Supplementary Materials

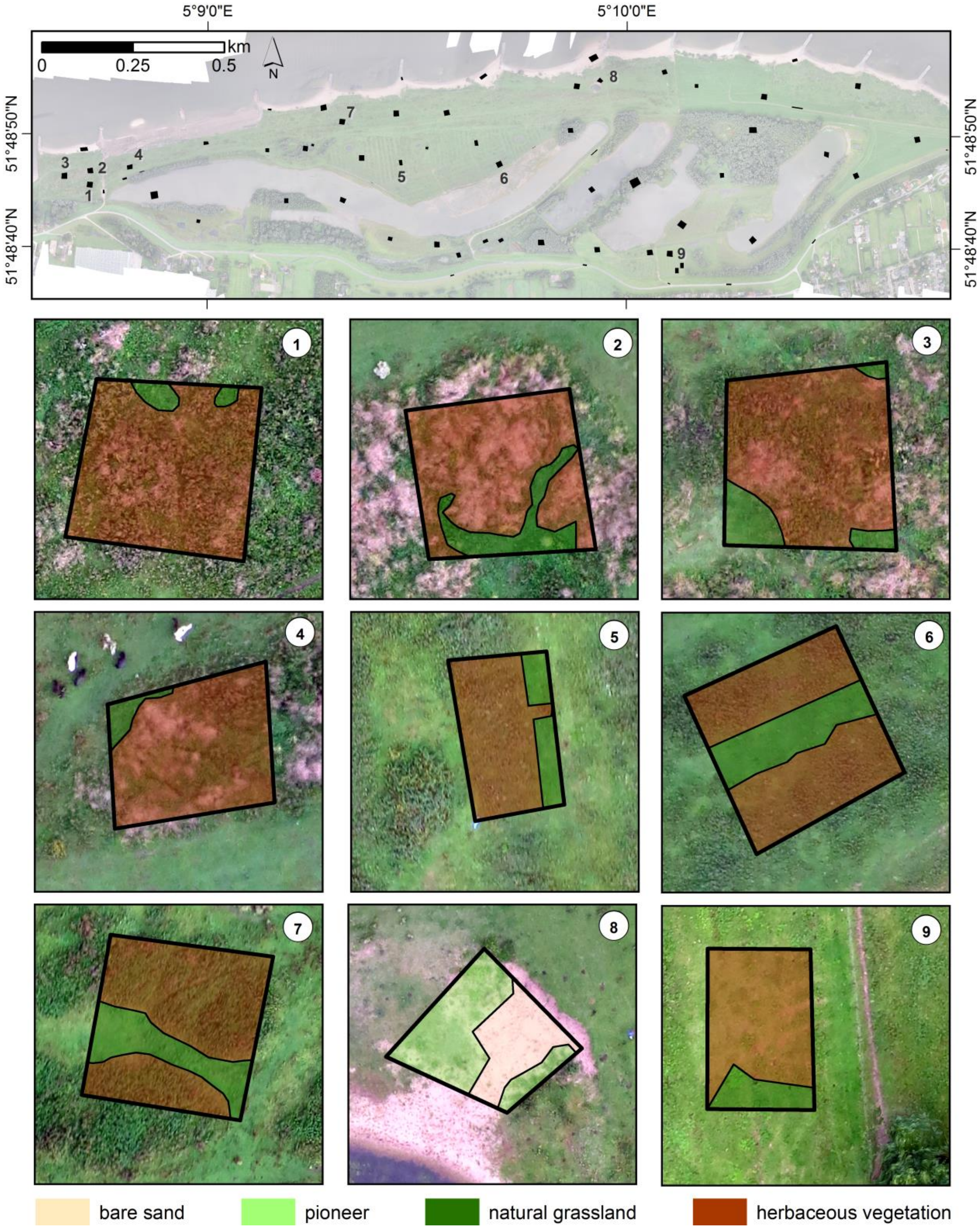

Figure S1. The nine field plots containing a mixture of two vegetation types. The top figure shows the location of these mixed plots. Field sketches of the plots at the end of the growing season in September were used to assign classes to different homogeneous parts (referred to as polygons) within the plots.

