

Appendix S2 Estimation of abiotic species indicator values and environmental characteristics of Dutch habitat types

We considered soil and (micro) climatic factors, applying approaches of species indicator values. For soil factors, indicator-values were taken from an on-line database providing for each species response curves calculated directly from soil measurements in an independent set of plots (Wamelink *et al.*, 2005; 2011; 2012). This database is registered in the Global Index of Vegetation-Plot Databases (ID: EU-00-006) and aggregated data at the level of species, associations and vegetation classes are freely available at: www.abiotic.wur.nl. We used indicator-values based on measurements for: mean spring ground water level (further in the text: 'ground water level'), soil reaction (soil pH), and soil fertility as total phosphorus (phosphorus limits many vegetation types more than nitrogen, in particular in less productive habitats [Olf & Pegtel, 1994; Wassen *et al.*, 2005]). Specifically, we compiled vegetation plots, for which field measurements were available, into a database used to estimate species indicator values for soil factors. The database with measurements of ground water level, soil pH, and total phosphorus consists of 1000, 5190, and 849 plots, respectively. Response functions for species for the three soil variables were estimated using splines (Wamelink *et al.*, 2005; 2012; www.abiotic.wur.nl). For each species the mean of a response to abiotic variables was estimated. The means were subsequently used to estimate the abiotic conditions for a calibration set of 160,000 plots. We appointed the so estimated abiotic conditions to each species in the plot and used these values to re-estimate the species response. Based on the re-estimated responses a new mean and percentiles of the species were calculated (Wamelink *et al.*, 2011). We validated the indicator values for a regional independent dataset of 547 plots (Wamelink *et al.*, 2010). Based on the species in the plots, we estimated the soil pH and total phosphorus content of the soil and compared these indicator values with the measured values. Both relations were highly significant ($p < 0.001$) with explained variance of 0.69 for pH and 0.43 for phosphorus.

For (micro) climatic environmental factors (light and temperature) we used the indicator values of Ellenberg (Ellenberg *et al.*, 1992). For these factors no direct measurements at the habitat scale were available for most species. We note, however, that Ellenberg values are deduced from hundreds of studies with direct measurements, and community-means calculated across Ellenberg values have proven to be strongly correlated to direct measurements of the same local communities (Hill & Carey, 1997; Ertsen *et al.*, 1998; Diekmann, 2003; Ozinga *et al.*, 2004; Smart *et al.*, 2010).

For each habitat type, we calculated means of Ellenberg and Wamelink indicator values within each of 36,328 vegetation plots distributed across The Netherlands and averaged these means within habitat types (for details, see Bartish *et al.*, 2010). The mean values and their standard deviations across all plots in each habitat type are reported in Table S2.

Table S2 Environmental characteristics of Dutch habitat types: Means (and SDs) of light and temperature, ground water level, soil pH, and soil phosphorus of each of 43 habitat types calculated across 36,328 local plots, each local plot being characterized as the mean of the indicator values of its incumbent species. Area size Values outside of the 5–95 percentiles range calculated across all local plots of all habitats are underlined and extreme habitat types for each environmental factor are in bold. Numbers are referred to Fig. 1 in the body of the manuscript.

Habitat type	Light	Temperature	Ground Water Level (cm)	Soil pH	Phosphorus (mg/kg)
01 Free floating duckweeds	7.04 (0.28)	5.87 (0.45)	-10.37 (8.33)	8.09 (0.60)	<u>303.75</u> <u>(17.96)</u>
02 Submerged communities in brackish waters	6.41 (0.74)	5.92 (0.20)	-11.20 (10.82)	<u>9.36 (1.15)</u>	<u>289.30</u> <u>(63.11)</u>
03 Sublittoral and eulittoral zones of temperate seas	7.19 (0.29)	5.86 (0.22)	<u>3.27</u> ¹⁾	<u>9.71 (0.10)</u>	133.03 (41.87)
04 Submerged stonewort swards	6.81 (0.70)	5.71 (0.35)	-9.71 (8.33)	7.82 (1.03)	282.04 (45.56)
05 Floating or submerged rooted plants in fresh waters	6.87 (0.45)	5.81 (0.31)	-12.40 (8.71)	8.08 (0.68)	<u>302.62</u> <u>(28.40)</u>
06 Soakways and shallow, fluctuating standing waters	7.31 (0.34)	5.54 (0.31)	-18.63 (14.33)	5.78 (0.64)	185.00 (37.80)
07 Spring vegetation of weakly basic waters	6.08 (0.89)	5.15 (0.30)	-45.15 (21.20)	5.68 (0.50)	237.36 (28.15)
08 Swamps and fens	7.18 (0.32)	5.62 (0.29)	-16.75 (9.59)	6.45 (0.64)	258.88 (31.89)
09 Small sedges on wet to moist soils	7.26 (0.36)	5.30 (0.26)	-25.08	5.43 (0.55)	167.96

