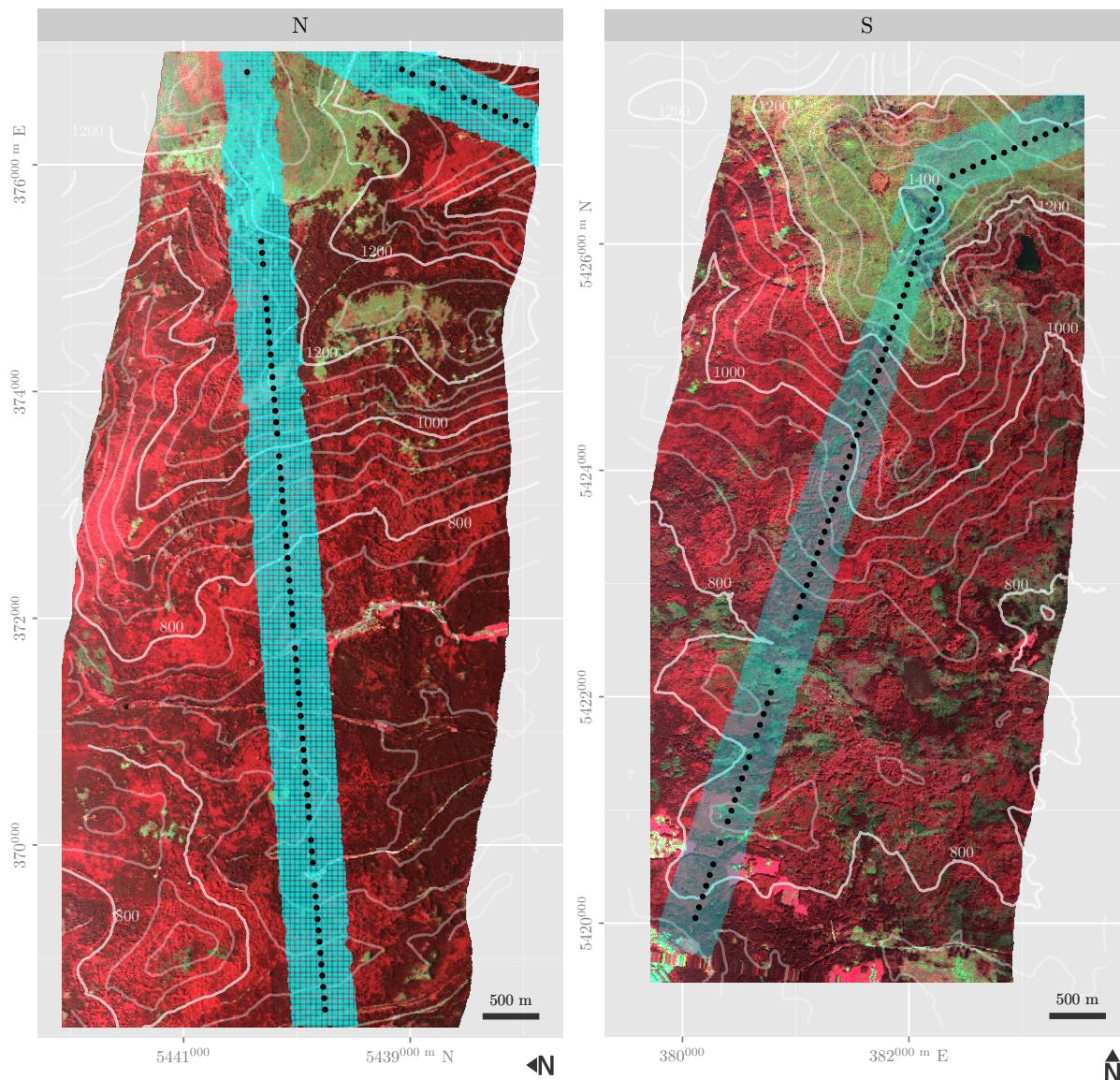


## Sampling Scheme

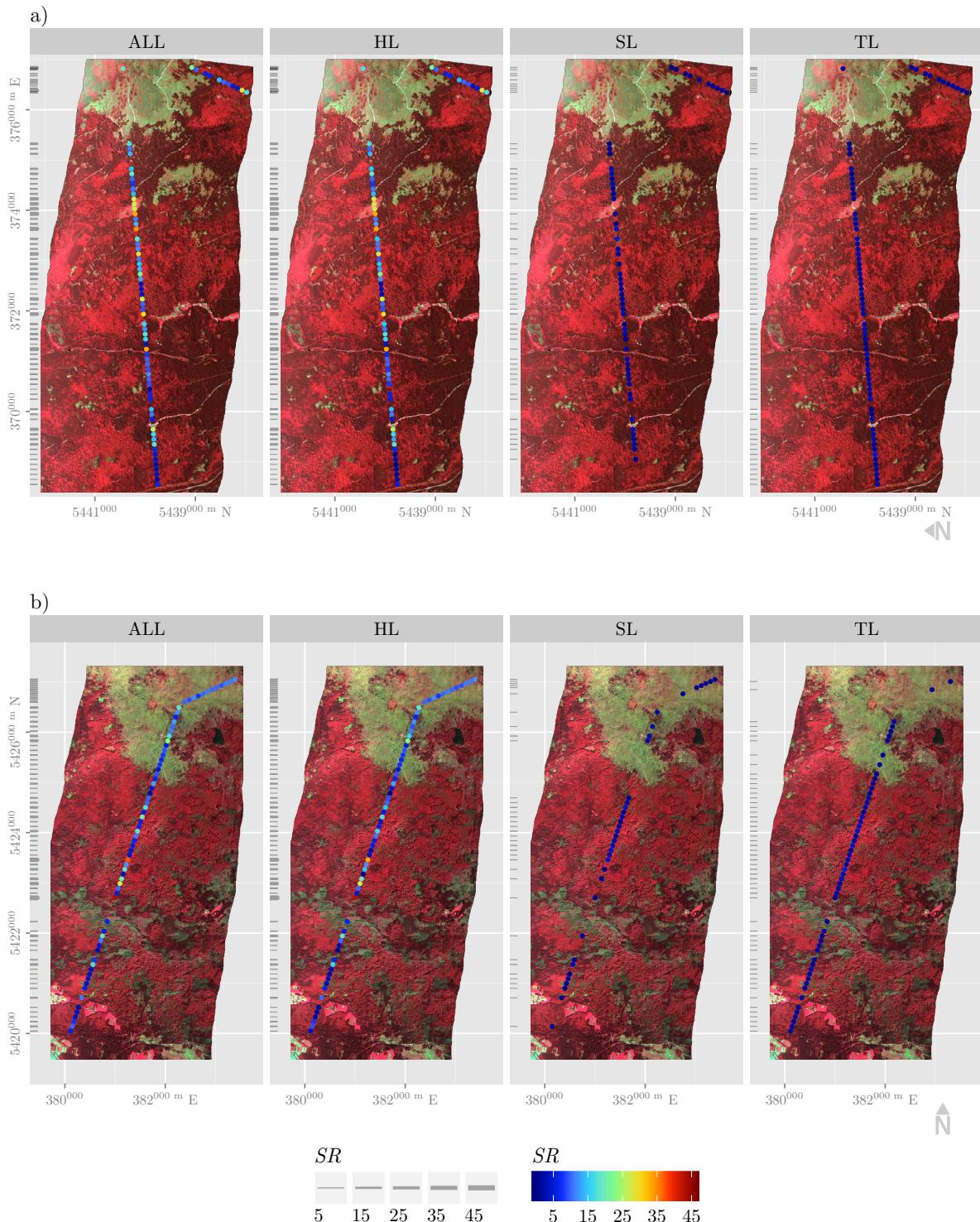
**Figure S1.** Color infra-red RGB composite image of northern and southern HyMap scenes (bands 21, 14, 7), full-waveform LiDAR coverage (cyan coloured strips) and ground plots with vegetation surveys. Isohypses are shown in 50 m intervals. Projection: WGS84 UTM 33N.