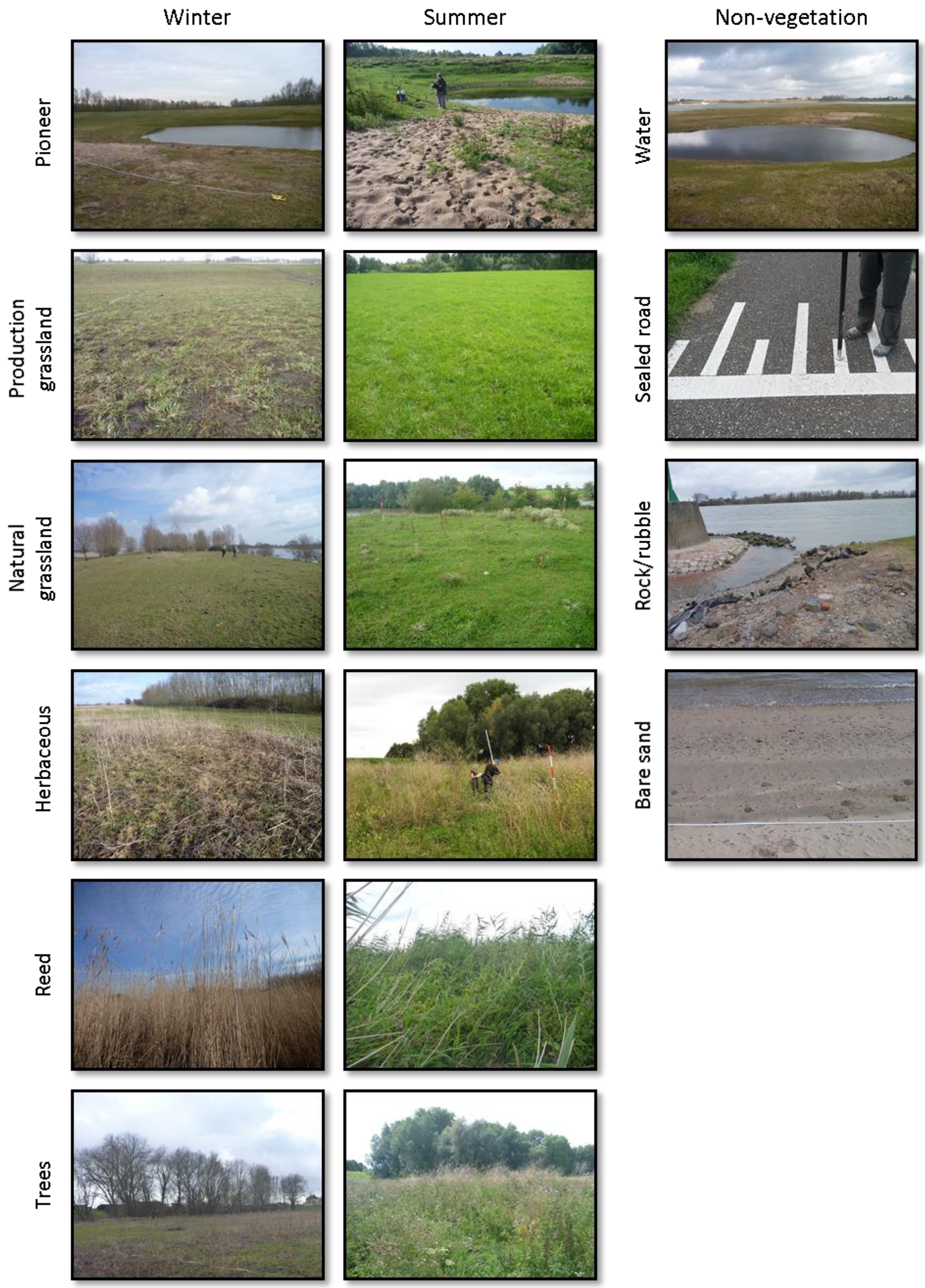

Figure S2. Field impressions of the vegetation types in the Breemwaard study area. For the vegetation classes, photos taken during the field surveys in February (winter) and September (summer) show the change in greenness and vegetation height over these seasons. For the non-vegetation classes water, sealed road, rock/rubble and bare sand we provided only single images, because they are assumed to remain stable regarding height and spectral properties over a growing season.

