

*Supplementary Information*

## **Categorizing Grassland Vegetation with Full-Waveform Airborne Laser Scanning: A Feasibility Study for Detecting Natura 2000 Habitat Types. *Remote Sensing* 2014, 6, 8056–8087**

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**Table S1.** Single-band importances (all input layers, 5 classes).

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-off	NDSM		1	4.403%
Leaf-off	NDSM		3	4.212%
Difference	Reflectance		3	4.074%
Leaf-on	Reflectance		1	3.680%

Table S1. Cont.

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Difference	Reflectance		1	3.639%
Leaf-on	Reflectance		3	3.588%
Leaf-off	Reflectance		1	3.317%
Leaf-off	Reflectance		3	3.279%
Leaf-on	Echo width		3	3.216%
Leaf-off	Echo width		3	3.213%
Leaf-off	Sigma Z		1	3.100%
Leaf-on	Difference between minimum and maximum openness	2	3	2.902%
Leaf-off	Sigma Z		3	2.800%
Leaf-off	Echo width		1	2.594%
Leaf-on	Difference between minimum and maximum openness	3	3	2.431%
Leaf-on	Echo width		1	2.262%
Leaf-on	Sigma Z		1	2.248%
Leaf-on	Minimum openness	3	3	2.161%
Leaf-off	Difference between minimum and maximum openness	3	3	2.152%
Leaf-on	NDSM		3	2.138%
Leaf-off	Difference between minimum and maximum openness	2	3	2.134%
Difference	NDSM		3	1.941%
Leaf-on	NDSM		1	1.939%
Difference	NDSM		1	1.920%
Leaf-off	Minimum openness	3	3	1.761%
Leaf-on	Minimum openness	2	3	1.661%
Difference	Echo width		3	1.647%
Leaf-off	Minimum openness	2	3	1.584%
Leaf-on	Difference between minimum and maximum openness	2	Unfiltered	1.472%
Difference	Echo width		1	1.370%
Leaf-on	Sigma Z		3	1.361%
Leaf-off	Difference between minimum and maximum openness	2	Unfiltered	1.319%
Difference	Sigma Z		3	1.169%
Leaf-off	Reflectance		Unfiltered	1.092%
Leaf-on	Sigma Z		Unfiltered	1.002%
Leaf-on	Reflectance		Unfiltered	0.988%
Leaf-on	NDSM		Unfiltered	0.935%
Difference	Reflectance		Unfiltered	0.871%
Leaf-off	Sigma Z		Unfiltered	0.854%
Leaf-on	Echo width		Unfiltered	0.723%
Difference	Maximum openness	1	3	0.666%
Leaf-off	NDSM		Unfiltered	0.624%
Leaf-on	Minimum openness	1	3	0.593%
Difference	Difference between minimum and maximum openness	3	3	0.582%
Difference	Difference between minimum and maximum openness	2	3	0.527%
Leaf-off	Minimum openness	2	Unfiltered	0.494%

Table S1. Cont.

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-off	Echo width		Unfiltered	0.467%
Leaf-off	Maximum openness	2	3	0.401%
Difference	Minimum openness	2	3	0.389%
Leaf-on	Maximum openness	3	3	0.383%
Leaf-on	Maximum openness	2	3	0.382%
Difference	Minimum openness	3	3	0.379%
Difference	Sigma Z		Unfiltered	0.347%
Difference	NDSM		Unfiltered	0.344%
Leaf-on	Minimum openness	1	1	0.330%
Leaf-off	Maximum openness	3	3	0.315%
Leaf-on	Maximum openness	1	3	0.284%
Difference	Maximum openness	3	3	0.268%
Difference	Minimum openness	1	1	0.264%
Leaf-off	Difference between minimum and maximum openness	3	Unfiltered	0.251%
Difference	Maximum openness	2	3	0.238%
Leaf-on	Difference between minimum and maximum openness	3	Unfiltered	0.217%
Difference	Echo width		Unfiltered	0.207%
Leaf-on	Minimum openness	1	Unfiltered	0.185%
Leaf-on	Maximum openness	3	Unfiltered	0.157%
Leaf-off	Minimum openness	3	Unfiltered	0.154%
Leaf-on	Minimum openness	2	Unfiltered	0.154%
Leaf-on	Minimum openness	3	Unfiltered	0.149%
Leaf-off	Maximum openness	3	Unfiltered	0.117%
Difference	openness		Unfiltered	0.115%
Difference	Difference between minimum and maximum openness		Unfiltered	0.113%
Leaf-on	Maximum openness	2	Unfiltered	0.113%
Leaf-off	Maximum openness	2	Unfiltered	0.093%
Leaf-on	Maximum openness	1	1	0.092%
Difference	Minimum openness	2	Unfiltered	0.089%
Difference	Minimum openness	3	Unfiltered	0.088%
Difference	Difference between minimum and maximum openness	3	Unfiltered	0.074%
Difference	Maximum openness	3	Unfiltered	0.072%
Difference	Maximum openness	2	Unfiltered	0.067%
Leaf-on	Maximum openness	1	Unfiltered	0.064%

**Table S2.** Grouped band importances (5 categories).

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-on				21.5%
Leaf-off				40.7%
Difference				36.3%
	Reflectance			24.5%
	Echewidth			15.7%
	Sigma Z			12.9%
	NDSM			18.5%
	Maximum openness			5.2%
	Minimum openness			9.1%
	Difference between minimum and maximum openness			14.2%
		1		2.6%
		2		12.9%
		3		11.4%
			3	30.0%
			1	54.8%
			unfiltered	15.6%

