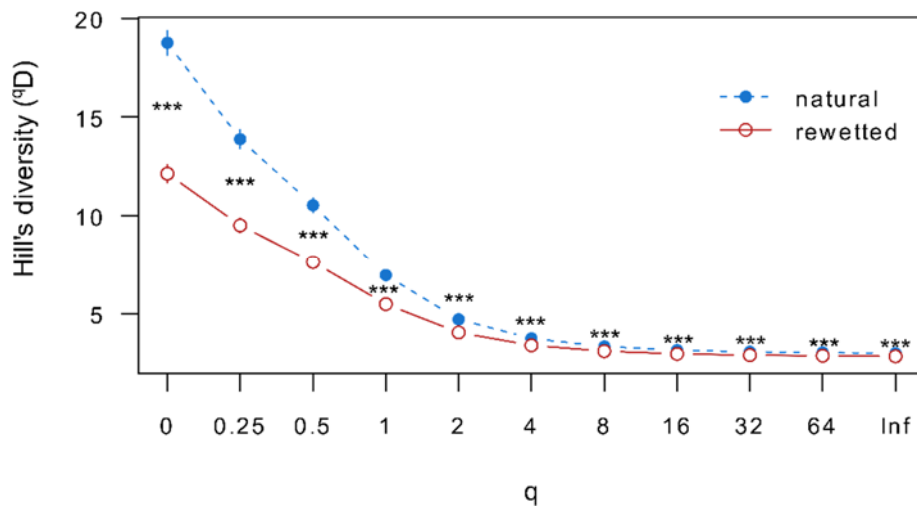


## **Supplementary Information file to**

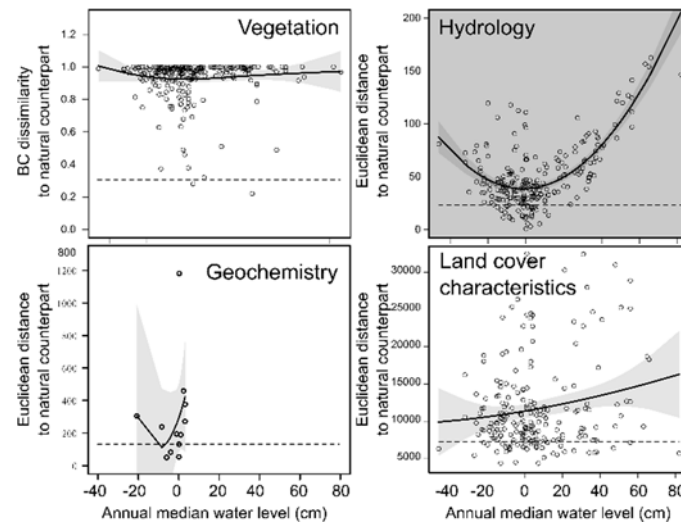
### **Rewetting does not return drained fen peatlands to their old selves**

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**Supplementary Figure 1 | Hill's diversity numbers<sup>1</sup> compared between 320 rewetted and 243 natural sites.** At  $q=1$  the species contribute with their true abundances to the mathematical result, below 1 rare species increase their influence on the result, above 1 the importance of common species increases. All pairwise comparisons between rewetted and near-natural were highly significant (\*\*\*:  $p < 0.001$ ) according to post-hoc tests (function 'emmeans' of the package 'emmeans' 1.5.1) of a two-sided mixed model ANOVA with  $qD$  as response parameter,  $q$  and the drainage status (rewetted vs. near-natural) as fixed effects and siteID as random effect to account for dependencies in the data. According to the Analysis of Variance of the mixed model, the two fixed effects and their interaction yielded significance ( $p < 0.001$ ). Hill's diversity was calculated with the function 'renyi' of the package 'vegan' 2.5-6 in R<sup>2</sup>



**Supplementary Figure 2 | Water table close to surface has little effect on the pairwise dissimilarity between rewetted sites and natural counterparts of similar origin.**

Dissimilarity in unitless Bray Curtis dissimilarity for the vegetation (0 = identical species composition, 1 = no shared species) and in Euclidean distance (0 to infinite) for the other response clusters between each rewetted site with a natural counterpart (same peatland origination, comparable altitude, same biogeographic zone, minimum spatial distance) against median annual water table of the rewetted sites. Black lines indicate a LOESS spline with span =1.4 (lowest span not leading to uninformative multiple local minima or maxima) and its 95% confidence interval shaded in grey. Horizontal dashed lines indicate the mean pairwise dissimilarity of semi-natural to semi-natural counterparts selected the same way as the semi-natural counterparts of the rewetted sites. Linear models indicate highly significant intercepts ( $p < 0.001$  for all four response clusters) and no significant slopes ( $p = 0.158$  and  $p = 0.159$ ) for vegetation and geochemistry. The results for hydrology are inconclusive and therefore shaded in grey as the mean annual water table (x-axis) is also part of the input variables used to derive the Euclidean distance (y-axis). A significant positive relationship for land cover characteristics ( $p = 0.004$ ) was detected by the linear model.