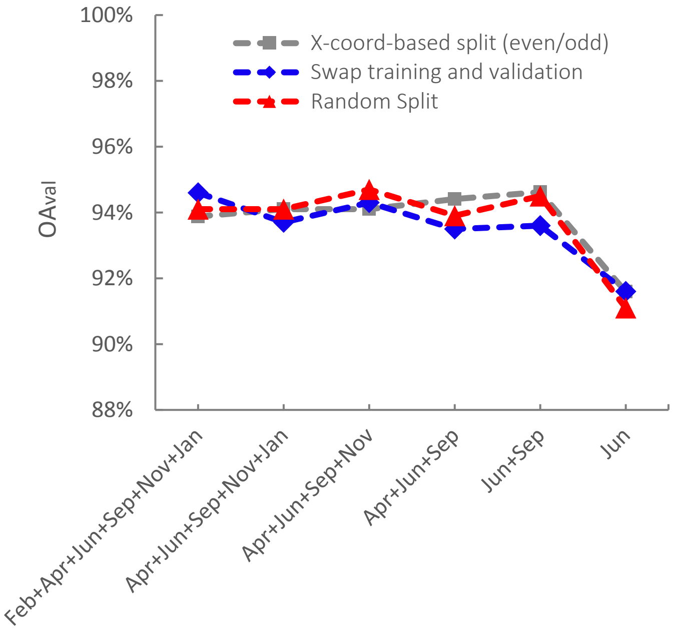

Figure S3. Accuracy of the RF classification by decreasing number of time steps for different sampling of the training and validation sets from the reference data. RF maxnodes was set to 25 for all runs.

Table S1. Error matrices of classifications with 1) $RF_{maxn=25}$ and $RF_{default}$ with structural and spectral data and $RF_{maxn=25}$with only spectral data for segmentations with six (n=6) and one (n=1) time steps