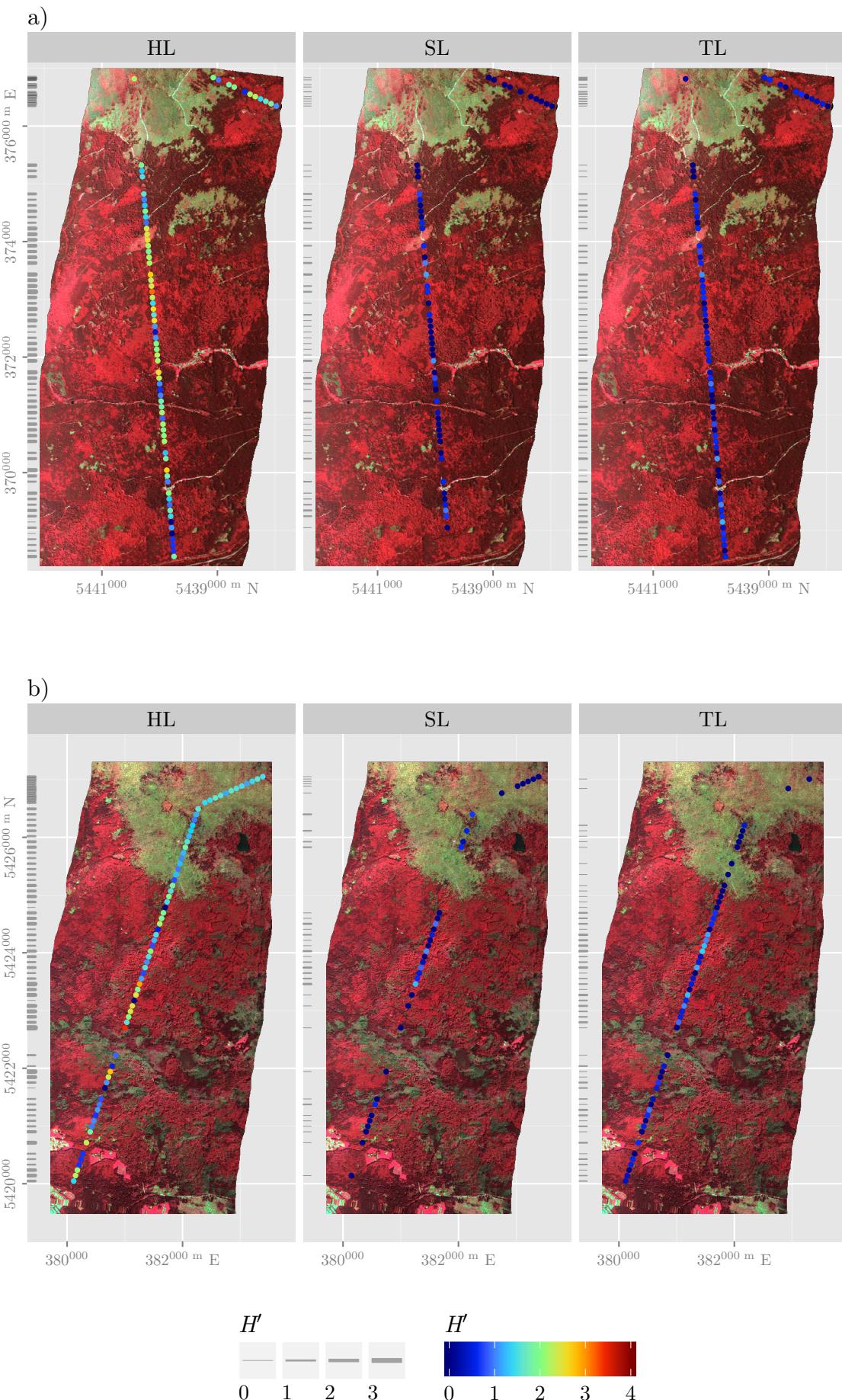
# Response Variables

2

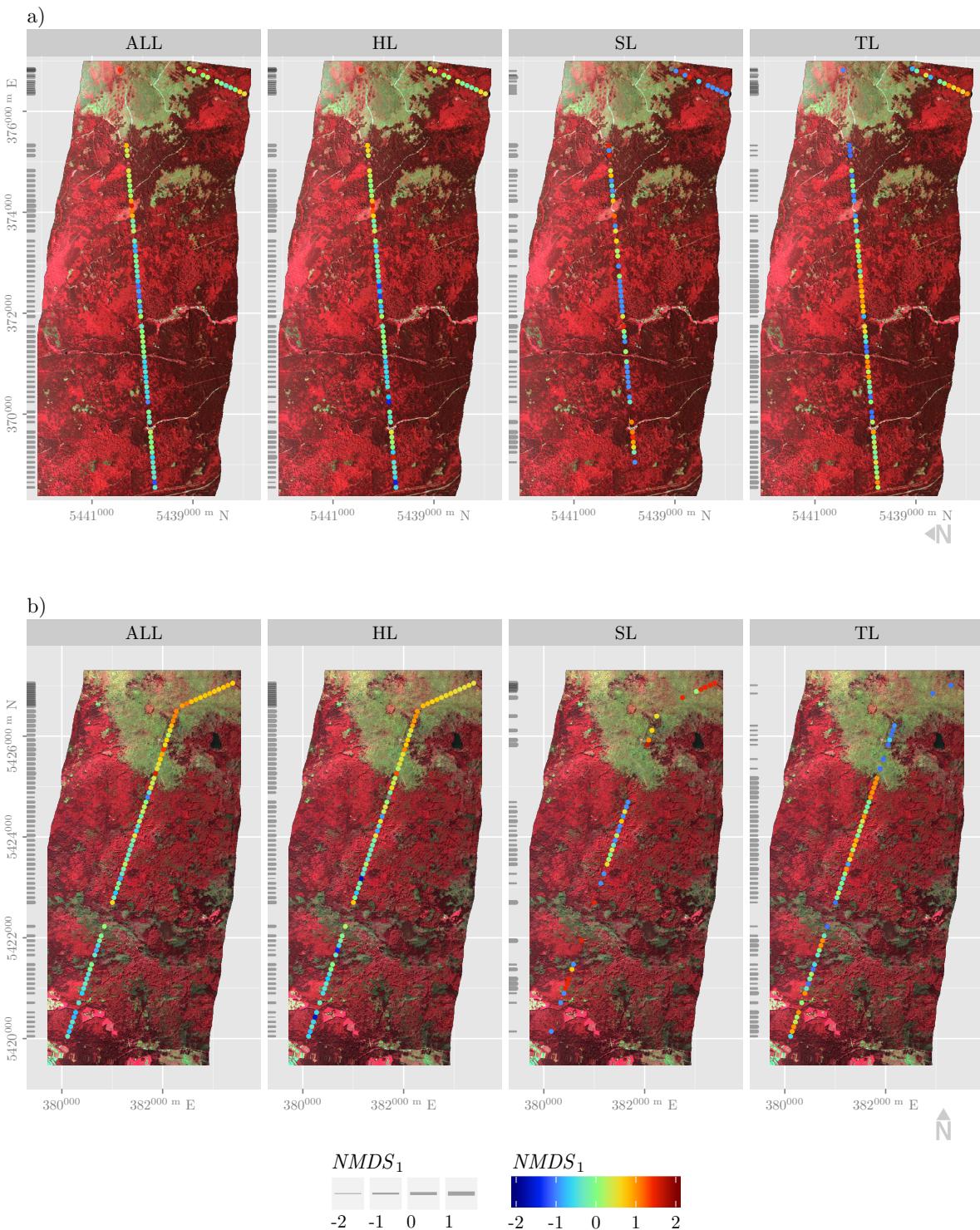
**Figure S2.** Spatial distribution of species richness *SR*. The width of the segments on the left additionally display species richness. a) northern scene, b) southern scene. The number of plots differs per layer, as not all layers were present in all plots. Background: colour infra-red RGB composite image of both HyMap scenes (bands 21, 14, 7). Projection: WGS84 UTM 33N.



