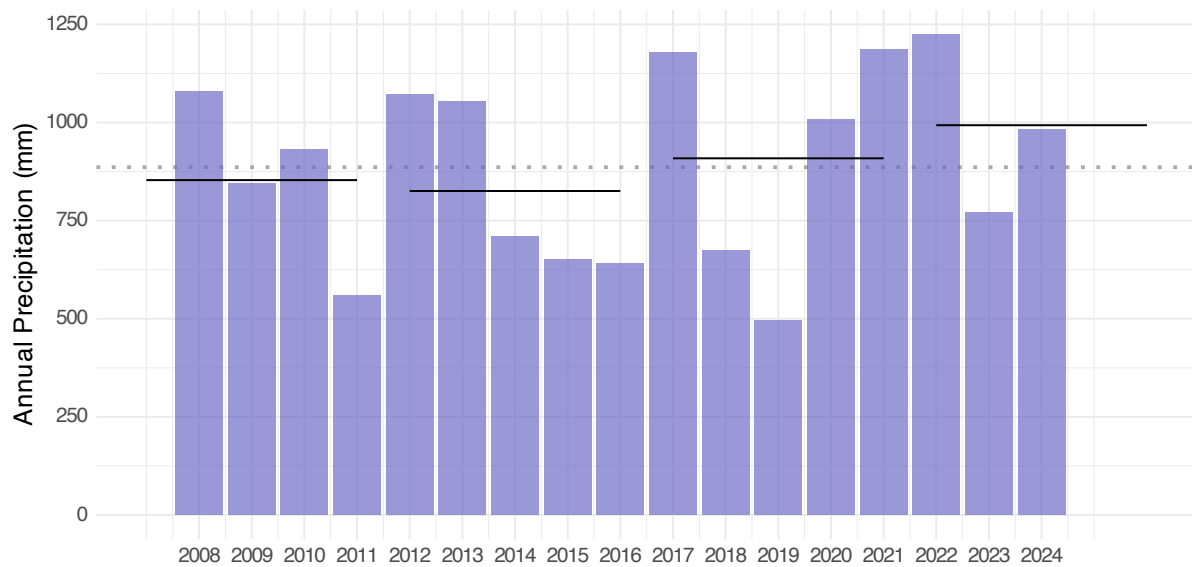
Five year interval precipitation

Figure 6: Five year intervals in precipitation means. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

1.3 Radiation

Data available from <https://data.g-e-m.dk> (GEM 2026d)



Figure 7: Five year intervals in PAR means. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

2 Historic climate data

2.1 Temperature

Data available from Cappelen (2021).

Station 4250 is Nuuk, and element 101 is precipitation.

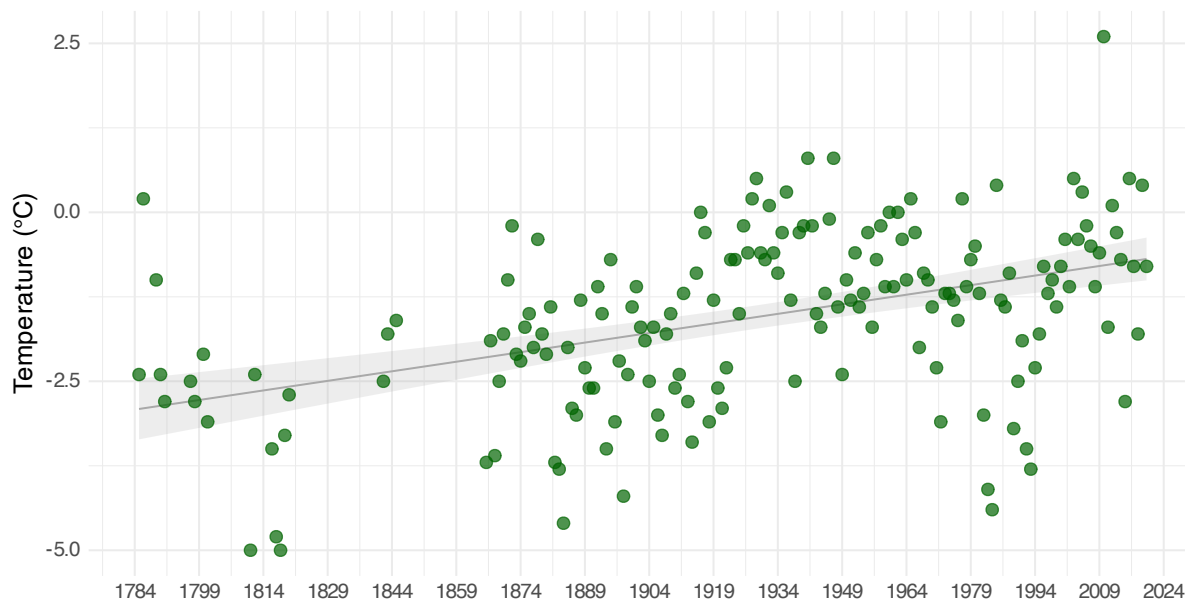


Figure 8: Historic yearly mean air temperature ($^{\circ}\text{C}$) in Nuuk, from 1785 to 2020. Yearly mean of -1.6°C . Yearly mean ranges from -5°C to 2.6°C . Modelled mean temperature has increase from -2.92°C in 1784 to -0.65°C in 2024 (increase of 2.27°C or $0.095^{\circ}\text{C}/\text{decade}$.)

3 Statistical analysis

3.1 Diversity

Data available from <https://data.g-e-m.dk> (GEM 2026a).

Data has been filtered to remove sections with only one remaining plot and subsections in saltmarsh, due to too few replicates in this community type. Final calculates included 134 subsections (full transect consists of 162 subsection).

Richness

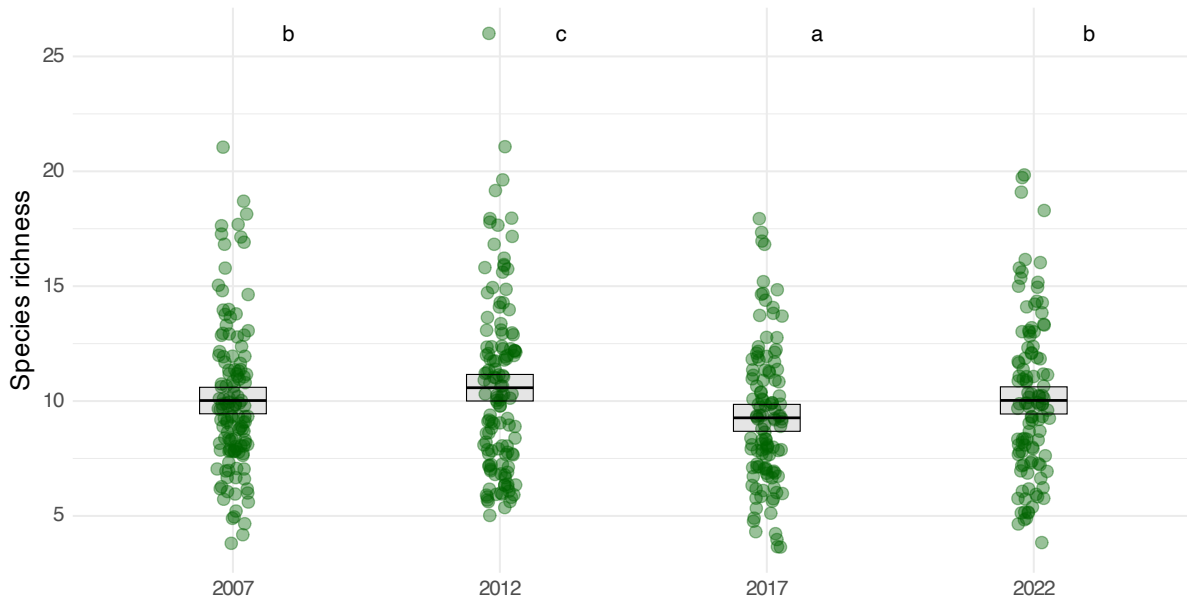


Figure 9: Species richness, number of species per subsection. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

Table 1: Estimated marginal means and CLD for species richness per survey year

year	emmean	SE	lower	upper	group
2007	10.023	0.292	9.287	10.758	b
2012	10.580	0.293	9.843	11.317	c
2017	9.269	0.297	8.522	10.017	a
2022	10.028	0.300	9.275	10.781	b