			Reference										
			Pionier vegetation	*Sealed road*	*Rock/ Rubble*	*Natural grassland*	*Production grassland*	*Herbaceous vegetation*	*Reed*	*Bare sand*	*Forest*	*Water*	UA
Prediction	**maxnodes-25**												
	n=6	*Pionier vegetation*	41881	2442	870	0	0	2955	0	1291	0	0	85%
		Sealed road	0	35893	0	0	0	0	0	0	0	0	100%
		Rock/Rubble	129	0	22242	0	0	0	0	0	0	0	99%
		Natural grassland	7226	0	0	73595	0	21282	0	0	0	0	72%
		Production grassland	7509	0	40	108	110501	573	0	0	0	0	93%
		Herbaceous veg.	0	0	0	712	0	17734	0	0	0	0	96%
		Reed	0	0	0	0	0	282	24759	0	0	0	99%
		Bare sand	1033	27	0	0	0	0	0	117448	0	0	99%
		Forest	0	0	0	0	0	0	0	0	22953	0	100%
		Water	0	0	0	0	0	0	0	0	0	245643	100%
		PA	72%	94%	96%	99%	100%	41%	100%	99%	100%	100%	
	n=1	*Pionier vegetation*	19293	228	79	84	16	2306	0	0	20	0	88%
		Sealed road	0	44396	0	0	0	0	0	0	0	0	100%
		Rock/Rubble	1334	396	19094	0	0	66	0	63	0	0	91%
		Natural grassland	11128	0	78	44205	414	17121	371	0	0	0	60%
		Production grassland	10054	0	21	17	80190	123	0	351	0	0	88%
		Herbaceous veg.	0	0	0	207	0	3240	292	0	0	0	87%
		Reed	0	0	0	0	0	3318	22608	0	66	0	87%
		Bare sand	5450	219	121	0	0	0	0	101276	0	0	95%
		Forest	0	0	0	109	0	0	0	0	21516	0	99%
		Water	0	0	0	0	0	0	0	0	0	232710	100%
		PA	41%	98%	98%	99%	99%	12%	97%	100%	100%	100%	
	maxnodes-default												
	n=6	*Pionier vegetation*	57317	0	0	0	0	0	0	765	0	0	99%
		Sealed road	0	38362	0	0	0	0	0	0	0	0	100%
		Rock/Rubble	23	0	23152	0	0	0	0	0	0	0	100%
		Natural grassland	0	0	0	72422	0	2210	0	0	0	0	97%
		Production grassland	0	0	0	0	110501	0	0	0	0	0	100%
		Herbaceous veg.	60	0	0	1993	0	40616	0	0	0	0	95%
		Reed	0	0	0	0	0	0	24759	0	0	0	100%
		Bare sand	378	0	0	0	0	0	0	117974	0	0	100%
		Forest	0	0	0	0	0	0	0	0	22953	0	100%
		Water	0	0	0	0	0	0	0	0	0	245643	100%
		PA	99%	100%	100%	97%	100%	95%	100%	99%	100%	100%	
	n=1	*Pionier vegetation*	40715	55	25	194	315	733	0	306	0	0	96%
		Sealed road	0	45109	0	0	0	0	0	0	0	0	100%
		Rock/Rubble	106	48	19280	0	0	0	0	23	0	0	99%
		Natural grassland	1473	0	0	40376	0	4658	0	0	0	0	87%
		Production grassland	2453	0	48	91	80277	9	0	0	0	0	97%
		Herbaceous veg.	346	0	0	3852	28	19253	1031	0	0	0	79%
		Reed	0	0	0	0	0	1521	22240	0	0	0	94%
		Bare sand	2166	27	40	0	0	0	0	101361	0	0	98%
		Forest	0	0	0	109	0	0	0	0	21602	0	99%
		Water	0	0	0	0	0	0	0	0	0	232710	100%
		PA	86%	100%	99%	90%	100%	74%	96%	100%	100%	100%	
	Spectral only												
	n=6	*Pionier vegetation*	41881	2442	870	0	0	2955	0	1291	0	0	85%
		Sealed road	0	35893	0	0	0	0	0	0	0	0	100%
		Rock/Rubble	129	0	22242	0	0	0	0	0	0	0	99%
		Natural grassland	7226	0	0	73595	0	21282	0	0	0	0	72%
		Production grassland	7509	0	40	108	110501	573	0	0	0	0	93%
		Herbaceous veg.	0	0	0	712	0	17734	0	0	0	0	96%
		Reed	0	0	0	0	0	282	24759	0	0	0	99%
		Bare sand	1033	27	0	0	0	0	0	117448	0	0	99%
		Forest	0	0	0	0	0	0	0	0	22953	0	100%
		Water	0	0	0	0	0	0	0	0	0	245643	100%
		PA	72%	94%	96%	99%	100%	41%	100%	99%	100%	100%	
	n=1	*Pionier vegetation*	8633	228	62	84	0	105	32	0	104	0	93%
		Sealed road	0	44323	0	0	0	0	0	358	0	0	99%
		Rock/Rubble	1821	504	18859	0	0	76	131	311	81	0	87%
		Natural grassland	10542	0	0	42167	151	15344	6096	0	3841	0	54%
		Production grassland	12803	0	15	37	79619	19	225	0	138	0	86%
		Herbaceous veg.	225	0	0	1811	0	5548	1911	0	1206	0	52%
		Reed	910	0	216	283	179	2402	10826	0	4602	0	56%
		Bare sand	5351	184	121	0	0	0	0	101021	0	0	95%
		Forest	6974	0	120	240	671	2680	4050	0	11630	0	44%
		Water	0	0	0	0	0	0	0	0	0	232710	100%
		PA	18%	98%	97%	94%	99%	21%	47%	99%	54%	100%	

Table S2: Classification accuracy with step-wise decrease in number of time steps with reversed training and validation set in the RandomForest classification, with training and validation set split based on X-coordinate. The * indicates the time step which adds least value. This time step is the group of 18 attributes collected for a specific and is not used in further analysis. OA = overall classification accuracy and κ= Kappa coefficient. Subscript $_{val}$ indicates validation is based on validation dataset and $_{train}$ based on training dataset. Bold OA_{val} show the accuracy of the RF with the same time steps used for the segmentation. The order of excluded timesteps was not adjusted to allow the use of the six existing segmentations, but timesteps marked with a red asterisk should have been excluded according to this training and validation set sampling method.

