

Supplementary Materials



Figure S1. Examples of collection of reference data using Google image analysis in time: a) the plot is interpreted as unforested (Lon = 33.370047; Lat = 51.672211); b) the plot is classified as forested (Lon = 29.324394; Lat = 51.324563); c) for the period of 2010 the plot is forested but d) in 2015 is classified as unforested (Lon = 29.060559; Lat = 49.968467); e) in 2004 the plot is unforested whereas f) in 2015 is interpreted as forested (Lon = 34.403828; Lat = 50.597736)

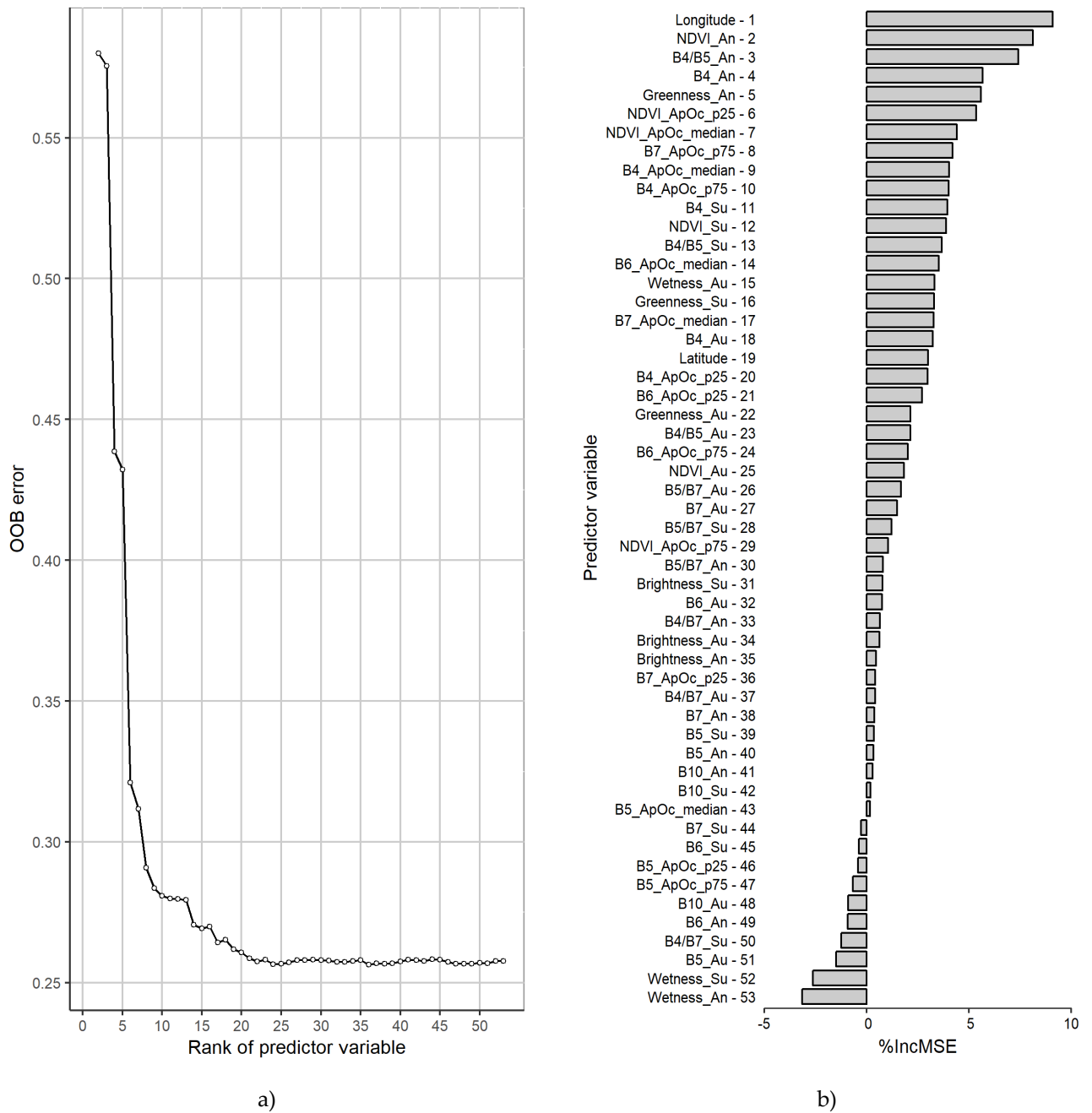


Figure S2. Impact of predictor variables onto the classification accuracy (panel a) shows the relationship between the number of variables and out-of-bag classification error, panel b) shows the ranked predictors' impact onto the decrease of MSE of a model)