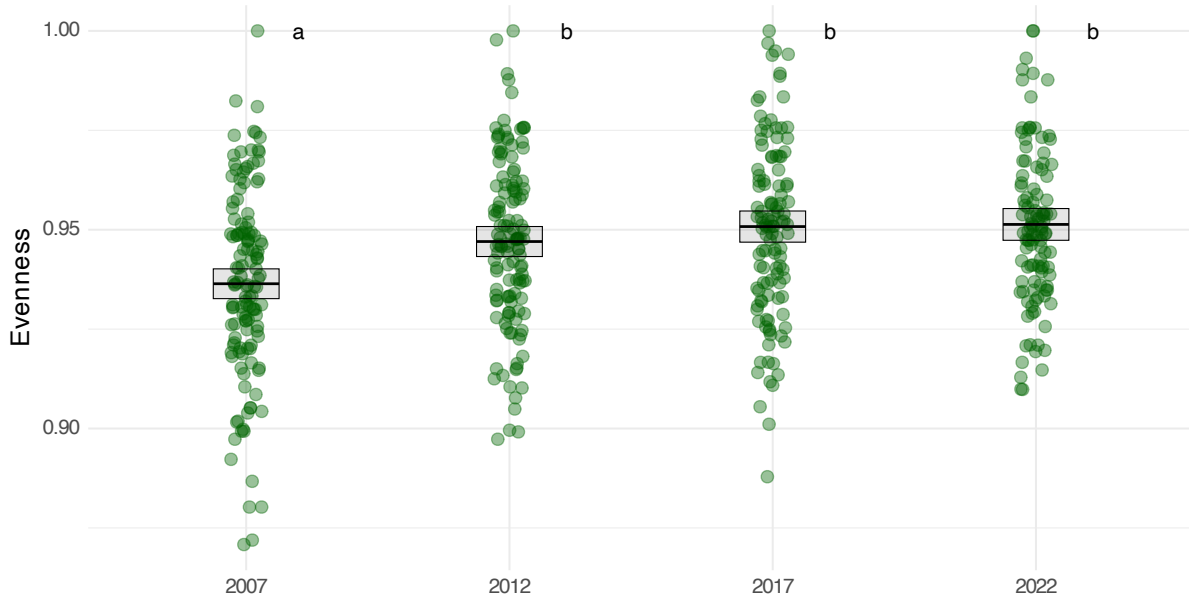
Evenness

Figure 10: Evenness per subsection. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

Table 2: Estimated marginal means and compact letter display for evenness per survey year

year	emmean	SE	lower	upper	group
2007	0.936	0.002	0.932	0.941	a
2012	0.947	0.002	0.942	0.952	b
2017	0.951	0.002	0.946	0.956	b
2022	0.951	0.002	0.946	0.956	b

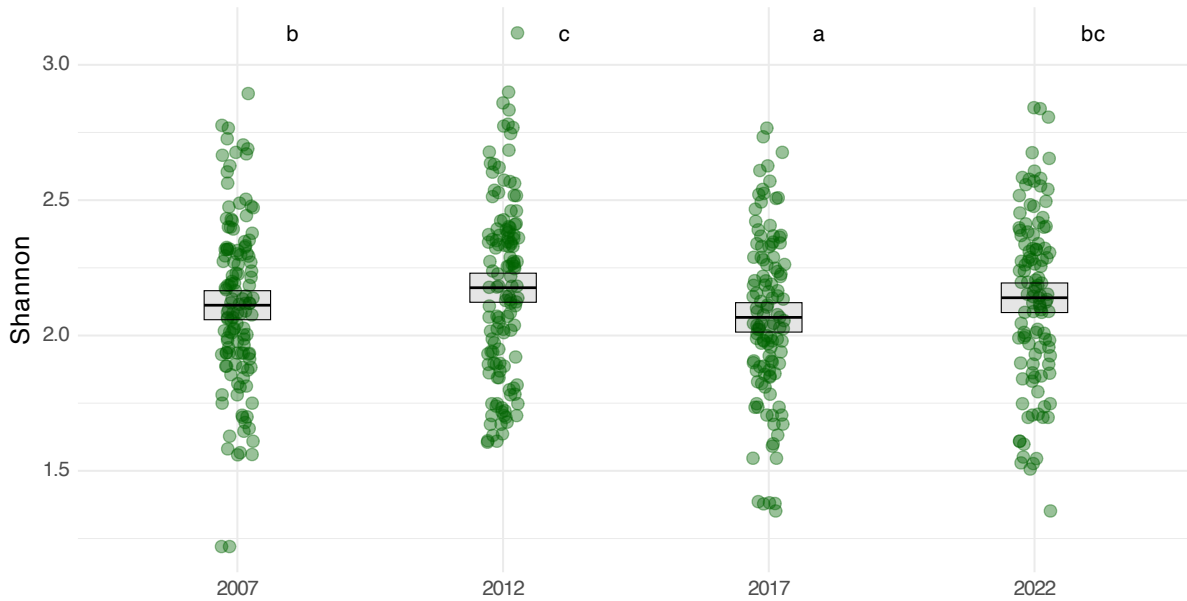
Shannon

Figure 11: Shannon diversity per year calculate pr subsection. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

Table 3: Estimated marginal means and compact letter display for evenness per survey year

year	emmean	SE	lower	upper	group
2007	2.112	0.027	2.044	2.180	b
2012	2.176	0.027	2.108	2.245	c
2017	2.067	0.028	1.998	2.136	a
2022	2.139	0.028	2.070	2.209	bc

Turnover

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Figure 12: Turnover per year calculate per subsection, but only for plots/subsections present all survey years. A total of 131 subsections maintain more than 1 plots for all 4 surveys. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level.

Table 4: Estimated marginal means and compact letter display for evenness per survey year

year	emmean	SE	lower	upper	group
2007	NA	NA	NA	NA	
2012	0.202	0.012	0.173	0.231	b
2017	0.234	0.012	0.204	0.264	c
2022	0.154	0.013	0.124	0.185	a

Plots combined

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Removed 1 row containing missing values or values outside the scale range (``geom_crossbar()``).

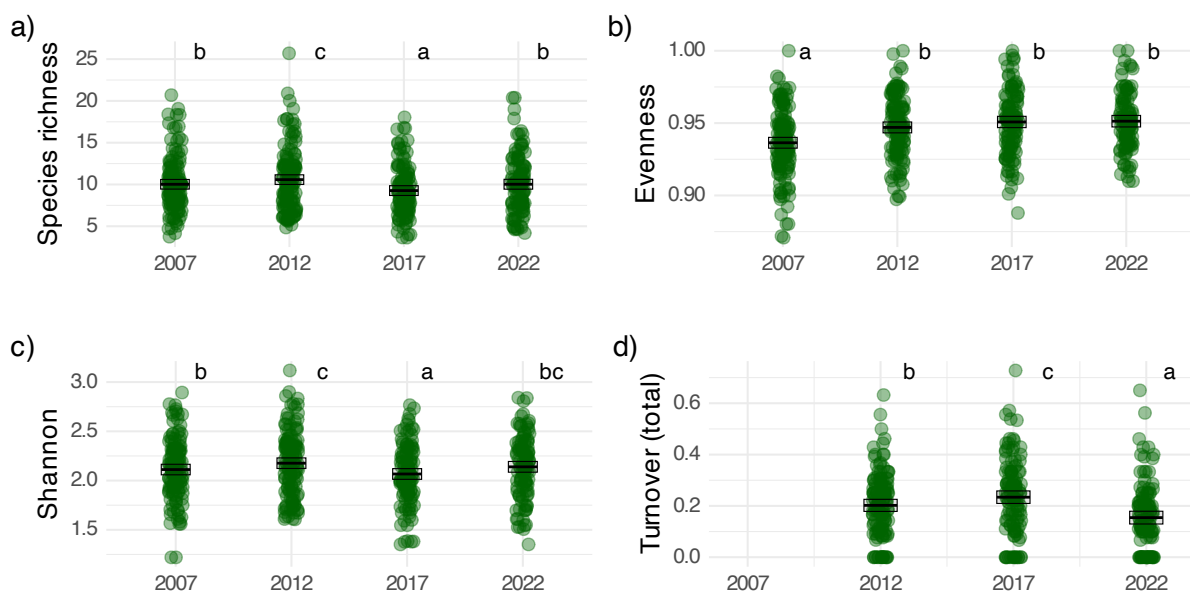


Figure 13: Diversity metrics, a) Shannon diversity, b) Species richness, c) Evenness, c) Species turnover. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level. (Figure 3)

3.2 Community composition

NMDS

Community composition data ready for analysis consists of 134 subsections from 4 years of surveys. 99 species have been observed across all surveys.