**Table S3.** Single-band importances (all input layers, 10 classes).

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Difference	Reflectance		1	5.206%
Leaf-off	Echo width		3	4.320%
Leaf-off	Echo width		1	4.296%
Leaf-off	NDSM		3	4.291%
Difference	Reflectance		3	4.223%
Leaf-off	NDSM		1	4.206%
Leaf-on	Reflectance		1	3.717%
Leaf-on	Reflectance		3	3.466%
Leaf-off	Reflectance		1	3.265%
Leaf-on	Echo width		3	3.165%
Leaf-off	Reflectance		3	3.150%
Leaf-off	Difference between minimum and maximum openness	3	3	2.624%
Difference	Echo width		3	2.262%
Leaf-on	Echo width		1	2.227%
Leaf-on	NDSM		1	2.209%
Leaf-on	Sigma Z		1	2.206%
Leaf-off	Minimum openness	3	3	2.161%
Difference	NDSM		1	2.142%
Leaf-on	NDSM		3	2.126%
Leaf-off	Difference between minimum and maximum openness	2	3	2.085%
Difference	Echo width		1	2.078%

Table S3. Cont.

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-off	Sigma Z		1	2.013%
Leaf-off	Sigma Z		3	2.010%
Leaf-on	Difference between minimum and maximum openness	3	3	1.950%
Leaf-on	Difference between minimum and maximum openness	2	3	1.867%
Difference	NDSM		3	1.787%
Leaf-on	Sigma Z		3	1.722%
Leaf-off	Reflectance		Unfiltered	1.437%
Leaf-on	Minimum openness	3	3	1.381%
Difference	Minimum openness	1	3	1.336%
Leaf-off	Minimum openness	2	3	1.286%
Leaf-on	Minimum openness	2	3	1.277%
Difference	Sigma Z		3	1.215%
Difference	Reflectance		Unfiltered	1.023%
Leaf-off	Difference between minimum and maximum openness	2	Unfiltered	1.009%
Leaf-on	Reflectance		Unfiltered	0.932%
Leaf-on	NDSM		Unfiltered	0.830%
Difference	Difference between minimum and maximum openness	3	3	0.738%
Leaf-on	Difference between minimum and maximum openness	2	Unfiltered	0.701%
Leaf-off	Echo width		Unfiltered	0.662%
Leaf-on	Echo width		Unfiltered	0.513%
Leaf-off	Sigma Z		Unfiltered	0.490%
Difference	Minimum openness	3	3	0.488%
Leaf-on	Minimum openness	1	3	0.482%
Difference	Difference between minimum and maximum openness	2	3	0.473%
Leaf-off	NDSM		Unfiltered	0.430%
Difference	Minimum openness	2	3	0.420%
Leaf-on	Sigma Z		Unfiltered	0.403%
Leaf-off	Maximum openness	2	3	0.374%
Leaf-on	Maximum openness	2	3	0.335%
Difference	Sigma Z		Unfiltered	0.328%
Difference	NDSM		Unfiltered	0.316%
Leaf-off	Maximum openness	3	3	0.312%
Leaf-on	Difference between minimum and maximum openness	3	Unfiltered	0.310%
Leaf-on	Minimum openness	2	Unfiltered	0.296%
Leaf-on	Maximum openness	3	3	0.294%
Leaf-off	Minimum openness	2	Unfiltered	0.266%
Difference	Minimum openness	1	1	0.252%
Difference	Maximum openness	3	3	0.242%
Difference	Maximum openness	2	3	0.201%
Difference	Echo width		Unfiltered	0.189%
Leaf-on	Minimum openness	1	1	0.187%
Leaf-on	Maximum openness	1	3	0.171%

Table S3. Cont.

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-off	Difference between minimum and maximum openness	3	Unfiltered	0.158%
Leaf-on	Minimum openness	1	Unfiltered	0.152%
Leaf-on	Minimum openness	3	Unfiltered	0.150%
Leaf-off	Minimum openness	3	Unfiltered	0.139%
Difference	Minimum openness	1	Unfiltered	0.106%
Leaf-on	Maximum openness	3	Unfiltered	0.105%
Difference	Difference between minimum and maximum openness	2	Unfiltered	0.093%
Leaf-on	Maximum openness	2	Unfiltered	0.090%
Leaf-off	Maximum openness	3	Unfiltered	0.089%
Difference	Minimum openness	2	Unfiltered	0.088%
Difference	Minimum openness	3	Unfiltered	0.077%
Difference	Difference between minimum and maximum openness	3	Unfiltered	0.076%
Leaf-on	Maximum openness	1	1	0.073%
Leaf-off	Maximum openness	2	Unfiltered	0.071%
Difference	Maximum openness	3	Unfiltered	0.060%
Difference	Maximum openness	2	Unfiltered	0.056%
Leaf-on	Maximum openness	1	Unfiltered	0.048%

Table S4. Grouped band importances (10 categories).

Season	Attribute	Kernel Size (If Applicable)	Bilateral Filtering Similarity Parameter	Contribution to Final Accuracy
Leaf-on				32.3%
Leaf-off				41.1%
Difference				25.5%
	Reflectance			26.4%
	Echewidth			19.7%
	Sigma Z			10.4%
	NDSM			18.3 %
	Maximum openness			2.2%
	Minimum openness			11.9%
	Difference between minimum and maximum openness			12.1%
		1		2.8%
		2		10.9%
		3		11.4%
			3	34.0%
			1	54.2%
			unfiltered	11.8%