**Supplementary Table 1 | Relative frequency of 320 rewetted and 243 semi-natural fen peatlands attributable to EUNIS 2020 habitats<sup>3,4</sup>.** Sorted by decreasing absolute difference in the relative frequency between natural and rewetted peatlands. The higher relative frequency is set off in bold for all absolute differences larger than 5%. Chi<sup>2</sup> test:  $p < 0.0001$ . Note that some natural sites were classified into EUNIS habitats commonly not considered fens. We conservatively kept those in the analyses in order to avoid an artificial bias that would reduce variation among the natural sites.

| EUNIS 2020 | natural     | rewetted    | EUNIS 2020 habitat name                                                           |
|------------|-------------|-------------|-----------------------------------------------------------------------------------|
| Q51        | 6.2         | <b>30.5</b> | Tall-helophyte bed                                                                |
| Qb         | <b>25.5</b> | 5.6         | Wetlands                                                                          |
| Qa         | <b>7.5</b>  | 0.3         | Mires                                                                             |
| R          | 7.5         | <b>14.1</b> | Grasslands and lands dominated by forbs, mosses or lichens                        |
| R36        | 0.0         | 4.5         | Moist or wet mesotrophic to eutrophic pasture                                     |
| R37        | 4.2         | 0.0         | Temperate and boreal moist or wet oligotrophic grassland                          |
| C12b       | 0.0         | 4.0         | Rooted submerged vegetation of oligotrophic waterbodies                           |
| Q53        | 2.9         | 6.1         | Tall-sedge bed                                                                    |
| Q24        | 3.3         | 0.3         | Intermediate fen and soft-water spring mire                                       |
| Q42        | 2.6         | 0.0         | Extremely rich moss–sedge fen                                                     |
| C          | 0.0         | 2.4         | Inland surface waters                                                             |
| Q22        | 2.3         | 0.0         | Poor fen                                                                          |
| S92        | 3.3         | 1.1         | Salix fen scrub                                                                   |
| C35a       | 0.0         | 1.9         | Plankton communities of eutrophic standing waters                                 |
| Q52        | 1.6         | 3.2         | Small-helophyte bed                                                               |
| R35        | 4.9         | 6.4         | Moist or wet mesotrophic to eutrophic hay meadow                                  |
| Q41        | 1.0         | 0.0         | Alkaline, calcareous, carbonate-rich small-sedge spring fen                       |
| R21        | 0.0         | 0.8         | Mesic permanent pasture of lowlands and mountains                                 |
| T          | 0.0         | 0.8         | Forests and other wooded land                                                     |
| Q43        | 0.7         | 0.0         | Tall-sedge base-rich fen                                                          |
| T15        | 0.7         | 0.0         | Broadleaved swamp forest on non-acid peat                                         |
| R55        | 0.3         | 0.8         | Lowland moist or wet tall-herb and fern fringe                                    |
| T12        | 0.3         | 0.0         | <i>Alnus glutinosa</i> – <i>Alnus incana</i> forest on riparian and mineral soils |
| T16        | 0.3         | 0.0         | Broadleaved mire forest on acid peat                                              |
| H25        | 0.0         | 0.3         | Acid siliceous screes of warm exposures                                           |
| R22        | 0.7         | 0.5         | Low and medium altitude hay meadow                                                |