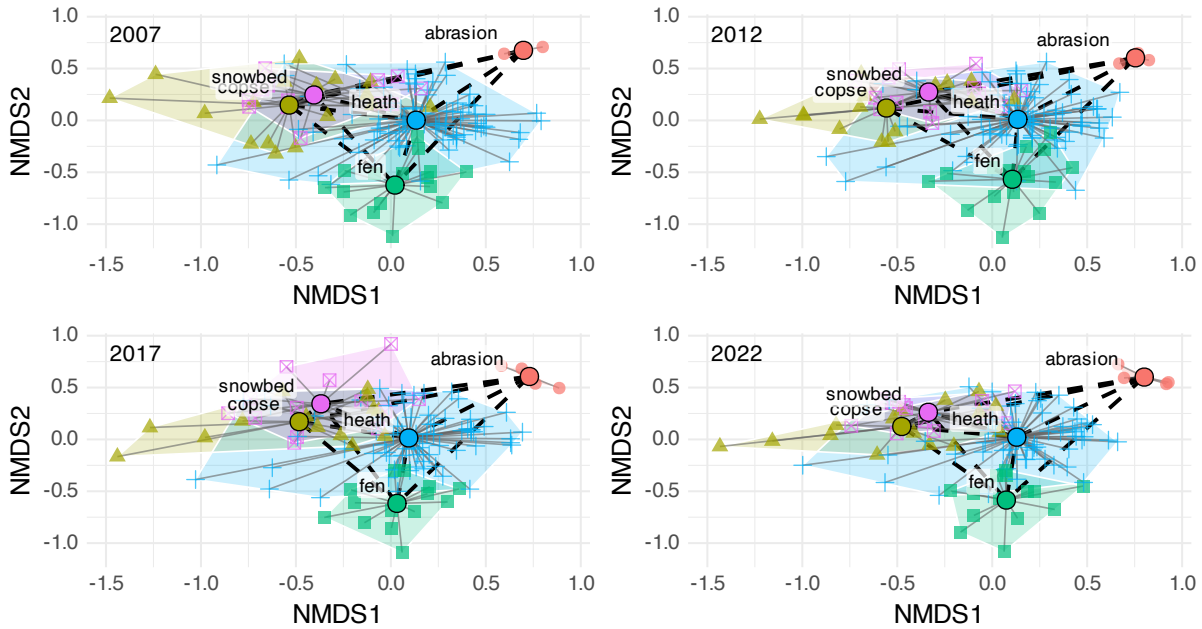


Figure 14: Plant community dynamics. Non-metric multidimensional scaling (NMDS) ordination of vegetation composition across years and vegetation types. Each panel represents subset of years of the full NMDS including all data to keep NMDS distances comparable. Grey lines connect plots within vegetation types, the within-type centroid distances. Black dashed lines indicate distances between vegetation-type centroids.

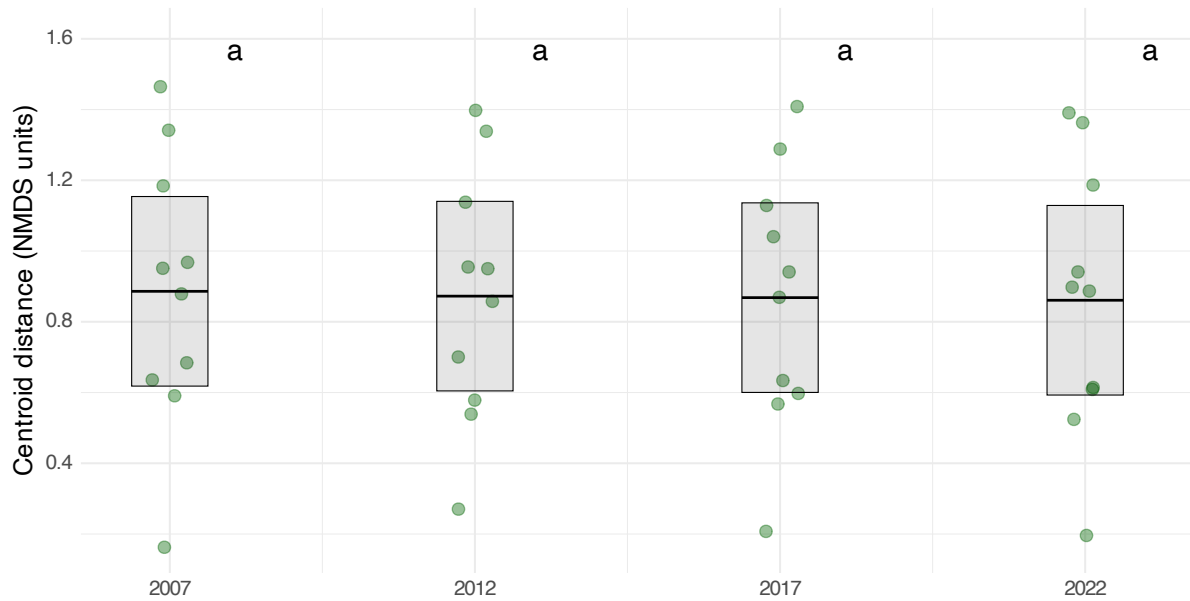
Between vegetation composition

Figure 15: Between plant community dynamics. Estimated mean distance between vegetation-type centroids within each survey year based on linear mixed-effects models. Black lines are estimated means ($\pm$ SE), and grey dots represent raw subsection-level distances (NMDS units). Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level. (Figure 5)

Table 5: Estimated mean centroid distances and compact letter display per survey year

year	emmean	SE	lower	upper	group
2007	0.886	0.119	0.520	1.253	a
2012	0.873	0.119	0.506	1.239	a
2017	0.868	0.119	0.502	1.235	a
2022	0.861	0.119	0.494	1.227	a

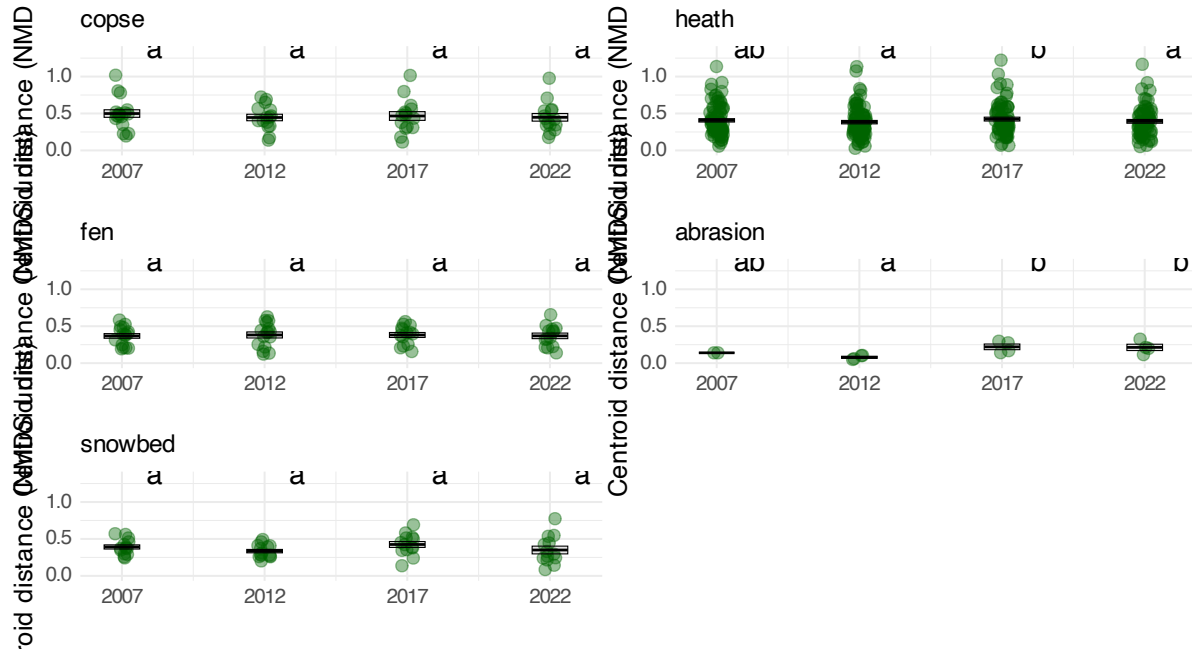
Within vegetation composition

Figure 16: Within community dynamics. Estimated mean centroids-subsection distances per community each survey year based on linear mixed-effects models. Black lines are estimated means ($\pm$ SE), and grey dots represent raw distances (NMDS units). Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level. (Figure 6)

Table 6: Estimated marginal means and compact letter display per vegetation type and survey year

veg_type	year	emmean	SE	lower.CL	upper.CL	group
abrasion	2007	0.116	0.046	-0.024	0.257	ab
abrasion	2012	0.079	0.033	-0.025	0.183	a
abrasion	2017	0.221	0.033	0.117	0.325	b
abrasion	2022	0.213	0.033	0.109	0.317	b
copse	2007	0.499	0.050	0.365	0.634	a
copse	2012	0.429	0.051	0.293	0.566	a
copse	2017	0.447	0.051	0.311	0.584	a
copse	2022	0.429	0.051	0.293	0.566	a
fen	2007	0.368	0.035	0.273	0.464	a