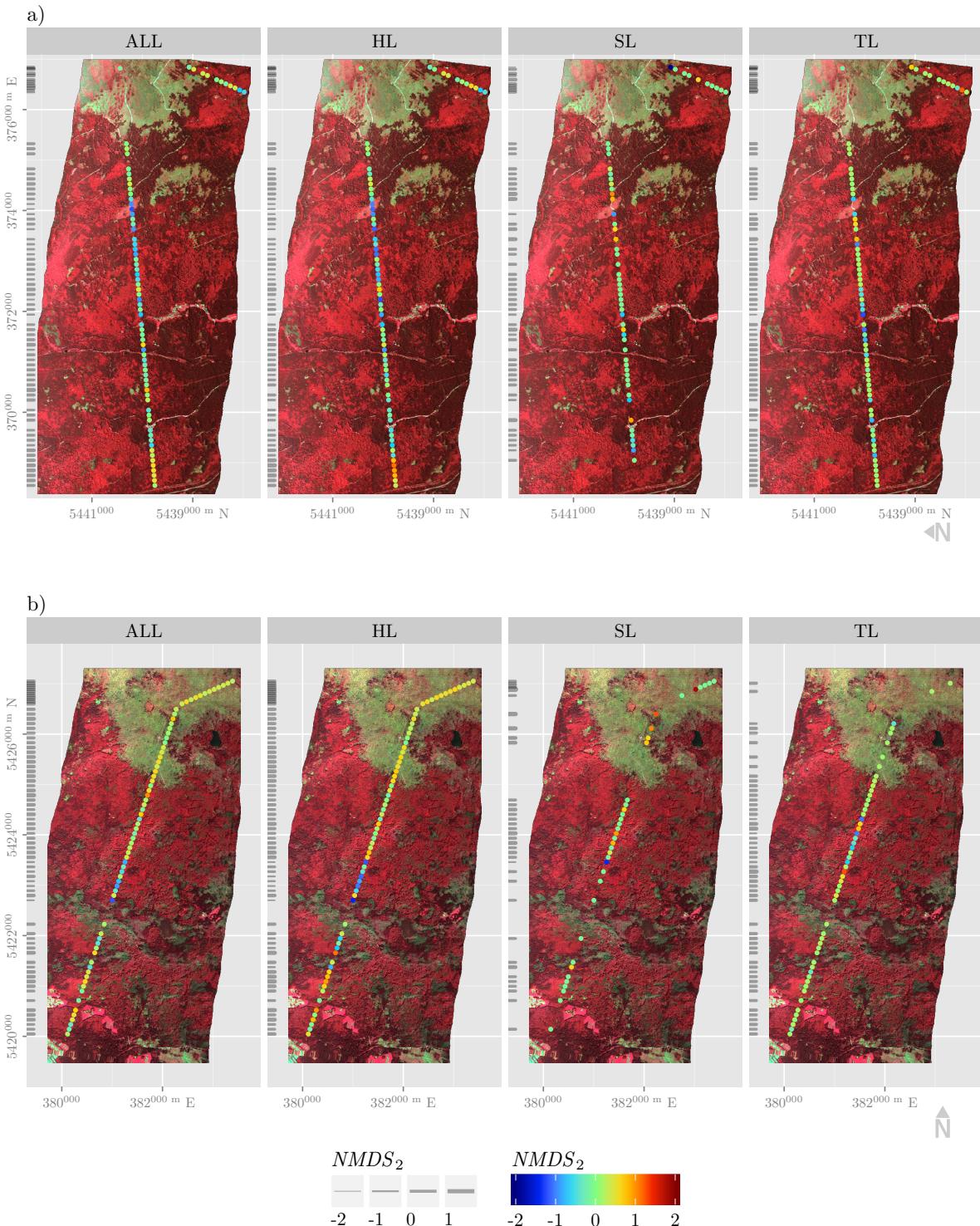
**Figure S3.** Spatial distribution of Shannon index. The width of the segments on the left additionally display the  $H'$ . a) northern scene, b) southern scene. The number of plots differs per layer, as not all layers were present in all plots. Background: colour infra-red RGB composite image of both HyMap scenes (bands 21, 14, 7). Projection: WGS84 UTM 33N.