**Supplementary Table 2 |  $r^2$  for all significant ( $p < 0.05$ ) spectral-temporal metrics of the ordination in Figure 1.**

| Metric  | $r^2$ | Metric  | $r^2$ | Metric  | $r^2$ | Metric  | $r^2$ | Metric  | $r^2$ |
|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|
| MNW_AVG | 0.89  | TCW_AVG | 0.72  | MNW_STD | 0.58  | BLU_MAX | 0.30  | RED_SKW | 0.11  |
| MNW_Q75 | 0.88  | NDV_Q75 | 0.72  | TCW_MAX | 0.57  | NDV_IQR | 0.30  | RE3_SKW | 0.11  |
| MNW_Q50 | 0.87  | NDV_Q25 | 0.72  | NDV_RNG | 0.55  | RED_Q90 | 0.30  | BNR_SKW | 0.11  |
| NIR_Q75 | 0.86  | NDV_MAX | 0.71  | GRN_Q50 | 0.55  | BLU_MIN | 0.29  | RE2_SKW | 0.10  |
| NIR_AVG | 0.86  | MNW_Q10 | 0.71  | TCG_RNG | 0.54  | GRN_Q90 | 0.29  | GRN_IQR | 0.10  |
| TCB_Q50 | 0.83  | TCW_Q75 | 0.71  | SW2_Q90 | 0.54  | NIR_STD | 0.29  | BLU_IQR | 0.10  |
| MNW_MAX | 0.83  | TCB_Q10 | 0.70  | NDV_Q50 | 0.53  | SW1_RNG | 0.28  | NDB_IQR | 0.09  |
| BNR_AVG | 0.83  | TCB_MAX | 0.70  | SW2_MAX | 0.51  | TCB_IQR | 0.27  | NDB_SKW | 0.09  |
| BNR_Q75 | 0.83  | NDV_Q90 | 0.70  | GRN_AVG | 0.51  | BLU_RNG | 0.27  | RE1_IQR | 0.08  |
| NIR_Q90 | 0.83  | TCW_Q50 | 0.70  | GRN_MIN | 0.50  | SW1_STD | 0.27  | SW1_KRT | 0.08  |
| MNW_Q90 | 0.83  | BNR_Q25 | 0.69  | MNW_IQR | 0.49  | TCG_IQR | 0.27  | RED_KRT | 0.07  |
| TCG_AVG | 0.82  | NIR_Q10 | 0.69  | NDV_STD | 0.46  | BNR_STD | 0.27  | RE1_SKW | 0.05  |
| TCB_Q75 | 0.82  | SW2_Q10 | 0.69  | RE1_Q75 | 0.43  | SW1_IQR | 0.26  | NDB_Q90 | 0.05  |
| NDV_MIN | 0.82  | SW1_Q10 | 0.68  | TCG_STD | 0.42  | RED_STD | 0.25  | NDB_MAX | 0.04  |
| RE3_AVG | 0.82  | RE3_Q25 | 0.68  | NDB_MIN | 0.41  | RE3_STD | 0.25  | RE3_KRT | 0.04  |
| MNW_Q25 | 0.82  | SW1_Q90 | 0.68  | TCW_RNG | 0.41  | NDB_AVG | 0.24  | TCB_KRT | 0.04  |
| RE3_Q75 | 0.82  | RE2_Q25 | 0.68  | TCB_RNG | 0.40  | GRN_STD | 0.23  | TCG_KRT | 0.04  |
| TCG_Q75 | 0.81  | RE1_Q10 | 0.67  | RED_AVG | 0.39  | BLU_Q75 | 0.23  | RE2_KRT | 0.03  |
| TCB_AVG | 0.81  | TCW_Q25 | 0.67  | RE1_MAX | 0.39  | RE2_STD | 0.23  | NIR_KRT | 0.03  |
| NIR_MAX | 0.81  | MNW_MIN | 0.67  | BLU_Q25 | 0.39  | NDB_Q50 | 0.22  | BNR_KRT | 0.03  |
| NDV_Q10 | 0.80  | BNR_Q10 | 0.67  | BLU_Q10 | 0.38  | BLU_STD | 0.21  | NDV_KRT | 0.03  |
| SW1_Q50 | 0.80  | RE1_Q25 | 0.66  | TCW_STD | 0.38  | SW2_RNG | 0.21  | TCG_SKW | 0.02  |
| NIR_Q50 | 0.80  | TCW_Q90 | 0.66  | RED_Q25 | 0.38  | BLU_Q90 | 0.20  | NDV_SKW | 0.02  |
| RE2_Q75 | 0.80  | TCG_Q50 | 0.66  | GRN_Q75 | 0.37  | RE1_STD | 0.20  | NDB_KRT | 0.00  |
| RE2_AVG | 0.80  | RE3_Q10 | 0.65  | TCB_STD | 0.37  | NDB_STD | 0.20  |         |       |
| NDV_AVG | 0.80  | SW2_Q75 | 0.65  | NIR_RNG | 0.37  | RED_IQR | 0.19  |         |       |
| SW1_AVG | 0.79  | SW1_MAX | 0.65  | RED_Q50 | 0.37  | SW2_STD | 0.18  |         |       |