Table 6: Estimated marginal means and compact letter display per vegetation type and survey year

veg_type	year	emmean	SE	lower.CL	upper.CL	group
fen	2012	0.382	0.035	0.286	0.477	a
fen	2017	0.376	0.035	0.279	0.472	a
fen	2022	0.364	0.035	0.267	0.460	a
heath	2007	0.407	0.023	0.349	0.465	ab
heath	2012	0.387	0.023	0.329	0.446	a
heath	2017	0.420	0.023	0.361	0.479	b
heath	2022	0.382	0.023	0.323	0.442	a
snowbed	2007	0.391	0.036	0.296	0.487	a
snowbed	2012	0.335	0.036	0.239	0.430	a
snowbed	2017	0.424	0.037	0.327	0.522	a
snowbed	2022	0.345	0.037	0.247	0.443	a

3.3 Plant functional types

Functional groups

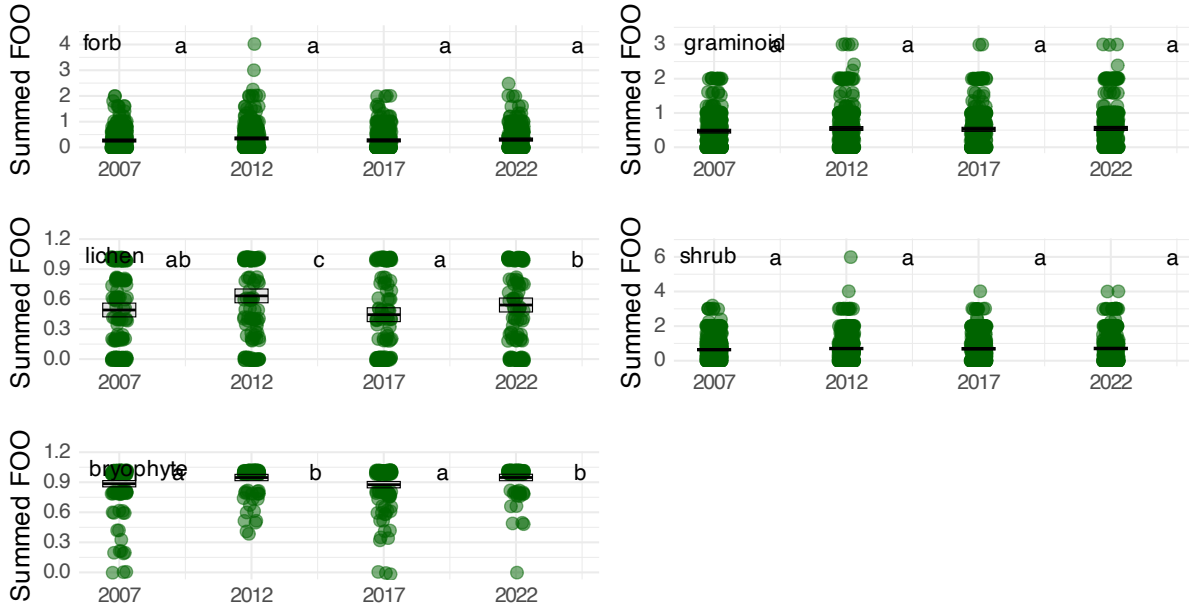


Figure 17: Plant functional group dynamics. Summed frequency of occurrence (FOO) for plant functional groups. Shared letters indicate non-significant differences among estimated marginal means according to a compact letter display based on Tukey-adjusted pairwise comparisons at the 5% significance level. (Figure 7)

Table 7: Estimated marginal means and compact letter display (based adjusted pairwise comparisons at the 5% significance level) per functional type and survey year

func_type	year	emmean	SE	df	lower.CL	upper.CL	group
bryophyte	2007	0.886	0.016	298.574	0.845	0.926	a
bryophyte	2012	0.947	0.016	300.019	0.907	0.987	b
bryophyte	2017	0.876	0.016	308.898	0.835	0.917	a
bryophyte	2022	0.948	0.016	320.224	0.907	0.989	b
forb	2007	0.268	0.029	456.607	0.196	0.341	a
forb	2012	0.351	0.028	422.755	0.279	0.422	a
forb	2017	0.272	0.030	491.535	0.197	0.347	a
forb	2022	0.306	0.030	493.655	0.231	0.382	a
graminoid	2007	0.469	0.028	907.475	0.400	0.539	a
graminoid	2012	0.547	0.028	929.536	0.476	0.618	a
graminoid	2017	0.523	0.030	1007.579	0.449	0.598	a

func_type	year	emmean	SE	df	lower.CL	upper.CL	group
graminoid	2022	0.549	0.030	958.333	0.475	0.624	a
lichen	2007	0.491	0.035	182.008	0.403	0.579	ab
lichen	2012	0.632	0.035	182.939	0.544	0.720	c
lichen	2017	0.444	0.035	186.170	0.356	0.532	a
lichen	2022	0.541	0.035	190.104	0.452	0.630	b
shrub	2007	0.639	0.032	1080.340	0.559	0.719	a
shrub	2012	0.703	0.033	1143.720	0.621	0.786	a
shrub	2017	0.691	0.035	1201.696	0.604	0.778	a
shrub	2022	0.707	0.035	1161.022	0.620	0.795	a

Individual species

A total of 97 species were analysed. 18 of them had any significant differences in means between survey years. Plots of the frequency of occurrence for these 18 species are rendered below.

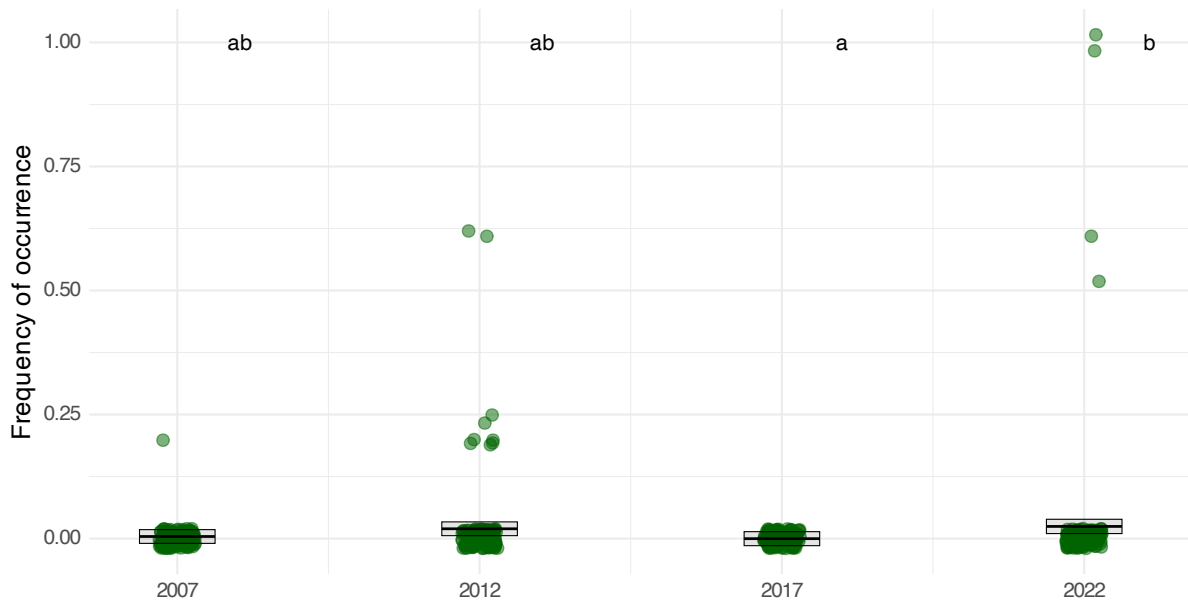


Figure 18: Frequency of occurrence for *Agrostis mertensii* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).