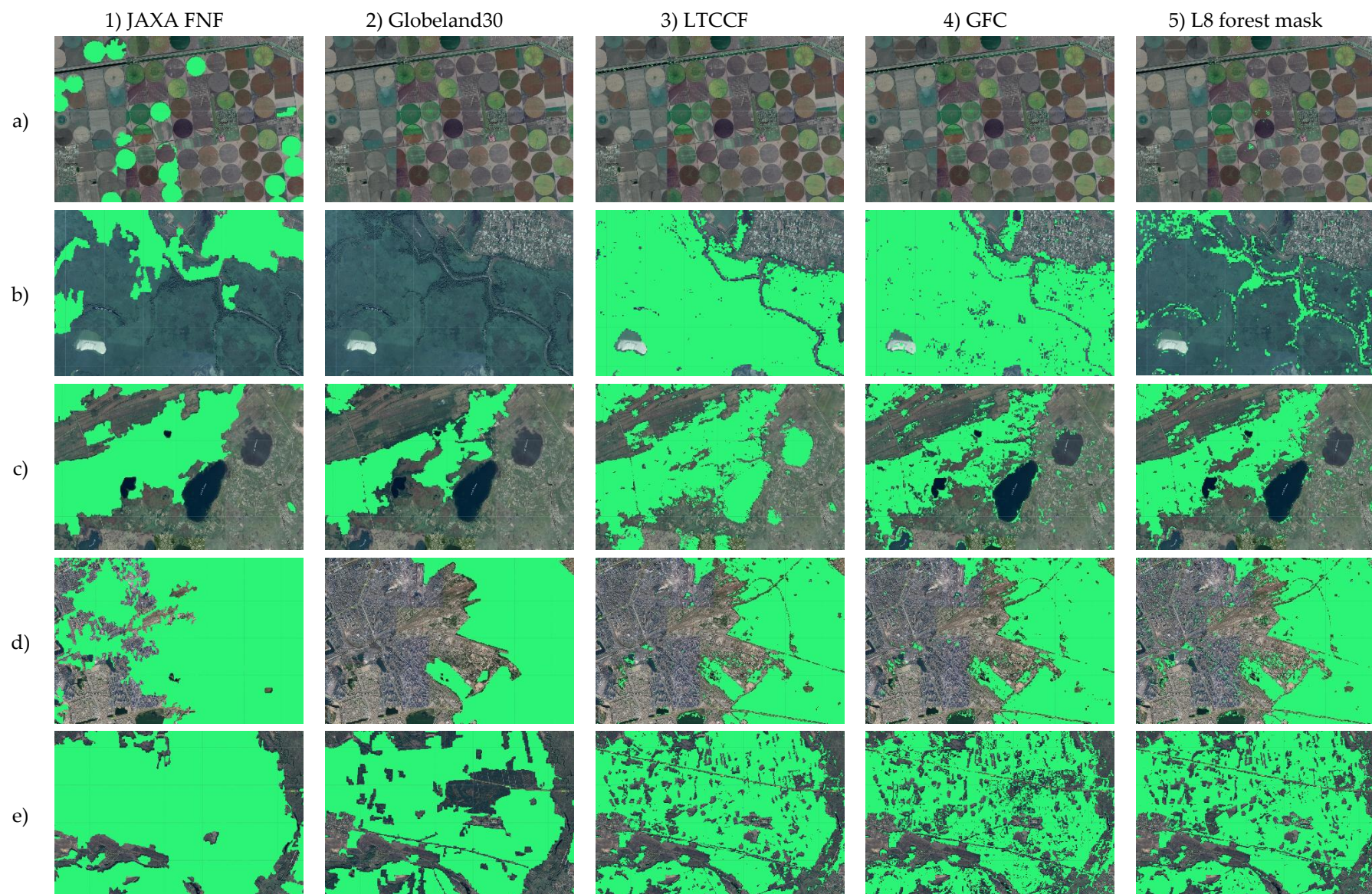


Figure S3. Examples of forest masks performance over different landscapes of flatland of Ukraine: a) irrigated croplands (Kherson oblast, Lon = 33.8736, Lat = 46.5905); b) wetlands (Odessa oblast, Lon = 30.0580, Lat = 46.4889); c) water bodies (Volyn (Lutsk) oblast, Lon = 24.1981, Lat = 51.4958); d) settlements (Kyiv oblast, Lon = 30.6755, Lat = 50.4186); e) clearcuts, meadows, unstocked forest crops (Zhytomyr oblast, Lon = 29.5300, Lat = 50.7236)

Table S1. The error matrix of Landsat-derived land cover classification over flat land Ukraine expressed in terms of the proportion of area as suggested in Olofsson et al. (2014)

Map class	Reference class								Total number of units	Map class area, thousands ha	The proportion of map class (weight)	Adjusted proportion of area of map class
	water bodies	wetlands	Settlements	other unproductive lands	croplands	grasslands	shrubland	forests				
Water bodies	0.025	0.001	0.000	0.001	0	0	0.000	0.000	900	1424.7	0.026	0.025
Wetlands	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000	900	400.4	0.007	0.023
Settlements	0.000	0.000	0.031	0.001	0.002	0.001	0.000	0.001	898	1941.5	0.036	0.035
Other unproductive lands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	898	22.7	0.000	0.003
Croplands	0	0.003	0.001	0	0.556	0.037	0.002	0.007	2232	32857.3	0.606	0.580
Grasslands	0	0.009	0.002	0.001	0.019	0.105	0.006	0.012	1176	8341.3	0.154	0.148