**Figure S4.** Spatial distribution of NMDS scores on first axis. The width of the segments on the left additionally display the NMDS scores. a) northern scene, b) southern scene. The number of plots differs per layer, as not all layers were present in all plots. Background: colour infra-red RGB composite image of both HyMap scenes (bands 21, 14, 7). Projection: WGS84 UTM 33N.



**Figure S5.** Spatial distribution of NMDS scores on second axis. The width of the segments on the left additionally display the NMDS scores. a) northern scene, b) southern scene. The number of plots differs per layer, as not all layers were present in all plots. Background: colour infra-red RGB composite image of both HyMap scenes (bands 21, 14, 7). Projection: WGS84 UTM 33N.



**Table S1.** Species acronyms each consisting of the first three letters of genus and species. Presence count over all plots, broken down into the herb layer, shrub layer, tree layer and their total. Total number of plots where the layers were present: ALL: 148 plots, HL: 147 plots, HL:92 plots, TL: 129 plots.

<b>Acronym</b>	<b>Species</b>	<b>Occurrences</b>			
		<b>ALL</b>	<b>HL</b>	<b>SL</b>	<b>TL</b>
Abialb	<i>Abies alba</i>	57	51	12	21
Acepla	<i>Acer platanoides</i>	2	1		1
Acepse	<i>Acer pseudoplatanus</i>	47	41	4	12
Achmil	<i>Achillea millefolium</i>	2	2		
Aconap	<i>Aconitum napellus</i>	2	2		
Actspi	<i>Actaea spicata</i>	1	1		
Agrcan	<i>Agrostis canina</i>	1	1		
Agrcap	<i>Agrostis capillaris</i>	9	9		
Ajurep	<i>Ajuga reptans</i>	18	18		
Alcmon	<i>Alchemilla monticola</i>	2	2		
Anenem	<i>Anemone nemorosa</i>	19	19		
Antsyl	<i>Anthriscus sylvestris</i>	1	1		
Athdis	<i>Athyrium distentifolium</i>	29	29		
Athfil	<i>Athyrium filix-femina</i>	58	58		
Betpen	<i>Betula pendula</i>	7	2	2	3
Betpub	<i>Betula pubescens</i>	1	1		
Blespi	<i>Blechnum spicant</i>	22	22		
Brasyl	<i>Brachypodium sylvaticum</i>	1	1		
Calaru	<i>Calamagrostis arundinacea</i>	1	1		
Calvil	<i>Calamagrostis villosa</i>	61	61		
Calpal	<i>Caltha palustris</i>	5	5		
Campat	<i>Campanula patula</i>	1	1		
Carama	<i>Cardamine amara</i>	3	3		
Carbul	<i>Cardamine bulbifera</i>	1	1		
Carbri	<i>Carex brizoides</i>	13	13		
Carcan	<i>Carex canescens</i>	3	3		
Carech	<i>Carex echinata</i>	6	6		
Carfla	<i>Carex flava</i>	1	1		
Carlep	<i>Carex leporina</i>	5	5		
Carnig	<i>Carex nigra</i>	6	6		
Carpal	<i>Carex pallescens</i>	1	1		
Carpil	<i>Carex pilulifera</i>	17	17		
Carrem	<i>Carex remota</i>	12	12		
Carsyl	<i>Carex sylvatica</i>	9	9		
Chahir	<i>Chaerophyllum hirsutum</i>	5	5		
Chralt	<i>Chrysosplenium alternifolium</i>	3	3		
Chropp	<i>Chrysosplenium oppositifolium</i>	3	3		
Cicalp	<i>Cicerbita alpina</i>	2	2		
Ciralp	<i>Circaeae alpina</i>	9	9		

**Table S1. Cont.**

<b>Acronym</b>	<b>Species</b>	<b>Occurrences</b>			
		<b>ALL</b>	<b>HL</b>	<b>SL</b>	<b>TL</b>
Cirlut	<i>Circaea lutetiana</i>	5	5		
Cirhet	<i>Cirsium heterophyllum</i>	1	1		
Cirpal	<i>Cirsium palustre</i>	7	7		
Dacglo	<i>Dactylis glomerata</i>	3	3		
Desces	<i>Deschampsia cespitosa</i>	9	9		
Desfle	<i>Deschampsia flexuosa</i>	43	43		
Digpur	<i>Digitalis purpurea</i>	3	3		
Drydil	<i>Dryopteris dilatata</i>	122	122		
Dryfil	<i>Dryopteris filix-mas</i>	9	9		
Epiang	<i>Epilobium angustifolium</i>	21	21		
Epimon	<i>Epilobium montanum</i>	2	2		
Epipal	<i>Epilobium palustre</i>	1	1		
Equsyl	<i>Equisetum sylvaticum</i>	7	7		
Eriang	<i>Eriophorum angustifolium</i>	1	1		
Erivag	<i>Eriophorum vaginatum</i>	1	1		
Fagsyl	<i>Fagus sylvatica</i>	116	83	67	98
Fesalt	<i>Festuca altissima</i>	2	2		
Fesrub	<i>Festuca rubra</i>	2	2		
Filulm	<i>Filipendula ulmaria</i>	1	1		
Fraves	<i>Fragaria vesca</i>	1	1		
Fraexc	<i>Fraxinus excelsior</i>	5	5		
Galtet	<i>Galeopsis tetrahit</i>	8	8		
Galodo	<i>Galium odoratum</i>	4	4		
Galpal	<i>Galium palustre</i>	2	2		
Galpum	<i>Galium pumilum</i>	1	1		
Galsax	<i>Galium saxatile</i>	19	19		
Genpan	<i>Gentiana pannonica</i>	3	3		
Gersyl	<i>Geranium sylvaticum</i>	1	1		
Glyflu	<i>Glyceria fluitans</i>	1	1		
Glynot	<i>Glyceria notata</i>	1	1		
Gnasyl	<i>Gnaphalium sylvaticum</i>	1	1		
Gymdry	<i>Gymnocarpium dryopteris</i>	10	10		
Hielac	<i>Hieracium lachenalii</i>	1	1		
Hielae	<i>Hieracium laevigatum</i>	1	1		
Hiemur	<i>Hieracium murorum</i>	2	2		
Hiepil	<i>Hieracium pilosella</i>	1	1		
Homalp	<i>Homogyne alpina</i>	16	16		
Hupsel	<i>Huperzia selago</i>	1	1		
Hypmac	<i>Hypericum maculatum</i>	5	5		
Hyprad	<i>Hypochaeris radicata</i>	1	1		
Impnol	<i>Impatiens noli-tangere</i>	9	9		
Juncon	<i>Juncus conglomeratus</i>	1	1		
Juneff	<i>Juncus effusus</i>	12	12		
Junfil	<i>Juncus filiformis</i>	1	1		
Junten	<i>Juncus tenuis</i>	1	1		