Figure 19: Frequency of occurrence for *Betula nana* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

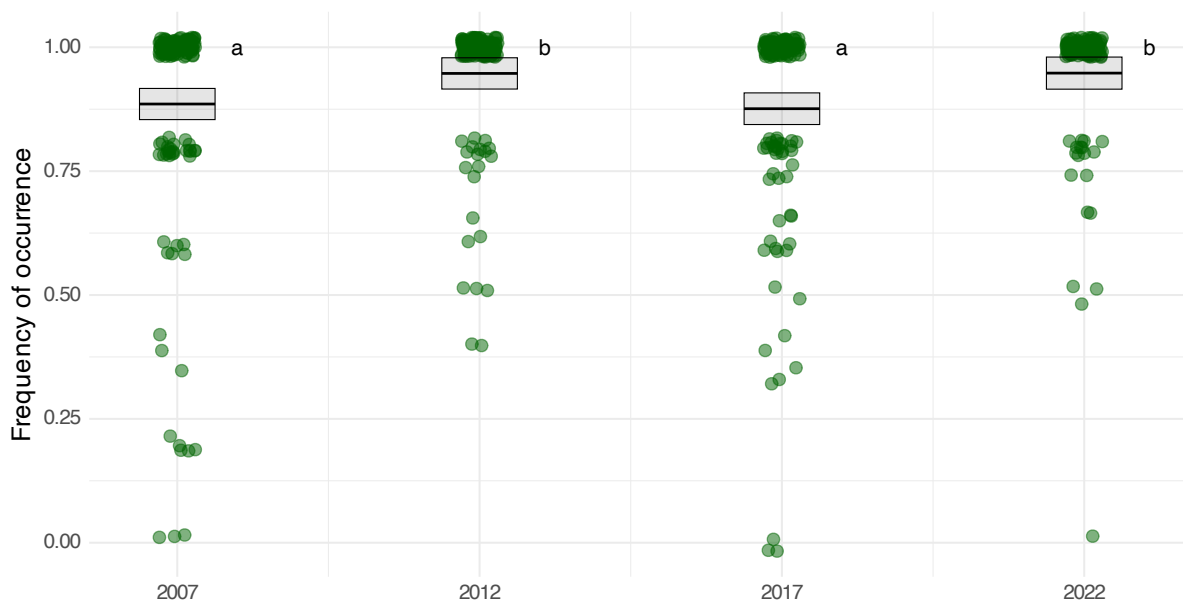


Figure 20: Frequency of occurrence for *Bryophyte* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

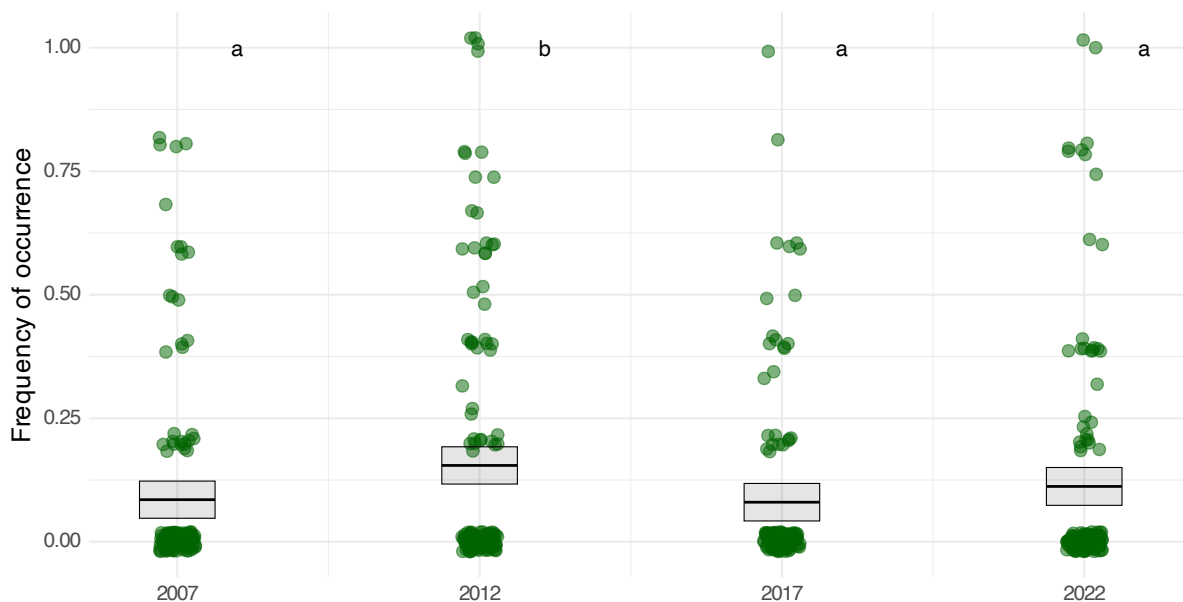
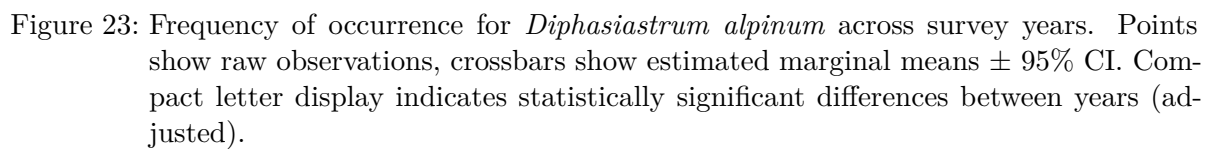


Figure 21: Frequency of occurrence for *Coptis trifolia* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).



Figure 22: Frequency of occurrence for *Deschampsia flexuosa* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).



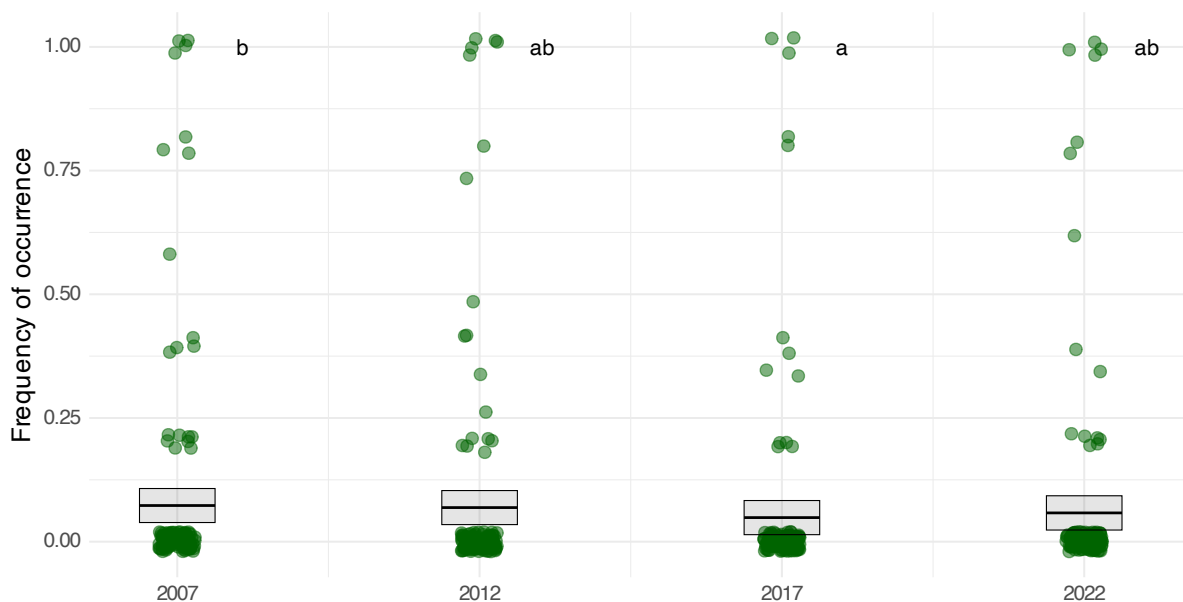


Figure 24: Frequency of occurrence for *Eriophorum angustifolium* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

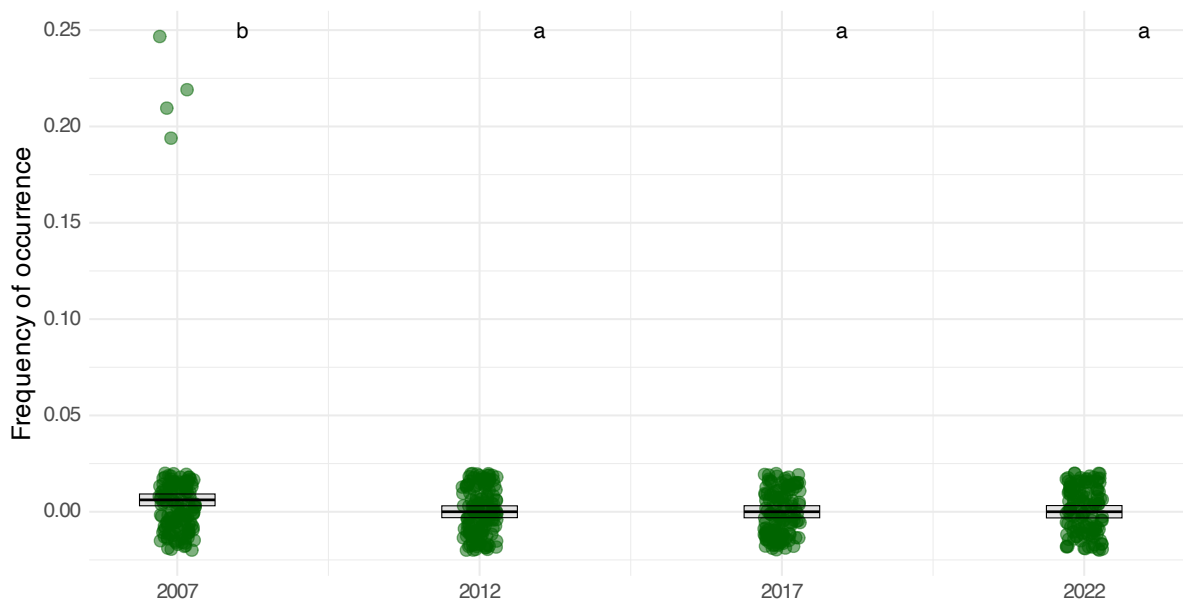


Figure 25: Frequency of occurrence for *Hieracium sp* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