Shrublands	0.000	0.000	0.000	0	0.001	0.000	0.001	0.001	900	156.3	0.003	0.012
Forests	0.000	0.004	0.001	0.000	0.003	0.004	0.002	0.153¹	1333	9111.7	0.168	0.174 ²

¹ The proportion of correctly classified sample units for the map class “forests” (\hat{p}_{ij}) was calculated using data from Table 4 and weighted of this class $W_i = 0,168$ (Table 4) as follows:

$$\hat{p}_{ij} = W_i \cdot \frac{n_{ij}}{n_i} = 0.168 \cdot \frac{1213}{1333} = 0.153, \quad (1)$$

where \hat{p}_{ij} denotes sample-based estimator of proportion mapped class i and reference class j ; W_i is the proportion of map area of class i ; n_{ij} is the number of sample units mapped as class i that belong to reference class j ; n_i is a total number of sample units mapped as class i .

²The adjusted proportion of area of class “forest” ($\hat{p}_{\cdot k}$) was calculated as the sum of the proportions of class “forest” from the reference classification (the sum of the column “forest” of Table S1):

$$\hat{p}_{\cdot k} = \sum_{i=1}^q \hat{p}_{ik} = 0.153 + 0.001 + 0.012 + 0.007 + 0.001 = 0.174, \quad (2)$$

where q denotes number of classes; \hat{p}_{ik} represents the proportion of area mapped as class k (i.e. “forest”)

The estimated forested area (\hat{A}_k) was calculated using estimated proportion of area of class “forest” ($\hat{p}_{\cdot k}$) and total map area (A):

$$\hat{A}_k = A \cdot \hat{p}_{\cdot k} = 54.256 \cdot 0.174 = 9.441 \text{ million ha.} \quad (3)$$