				(10.45)		(34.47)
10	Mires developing on mesotrophic peats	7.73 (0.55)	5.19 (0.57)	-33.95 (14.62)	4.72 (0.65)	147.93 (46.78)
11	Bog vegetation of deep, wet peats	7.53 (0.35)	4.96 (0.34)	-33.95 (10.66)	4.26 (0.49)	96.94 (24.12)
12	Strongly trampled vegetation in moist places	7.27 (0.28)	5.70 (0.30)	-40.28 (11.00)	6.58 (0.28)	169.43 (30.15)
13	Stonecrop communities of weathered calcareous rocks	7.41 (0.30)	5.73 (0.22)	-62.80 (3.19)	6.80 (0.17)	76.47 (19.68)
14	Swards on sandy soils	7.51 (0.40)	5.76 (0.26)	-65.89 (7.38)	6.06 (0.64)	64.85 (18.59)
15	Chalk grasslands	7.15 (0.14)	5.44 (0.15)	-54.78 (3.04)	6.79 (0.14)	79.27 (9.51)
16	Meadows and pastures of well-drained soils	7.02 (0.22)	5.39 (0.27)	-39.10 (12.08)	6.10 (0.43)	165.91 (33.54)
17	Fringe communities	6.83 (0.26)	5.48 (0.18)	-63.17 (7.44)	6.36 (0.27)	111.61 (17.81)
18	Woodland margin and ride vegetation in drier situations	6.11 (0.51)	5.39 (0.15)	-70.61 (10.21)	4.60 (0.60)	118.85 (20.52)
19	Unfertilized mat-grass pastures at lower elevations	7.08 (0.30)	5.29 (0.32)	-52.81 (13.81)	4.67 (0.67)	83.08 (17.06)
20	Heathlands	7.21 (0.37)	5.46 (0.36)	-57.36 (11.55)	4.50 (0.72)	68.25 (15.44)
21	Communities of crevices of sunny wells	6.43 (0.79)	6.02 (0.65)	-60.88 (11.37)	6.01 (0.43)	138.63 (27.63)
22	Salt-marsh and strandlines sometimes mixed with sand	8.25 (0.42)	5.98 (0.20)	-48.29 (7.25)	7.56 (0.44)	106.93 (25.33)
23	Pioneer vegetation of coastal foredunes	8.26 (0.49)	5.75 (0.37)	-59.21 (7.35)	6.93 (0.52)	67.78 (15.74)
24	Perennial cord grasses on intertidal mud and sand	7.98 (0.51)	5.58 (0.31)	-29.70 (12.35)	8.64 (1.29)	137.53 (34.17)
25	Annual succulent halophytes, periodically flooded	8.29 (0.28)	5.90 (0.14)	-25.08 (4.70)	9.06 (0.37)	128.46 (9.69)
26	Inundated and inland salt marsh ephemerals	8.07 (0.31)	5.98 (0.15)	-26.86 (6.56)	8.37 (0.68)	131.62 (13.91)
27	Ephemerals on bare or disturbed salt-	7.88 (0.28)	5.93 (0.25)	-35.03	7.10 (0.42)	108.89

	marsh mud and sand			(9.60)		(22.28)
28	Therophytes on bare, periodically flooded ground	7.21 (0.31)	5.60 (0.26)	-35.25 (11.87)	6.10 (0.39)	145.54 (33.14)
29	Heavily nutrient-loaded ruderal habitats	7.37 (0.35)	5.78 (0.21)	-30.18 (11.82)	6.81 (0.37)	203.47 (33.41)
30	Arable weed communities	6.73 (0.16)	5.79 (0.16)	-66.04 (5.03)	7.01 (0.21)	117.88 (15.37)
31	Xero-mesophilous ruderals on nutrient-rich soils	7.30 (0.28)	5.85 (0.25)	-62.47 (7.78)	6.65 (0.30)	126.56 (25.98)
32	Tall-herb vegetation on moist fertile soils and peats	7.04 (0.26)	5.49 (0.21)	-34.58 (9.85)	6.01 (0.31)	215.65 (25.77)
33	Sunny and semi-shaded margins and clearings of woods	6.46 (0.59)	5.56 (0.23)	-69.56 (11.73)	5.96 (0.35)	177.82 (29.76)
34	Herbaceous forest-clearing communities on poor soils	6.74 (0.47)	5.50 (0.22)	-68.18 (8.47)	4.86 (0.49)	113.65 (22.24)
35	Bramble underscrub of woodland edges and clearings	6.23 (0.54)	5.45 (0.32)	-75.69 (8.38)	4.50 (0.49)	121.56 (25.17)
36	Willow scrub and woodland of mires	6.79 (0.38)	5.42 (0.21)	-33.96 (11.54)	5.28 (0.48)	191.41 (35.79)
37	Hedges and scrub of mesotrophic, base-rich soils	6.63 (0.66)	5.51 (0.17)	-72.79 (9.52)	5.88 (0.44)	136.25 (42.60)
38	Woodland of river shoals and terraces	6.66 (0.41)	5.54 (0.22)	-46.00 (11.89)	6.00 (0.38)	221.08 (31.16)
39	Woodlands of swamps, fens and wet pastures	6.32 (0.33)	5.44 (0.14)	-41.04 (11.66)	5.12 (0.29)	214.03 (20.25)
40	Birch-dominated swampy woodlands	6.60 (0.45)	5.46 (0.31)	-51.64 (13.77)	4.42 (0.45)	142.12 (38.41)
41	Pine and juniper woodland communities of acid soils	6.27 (0.51)	5.59 (0.48)	-77.62 (7.42)	3.95 (0.35)	96.42 (15.75)
42	Acidophilous oak, birch, or beech forests	5.73 (0.63)	5.54 (0.31)	-82.13 (7.06)	3.93 (0.27)	112.28 (18.34)
43	Broadleaved woodlands on lime-rich and neutral mull soils	5.28 (0.68)	5.35 (0.15)	-79.71 (11.77)	5.04 (0.38)	204.81 (23.12)

¹⁾Local plots contained only a single species with an indicator value, rendering calculation of within-plot means and across plot-means and SDs obsolete. Instead we give the mean of the two species with indicator values found in this habitat type.