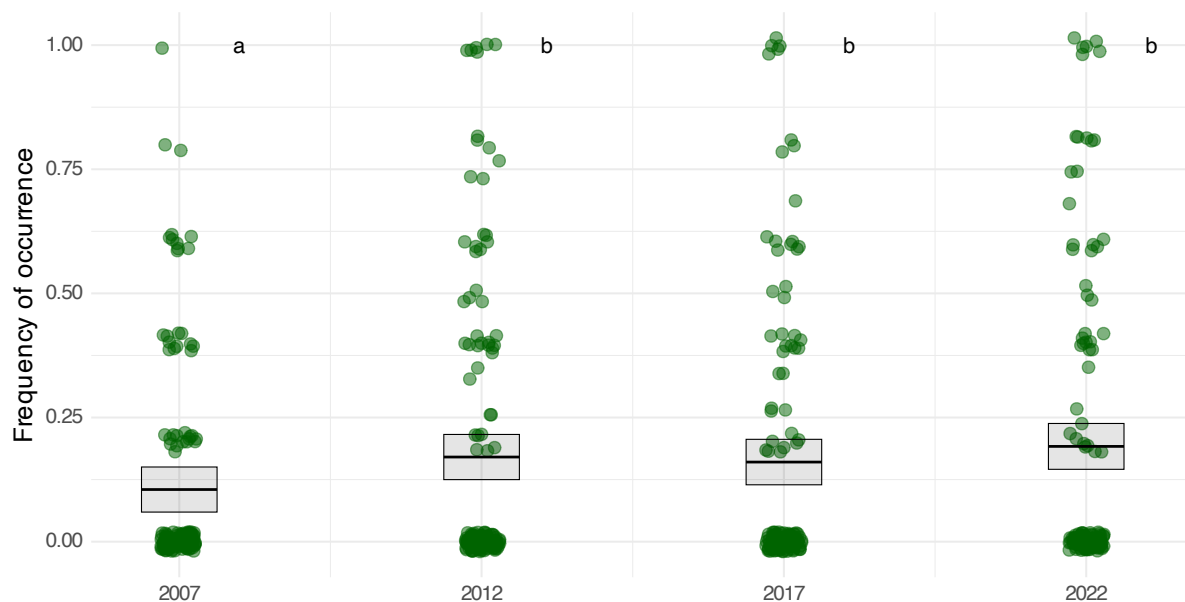


Figure 26: Frequency of occurrence for *Ledum groenlandicum* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

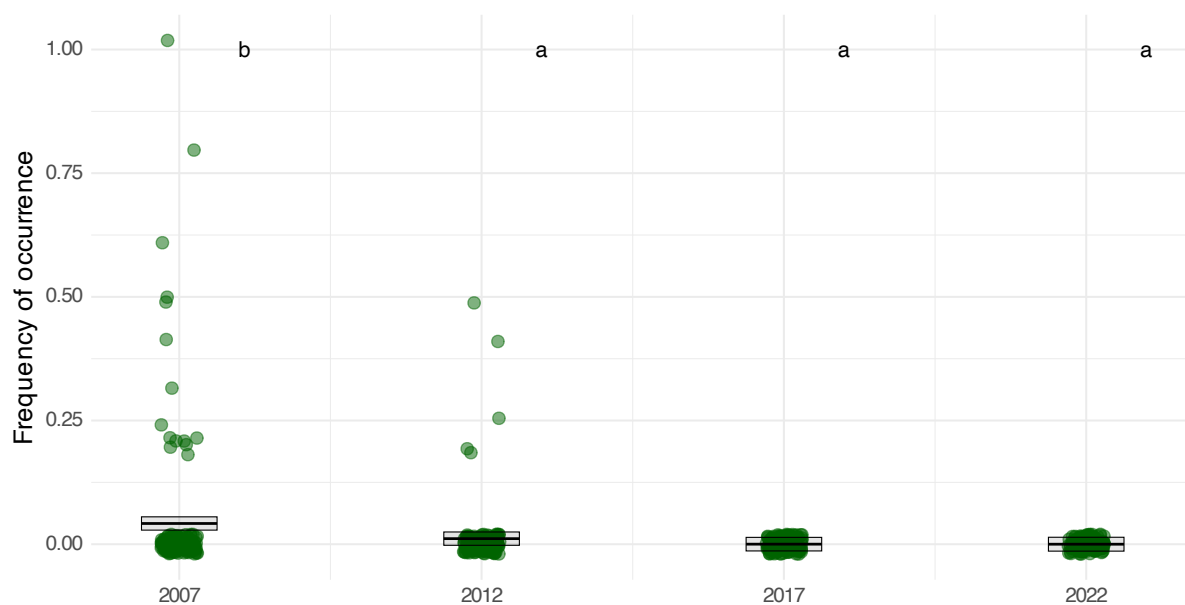


Figure 27: Frequency of occurrence for *Ledum palustre* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

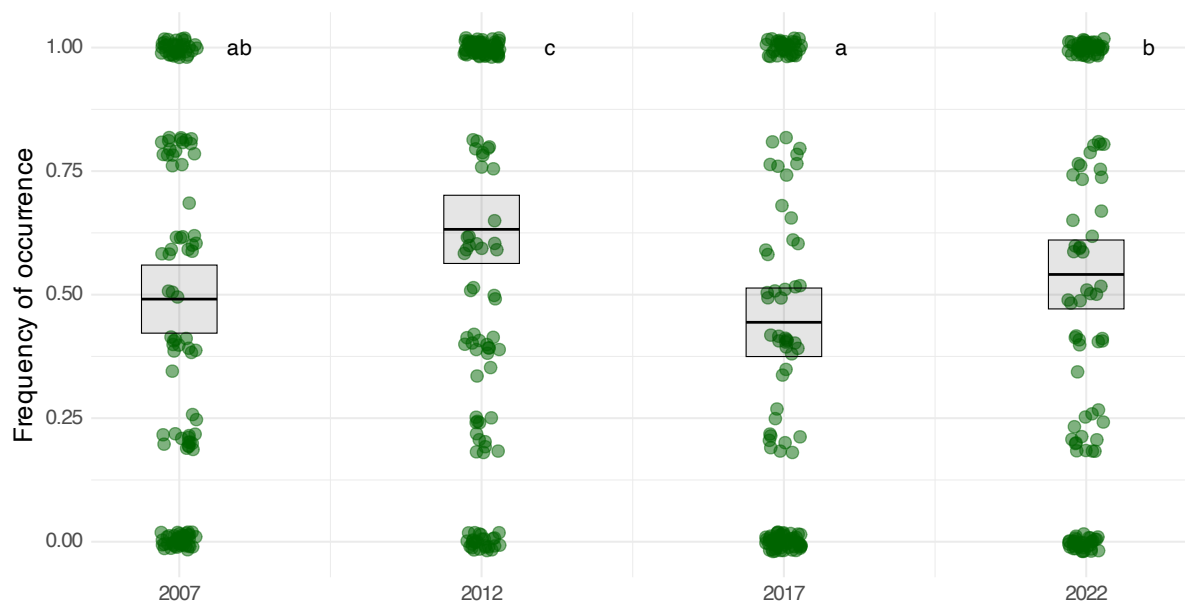


Figure 28: Frequency of occurrence for *Lichen* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