| BNR_Q90 | 0.79  | NIR_MIN | 0.64  | GRN_MAX | 0.37  | SW2_IQR | 0.18  |         |       |
| TCG_MAX | 0.79  | RE2_Q10 | 0.64  | RED_MAX | 0.36  | SW1_SKW | 0.18  |         |       |
| TCG_Q90 | 0.79  | TCB_MIN | 0.64  | BNR_RNG | 0.35  | SW2_SKW | 0.18  |         |       |
| BNR_MAX | 0.77  | BNR_MIN | 0.62  | RED_MIN | 0.35  | NIR_IQR | 0.17  |         |       |
| RE3_Q90 | 0.77  | MNW_RNG | 0.62  | RE1_Q90 | 0.35  | GRN_KRT | 0.16  |         |       |
| BNR_Q50 | 0.76  | RE1_Q50 | 0.61  | BLU_Q50 | 0.35  | BNR_IQR | 0.15  |         |       |
| SW1_Q75 | 0.76  | SW2_MIN | 0.61  | NDB_Q25 | 0.35  | NIR_SKW | 0.14  |         |       |
| RE3_MAX | 0.75  | TCW_Q10 | 0.61  | BLU_AVG | 0.35  | SW2_KRT | 0.14  |         |       |
| RE2_Q90 | 0.75  | RE3_MIN | 0.61  | RE3_RNG | 0.34  | RE3_IQR | 0.14  |         |       |
| TCB_Q90 | 0.75  | SW1_MIN | 0.60  | TCW_IQR | 0.33  | RE1_KRT | 0.14  |         |       |
| TCB_Q25 | 0.74  | TCG_Q10 | 0.60  | NDB_Q10 | 0.33  | TCB_SKW | 0.13  |         |       |
| SW1_Q25 | 0.74  | RE2_MIN | 0.60  | RED_RNG | 0.33  | BLU_KRT | 0.13  |         |       |
| RE3_Q50 | 0.74  | GRN_Q10 | 0.59  | RED_Q75 | 0.32  | TCW_SKW | 0.12  |         |       |
| RE2_MAX | 0.73  | TCG_Q25 | 0.59  | NDB_RNG | 0.32  | GRN_SKW | 0.12  |         |       |
| SW2_Q25 | 0.73  | RE1_MIN | 0.59  | GRN_RNG | 0.32  | MNW_KRT | 0.12  |         |       |
| RE2_Q50 | 0.73  | TCG_MIN | 0.58  | RE2_RNG | 0.31  | BLU_SKW | 0.12  |         |       |
| SW2_AVG | 0.73  | TCW_MIN | 0.58  | RE1_RNG | 0.30  | NDB_Q75 | 0.12  |         |       |
| SW2_Q50 | 0.73  | RE1_AVG | 0.58  | RED_Q10 | 0.30  | RE2_IQR | 0.11  |         |       |
| NIR_Q25 | 0.72  | GRN_Q25 | 0.58  | MNW_SKW | 0.30  | TCW_KRT | 0.11  |         |       |

Sentinel-2 reflectance bands: BLU – blue (0.492  $\mu\text{m}$ ), GRN – green (0.559  $\mu\text{m}$ ), RED – red (0.665  $\mu\text{m}$ ), RE1 – red edge 1 (0.704  $\mu\text{m}$ ), RE2 – red edge 2 (0.740  $\mu\text{m}$ ), RE3 – red edge 3 (0.783  $\mu\text{m}$ ), NIR – near infrared (0.833  $\mu\text{m}$ ), BNR – broad near infrared (0.864  $\mu\text{m}$ ), SW1 – short wave infrared 1 (1.61  $\mu\text{m}$ ), SW2 – short wave infrared 2 (2.19  $\mu\text{m}$ ); spectral indices: MNW – modified normalized difference water index<sup>5</sup>, NDV – Normalized difference vegetation index<sup>6</sup>, NBR – normalized burn ratio<sup>7</sup>, TCB/TCG/TCW – tasseled cap brightness/greenness/wetness<sup>8</sup>; metrics: AVG – average, STD – standard deviation, SKW – skewness, KRT – kurtosis, MIN – minimum, MAX – maximum, RNG – range, Q10/25/50/75/90 – percentiles (10, 25, 50, 75, 90), IQR – inter-quartile range.

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