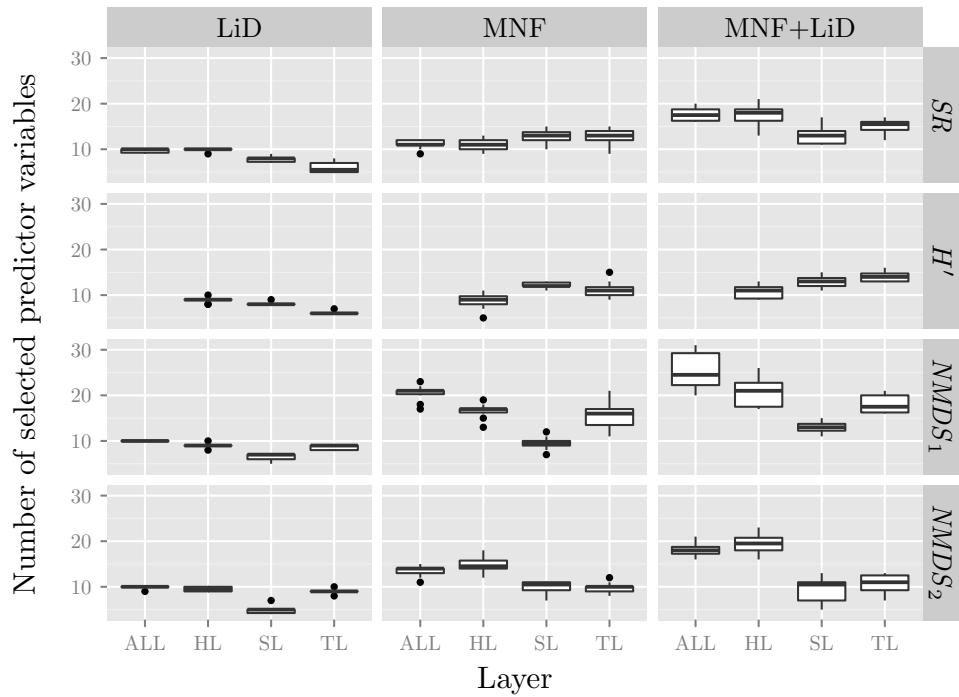
**Table S1.** *Cont.*

<b>Acronym</b>	<b>Species</b>	<b>Occurrences</b>			
		<b>ALL</b>	<b>HL</b>	<b>SL</b>	<b>TL</b>
Knadip	<i>Knautia dipsacifolia</i>	1	1		
Lammon	<i>Lamium montanum</i>	23	23		
Lardec	<i>Larix decidua</i>	1			1
Leoaut	<i>Leontodon autumnalis</i>	2	2		
Ligmut	<i>Ligusticum mutellina</i>	1	1		
Lonnig	<i>Lonicera nigra</i>	1	1		
Luzluz	<i>Luzula luzuloides</i>	5	5		
Luzmul	<i>Luzula multiflora</i>	1	1		
Luzpil	<i>Luzula pilosa</i>	9	9		
Luzsyl	<i>Luzula sylvatica</i>	40	40		
Lycann	<i>Lycopodium annotinum</i>	12	12		
Lyccla	<i>Lycopodium clavatum</i>	1	1		
Lysnem	<i>Lysimachia nemorum</i>	14	14		
Maibif	<i>Maianthemum bifolium</i>	38	38		
Melpra	<i>Melampyrum pratense</i>	8	8		
Merper	<i>Mercurialis perennis</i>	1	1		
Mileff	<i>Milium effusum</i>	1	1		
Moetri	<i>Moehringia trinervia</i>	1	1		
Molcae	<i>Molinia caerulea</i>	1	1		
Mycmur	<i>Mycelis muralis</i>	2	2		
Myosco	<i>Myosotis scorpioides</i>	7	7		
Narstr	<i>Nardus stricta</i>	5	5		
Orelim	<i>Oreopteris limbosperma</i>	12	12		
Oxaace	<i>Oxalis acetosella</i>	72	72		
Parqua	<i>Paris quadrifolia</i>	7	7		
Petalb	<i>Petasites albus</i>	13	13		
Phecon	<i>Phegopteris connectilis</i>	14	14		
Phlpra	<i>Phleum pratense</i>	1	1		
Picabi	<i>Picea abies</i>	125	90	45	92
Plamaj	<i>Plantago major</i>	2	2		
Poaann	<i>Poa annua</i>	3	3		
Poanem	<i>Poa nemoralis</i>	1	1		
Polver	<i>Polygonatum verticillatum</i>	11	11		
Poptre	<i>Populus tremula</i>	1	1		
Potere	<i>Potentilla erecta</i>	3	3		
Prepur	<i>Prenanthes purpurea</i>	59	59		
Ranacr	<i>Ranunculus acris</i>	3	3		
Ranpla	<i>Ranunculus platanifolius</i>	2	2		
Ranrep	<i>Ranunculus repens</i>	5	5		
Rhimin	<i>Rhinanthus minor</i>	1	1		
Rubfru	<i>Rubus fruticosus</i>	5	5		
Rubida	<i>Rubus idaeus</i>	37	37		
Rumace	<i>Rumex acetosella</i>	6	6		
Rumari	<i>Rumex arifolius</i>	7	7		
Rumobt	<i>Rumex obtusifolius</i>	1	1		