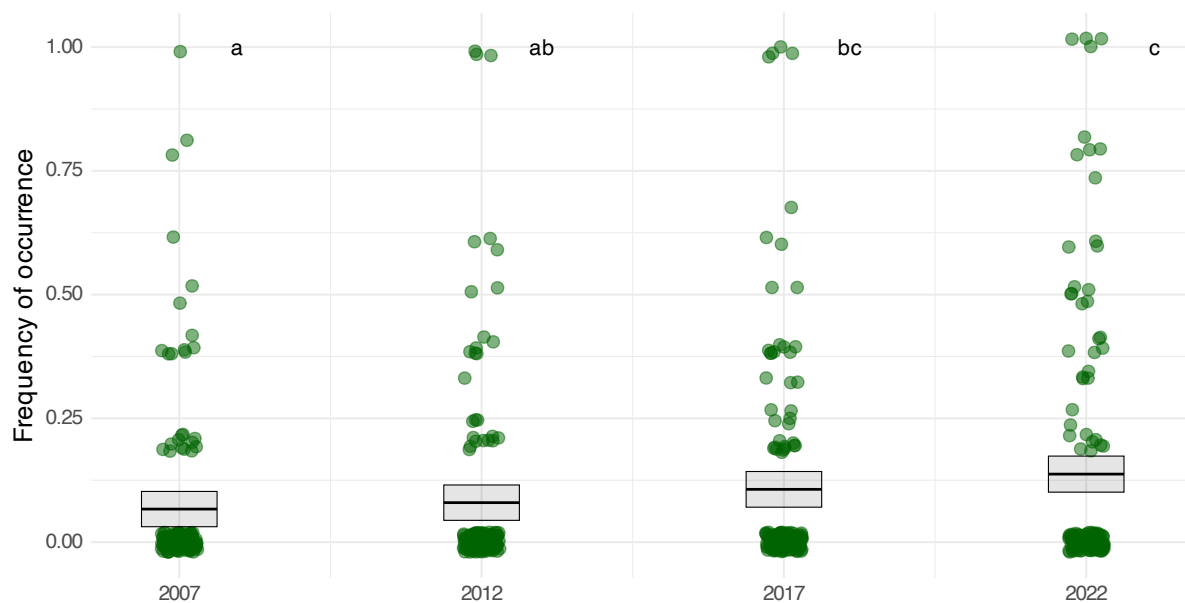


Figure 29: Frequency of occurrence for *Lycopodium annotinum* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

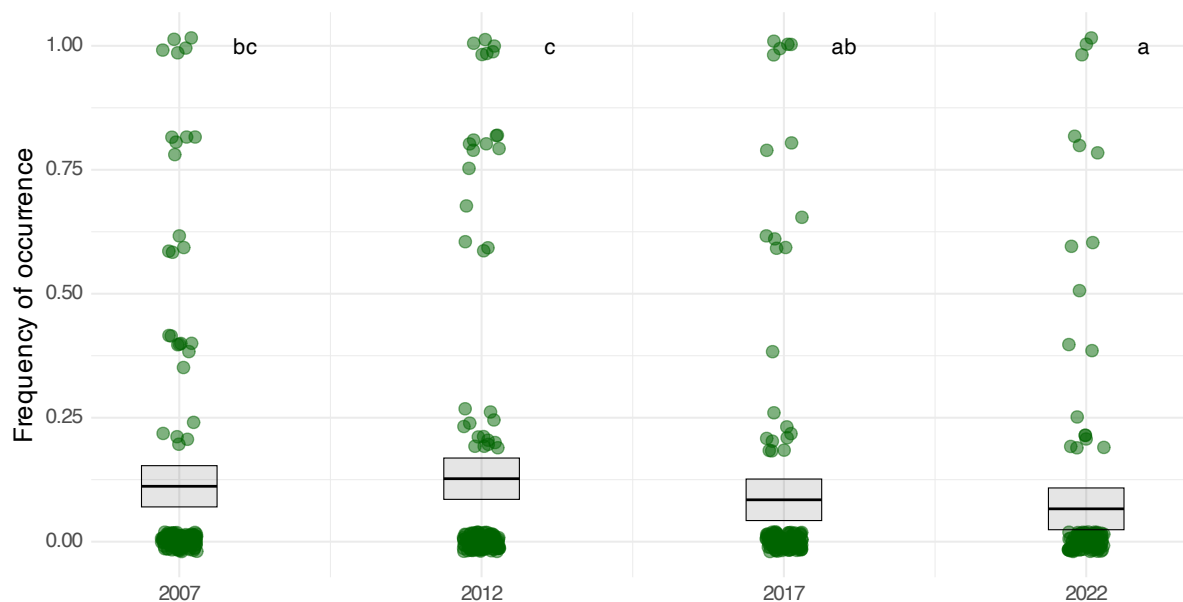


Figure 30: Frequency of occurrence for *Poa pratensis* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

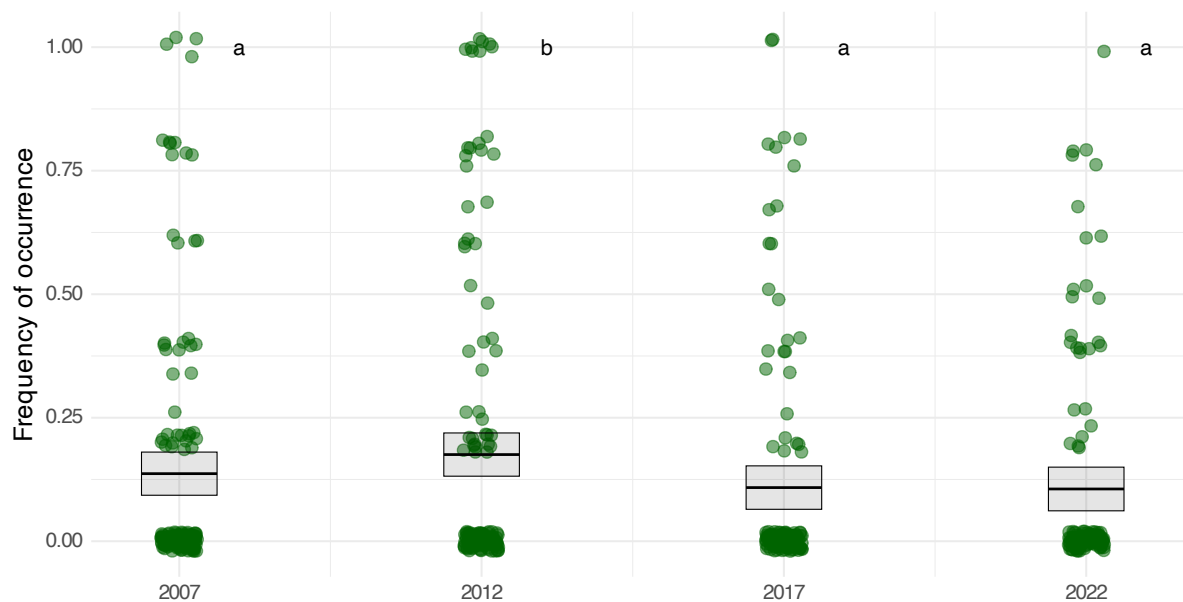


Figure 31: Frequency of occurrence for *Polygonum vivipara* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

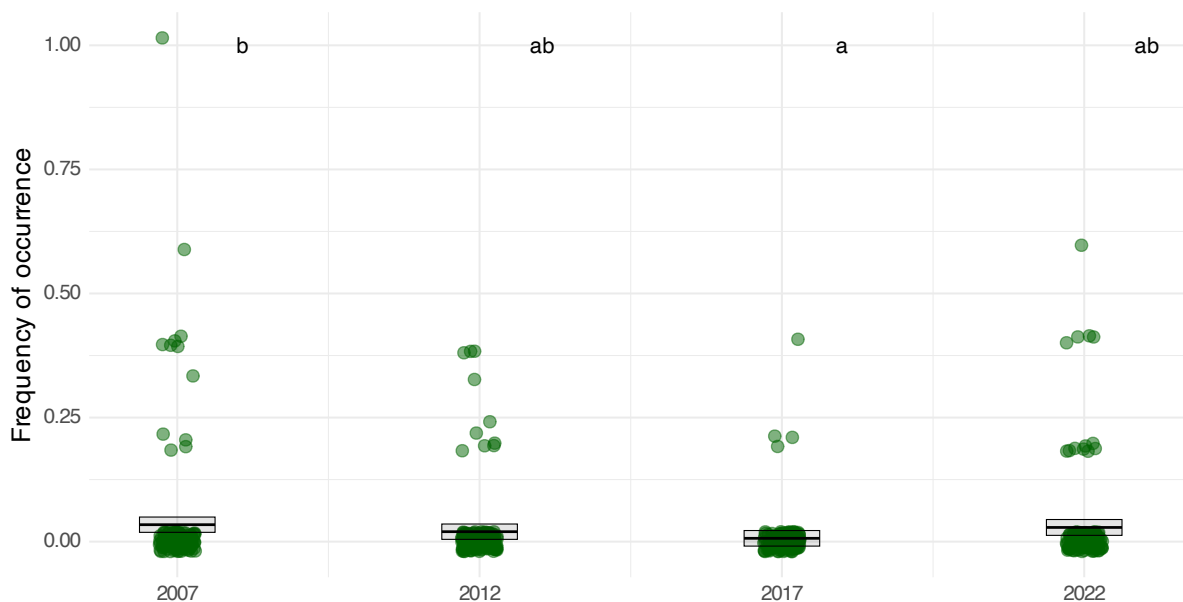


Figure 32: Frequency of occurrence for *Pyrola minor* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