Time steps included in segmentation	Time step excluded from classification	OA_{val} %	κ_{val} %	OA_{train} %	κ_{train} %	OA_{train} - OA_{val}
n=6 FEB APR JUN SEP NOV JAN	-	**94.6**	93.4	94.6	93.5	0.07
	FEB*	94.5	93.4	94.6	93.4	0.07
	APR	94.4	93.2	94.4	93.2	0.03
	JUN	92.2	90.5	92.1	90.4	-0.03
	SEP	93.7	92.4	93.5	92.2	-0.17
	NOV	94.6	93.5	94.6	93.4	0.00
	JAN*	94.6	93.5	94.5	93.4	-0.08
n=5 APR JUN SEP NOV JAN	-	**93.7**	92.3	94.6	93.3	0.86
	APR	93.6	92.1	94.6	93.3	1.01
	JUN	92.2	90.4	92.8	91.0	0.56
	SEP	93.2	91.6	93.8	92.3	0.55
	NOV*	93.8	92.3	94.5	93.2	0.76
	JAN*	93.7	92.3	94.5	93.2	0.72
n=4 APR JUN SEP NOV	-	**94.3**	93.1	94.4	93.1	0.10
	APR	94.0	92.5	94.5	93.3	0.53
	JUN	93.2	91.7	93.2	91.6	0.03
	SEP	93.2	91.7	94.4	91.8	1.17
	NOV*	94.0	92.7	94.1	92.7	0.07
n=3 APR JUN SEP	-	**93.5**	92.2	94.3	93.0	0.77
	APR*	93.7	92.4	94.5	93.3	0.76
	JUN	90.6	88.6	91.9	90.1	1.29
	SEP	92.1	90.4	92.9	91.3	0.76
n=2 JUN SEP	-	**93.6**	92.0	94.5	93.3	0.92
	JUN	88.3	85.6	89.6	87.0	1.29
	SEP*	91.4	89.3	91.9	90.0	0.46
n=1 JUN	-	**91.6**	89.6	91.3	89.2	-0.29

Table S3: Classification accuracy with step-wise decrease in number of time steps with random sampling of training and validation set per class from reference data instead of split based on X-coordinate. The * indicates the time step which adds least value. This time step is the group of 18 attributes collected for a specific and is not used in further analysis. OA = overall classification accuracy and κ= Kappa coefficient. Subscript $_{val}$ indicates validation is based on validation dataset and $_{train}$ based on training dataset. Bold OA_{val} show the accuracy of the RF with the same time steps used for the segmentation.

Time steps included in segmentation	Time step excluded from classification	OA_{val} %	κ_{val} %	OA_{train} %	κ_{train} %	OA_{train} - OA_{val}
n=6 FEB APR JUN SEP NOV JAN	-	**94.1**	92.7	95.2	94.2	1.05
	FEB*	95.6	93.5	94.8	93.9	-0.77
	APR	94.5	93.4	94.9	93.8	0.40
	JUN	93.0	91.5	94.0	92.7	0.99
	SEP	93.9	92.7	91.2	93.0	-2.75
	NOV	94.2	93.0	94.8	93.7	0.61
	JAN	94.4	93.3	95.2	94.2	0.81
n=5 APR JUN SEP NOV JAN	-	**94.1**	92.9	94.1	92.7	-0.02
	APR	93.9	92.6	93.9	92.4	-0.05
	JUN	93.5	92.0	93.4	91.8	-0.06
	SEP	93.9	92.5	93.7	92.2	-0.16
	NOV	94.0	92.6	94.1	92.7	0.14
	JAN*	94.4	93.1	94.3	92.9	-0.12
n=4 APR JUN SEP NOV	-	**94.7**	93.5	94.5	93.2	-0.18
	APR	94.5	93.2	94.0	92.6	-0.43
	JUN	93.5	92.1	93.8	92.3	0.22
	SEP	93.6	92.1	93.6	92.1	0.03
	NOV*	94.6	93.5	94.4	93.1	-0.25
n=3 APR JUN SEP	-	**93.9**	92.6	94.6	93.4	0.77
	APR*	94.1	92.9	94.7	93.6	0.64
	JUN	90.2	88.2	91.8	90.0	1.67
	SEP	92.5	91.0	93.1	91.6	0.64
n=2 JUN SEP	-	**94.5**	93.2	94.8	93.6	0.31
	JUN	87.9	85.1	88.8	96.2	0.88
	SEP*	92.2	90.3	92.2	90.4	0.04
n=1 JUN	-	**91.1**	89.1	91.6	89.5	0.57