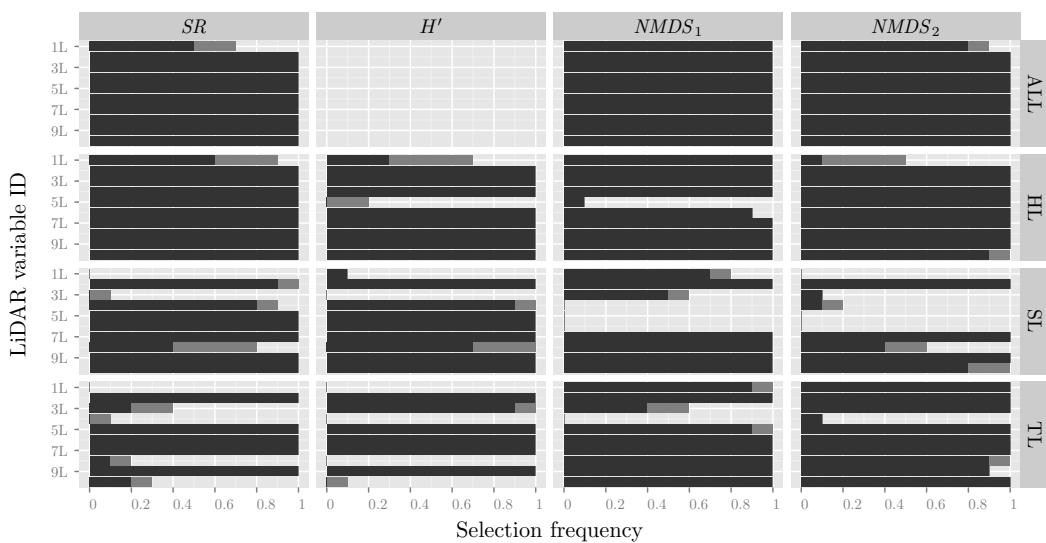
**Table S1.** *Cont.*

<b>Acronym</b>	<b>Species</b>	<b>Occurrences</b>			
		<b>ALL</b>	<b>HL</b>	<b>SL</b>	<b>TL</b>
Sagpro	<i>Sagina procumbens</i>	1	1		
Salaur	<i>Salix aurita</i>	2	2		
Salcap	<i>Salix caprea</i>	3	2	1	
Salcin	<i>Salix cinerea</i>	3	1	3	
Samrac	<i>Sambucus racemosa</i>	5	4	1	
Sanoff	<i>Sanguisorba officinalis</i>	1	1		
Saneur	<i>Sanicula europaea</i>	2	2		
Scisyl	<i>Scirpus sylvaticus</i>	2	2		
Scrnod	<i>Scrophularia nodosa</i>	1	1		
Senova	<i>Senecio ovatus</i>	17	17		
Sildio	<i>Silene dioica</i>	3	3		
Silnut	<i>Silene nutans</i>	1	1		
Silvul	<i>Silene vulgaris</i>	1	1		
Solmon	<i>Soldanella montana</i>	23	23		
Solvir	<i>Solidago virgaurea</i>	1	1		
Sorauc	<i>Sorbus aucuparia</i>	76	69	18	15
Sperub	<i>Spergularia rubra</i>	1	1		
Stasyl	<i>Stachys sylvatica</i>	4	4		
Steals	<i>Stellaria alsine</i>	1	1		
Stegra	<i>Stellaria graminea</i>	2	2		
Stenem	<i>Stellaria nemorum</i>	9	9		
TarHam	<i>Taraxacum Hamata</i>	2	2		
Trieur	<i>Trientalis europaea</i>	18	18		
Trirep	<i>Trifolium repens</i>	2	2		
Tusfar	<i>Tussilago farfara</i>	1	1		
Urtdio	<i>Urtica dioica</i>	5	5		
Vacmyr	<i>Vaccinium myrtillus</i>	75	75		
Vacvit	<i>Vaccinium vitis-idaea</i>	2	2		
Valoff	<i>Valeriana officinalis</i>	1	1		
Verbec	<i>Veronica beccabunga</i>	1	1		
Vercha	<i>Veronica chamaedrys</i>	4	4		
Vermon	<i>Veronica montana</i>	2	2		
Veroff	<i>Veronica officinalis</i>	2	2		
Viopal	<i>Viola palustris</i>	1	1		
Viorei	<i>Viola reichenbachiana</i>	2	2		
Vioriv	<i>Viola riviniana</i>	3	3		

**Figure S6.** Number of predictor variables of the final optimal *mtry* model which were identified as important during Boruta feature selection within the ten fold cross-validation scheme.