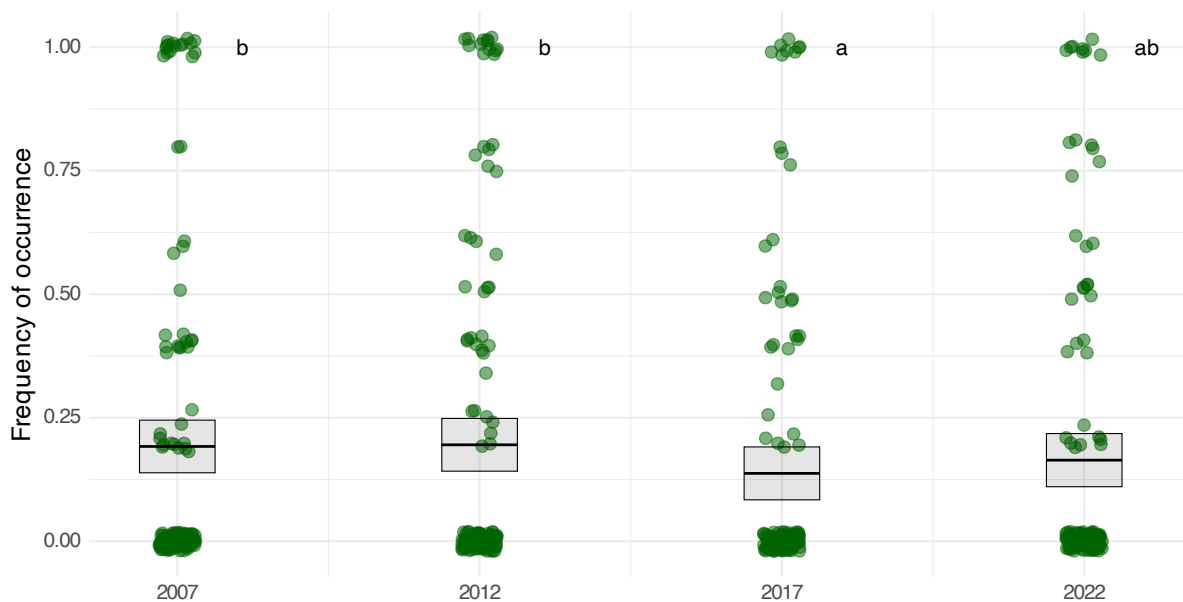


Figure 33: Frequency of occurrence for *Salix herbacea* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

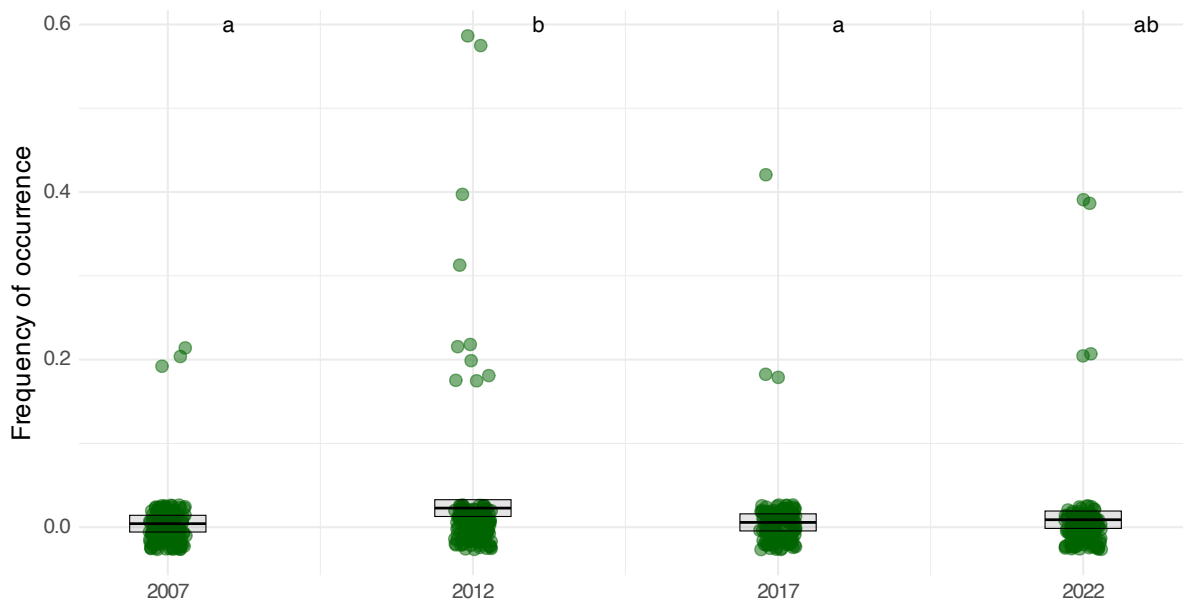


Figure 34: Frequency of occurrence for *Stellaria longipes* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).



Figure 35: Frequency of occurrence for *Vaccinium uliginosum* across survey years. Points show raw observations, crossbars show estimated marginal means $\pm$ 95% CI. Compact letter display indicates statistically significant differences between years (adjusted).

Table 8: Estimated marginal means and compact letter display for *Betula nana* per survey year

year	emmean	SE	lower.CL	upper.CL	group
2007	0.308	0.032	0.228	0.388	a
2012	0.324	0.032	0.244	0.405	ab
2017	0.325	0.032	0.244	0.406	ab
2022	0.356	0.032	0.275	0.437	b

4 Phenology (discussion)

4.1 NDVI

Data available from <https://data.g-e-m.dk> (GEM 2026b).

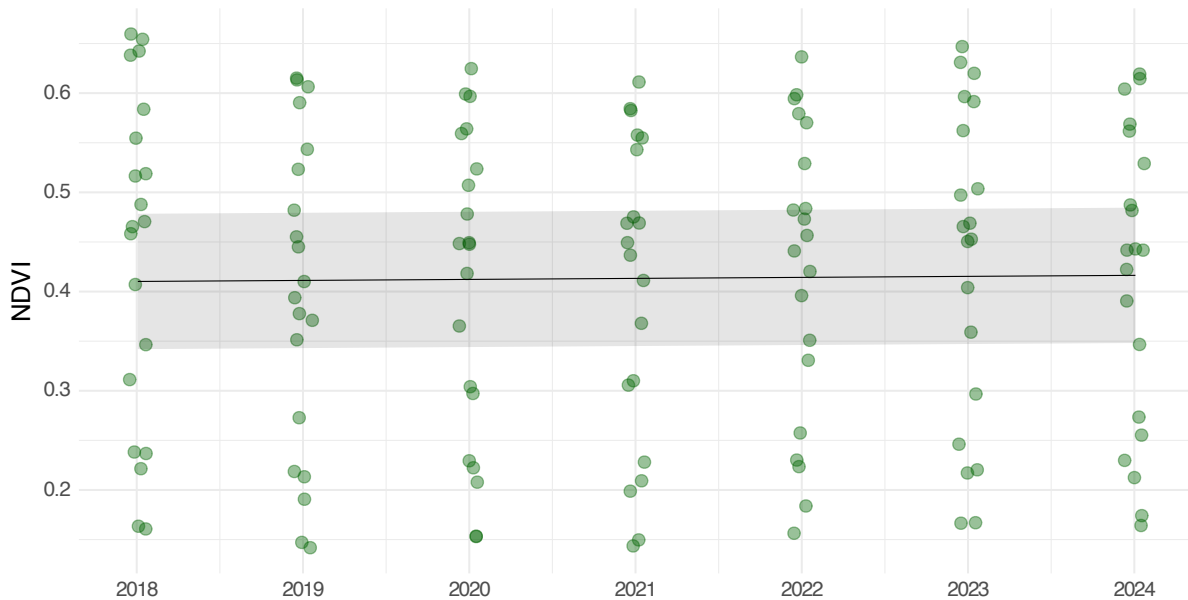


Figure 36: NDVI change over time. Mean NDVI per plot per year, based on in situ measurements from 2018 to 2024. The trend line shows a significant increase of 0.001 NDVI units per year (95% CI: $3\text{e-}04$ –0.0018), representing a cumulative increase of 0.0061 NDVI units over the study period.

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