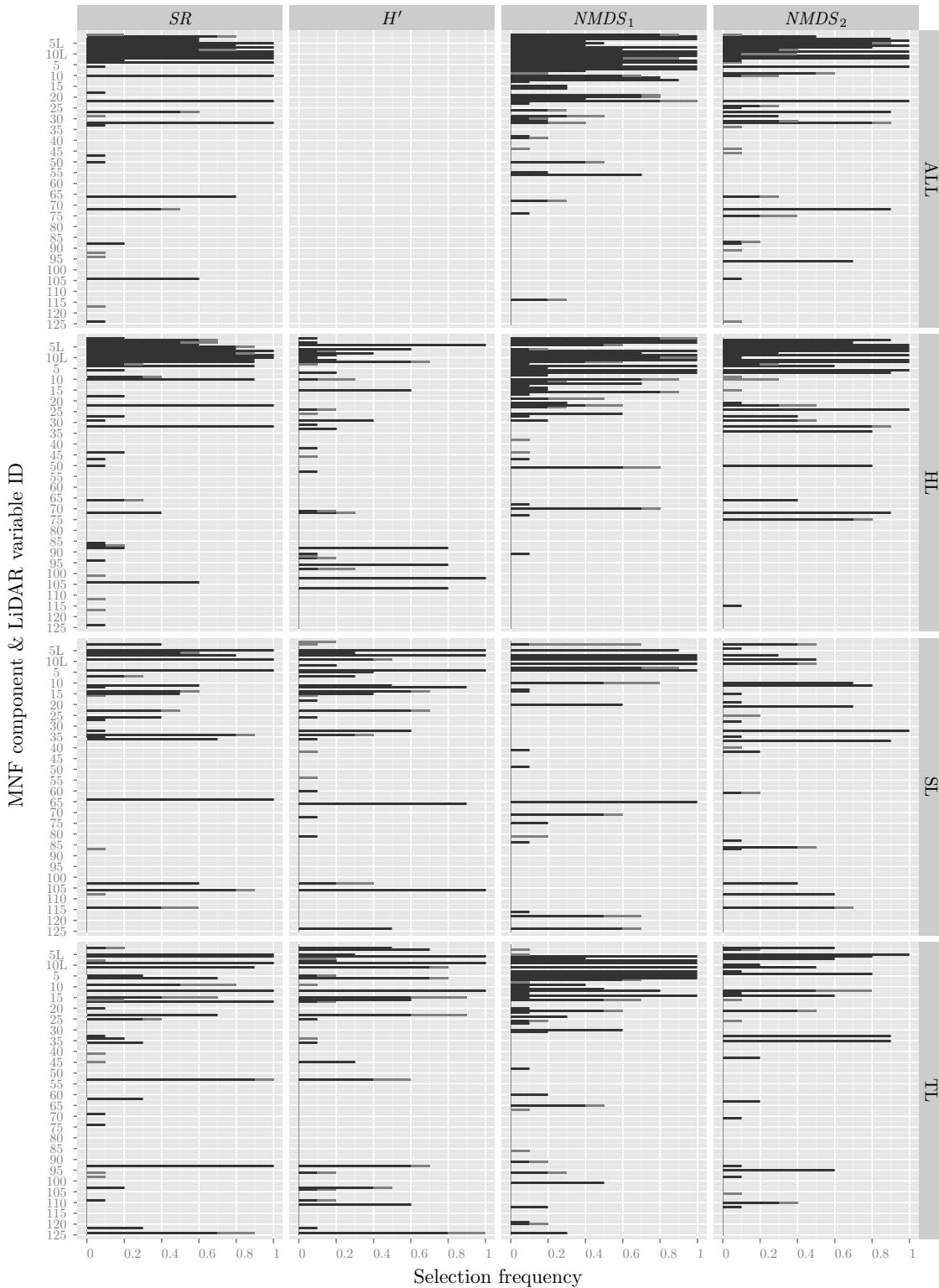
**Figure S7.** Selection frequency of individual variables of the LiD predictor set during Boruta feature selection over all ten cross-validation runs. Variable labels are dummy labels: 1L=HSTD, 2L=HMEAN, 3L = HMAX, 4L = PR0-1.5, 5L = PR1.5-5, 6L = PR5-12, 7L = PR12-50, 8L = PR0-50, 9L = PR2-50, 10L = HOME.



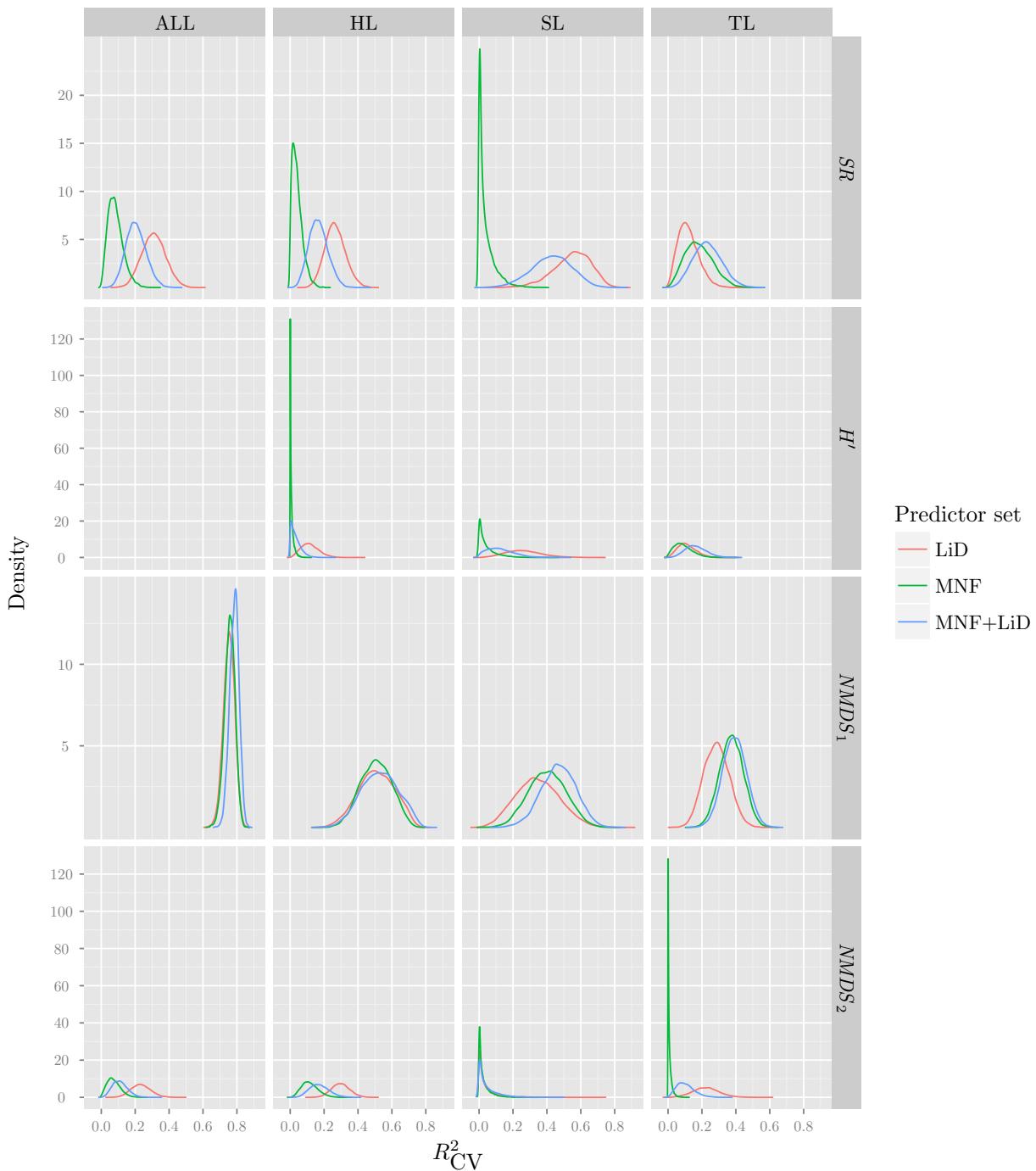
**Figure S8.** Selection frequency of individual variables of the MNF predictor set during Boruta feature selection over all ten cross-validation runs. Numbers on the y-axes refer to the MNF band ordering, i.e. MNF 1 has the highest S/N ratio.



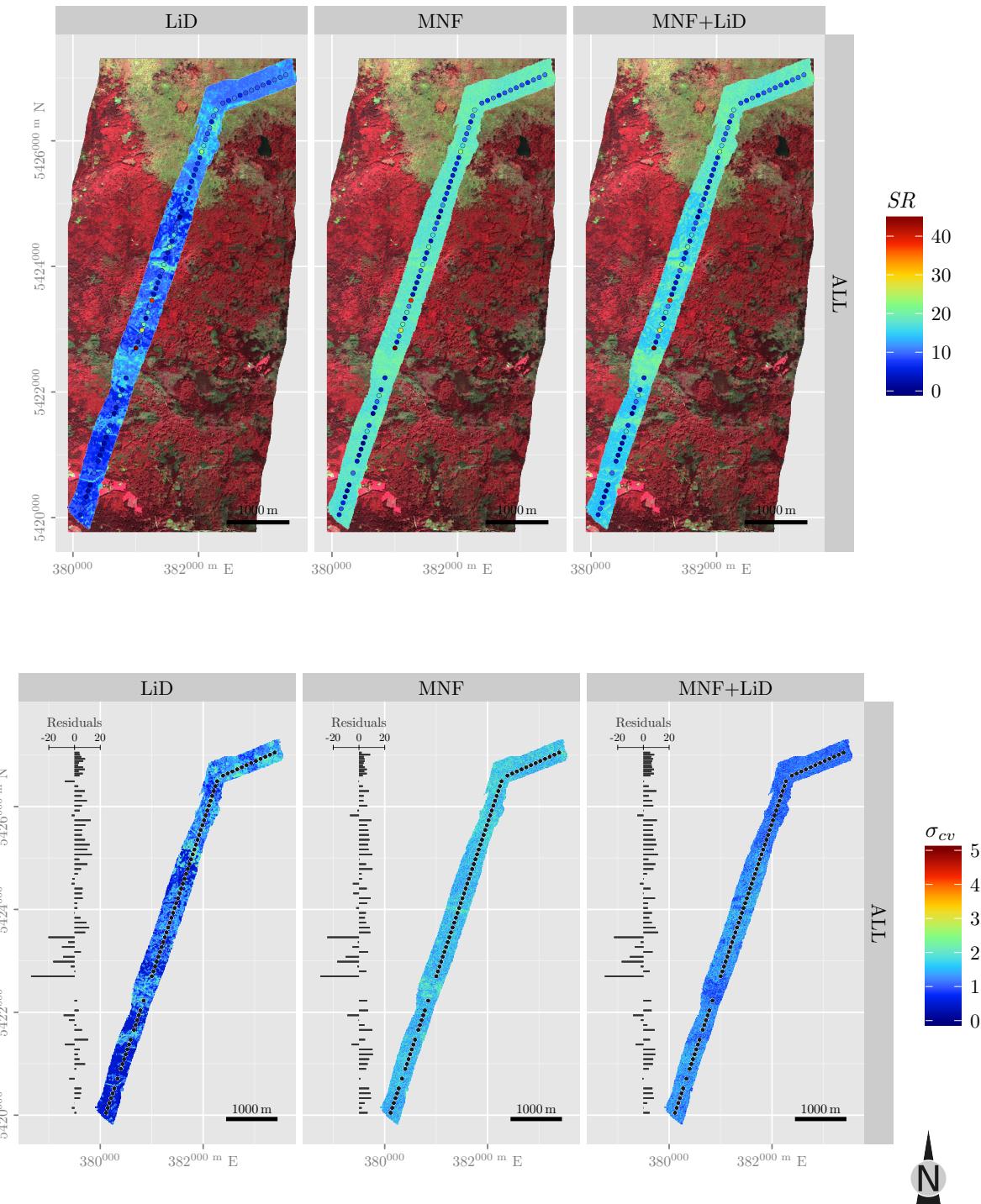
**Figure S9.** Selection frequency of individual variables of the MNF+LiD predictor set during Boruta feature selection over all ten cross-validation runs. Variable labels are dummy labels: 1L=HSTD, 2L=HMEAN, 3L = HMAX, 4L = PR0-1.5, 5L = PR1.5-5, 6L = PR5-12, 7L = PR12-50, 8L = PR0-50, 9L = PR2-50, 10L = HOME. Numbers on the y-axes refer to the MNF band ordering, i.e. MNF 1 has the highest S/N ratio.



**Figure S10.** Density estimates for bootstrapped  $R_{CV}^2$  for herb (HL), shrub (SL) and tree layer (TL) and their total (ALL) per response variable species richness  $SR$ , Shannon index ( $H'$ ), and first and second NMDS axes. Note that for the abundance based  $H'$  layer ALL does not exist. Density distributions were calculated using the density function in R. The number of underlying bootstrap estimates is  $n = 10000$ .



**Figure S11.** Predicted overall species richness (ALL) for the LiDAR (LiD) and hyperspectral (MNF) derived predictor sets and their combination (MNF+LiD). Upper panel: averaged predictions of ten cross-validation models. Points show the plot information (*SR*) used to build and evaluate the random forests. Background: CIR RGB composite of the underlying HyMap data. Lower panel: standard deviation of the predictions of the ten cross-validation models. Bar charts show the residuals between predicted and observed estimates in cross-validation.



**Figure S12.** Spatial prediction of position on the first NMDS axis of the tree layer (TL) for the LiDAR (LiD) and hyperspectral (MNF) derived predictor sets and their combination (MNF+LiD). Upper panel: averaged predictions of ten cross-validation models. Points show the plot information ( $NMDS_1$ ) used to build and evaluate the random forest models. The background image shows a CIR RGB composite of the underlying HyMap data. Lower panel: standard deviation of the predictions of the ten cross-validation models. Bar charts show the residuals between predicted and observed estimates in cross-validation.