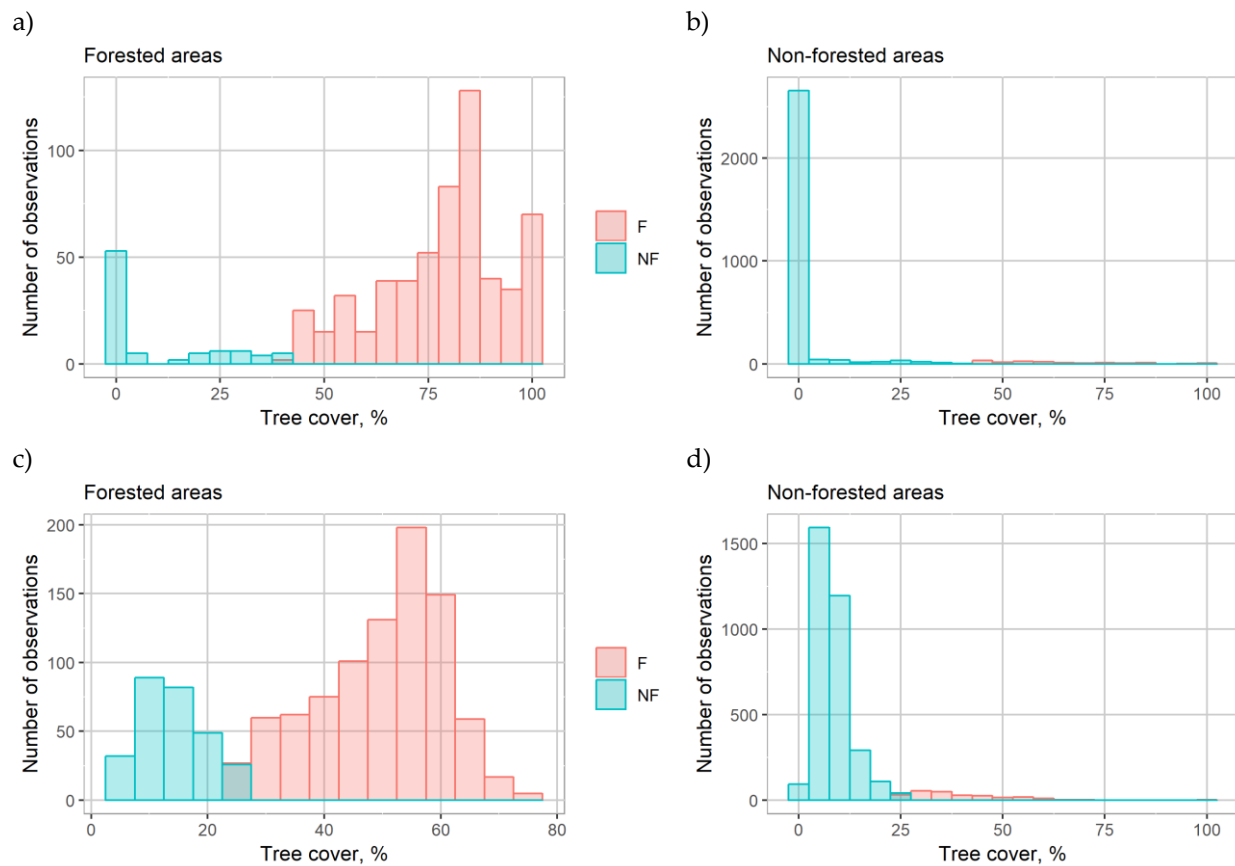


Figure S4. Distribution of reference sample units on tree cover values: a) GFC forested areas; b) GFC non-forested areas; c) LTCCF forested areas; d) LTCCF non-forested areas. F represents samples that would be classified as forests, NF – non-forests if a threshold of 40% is applied to GFC and 25% to LTCCF datasets

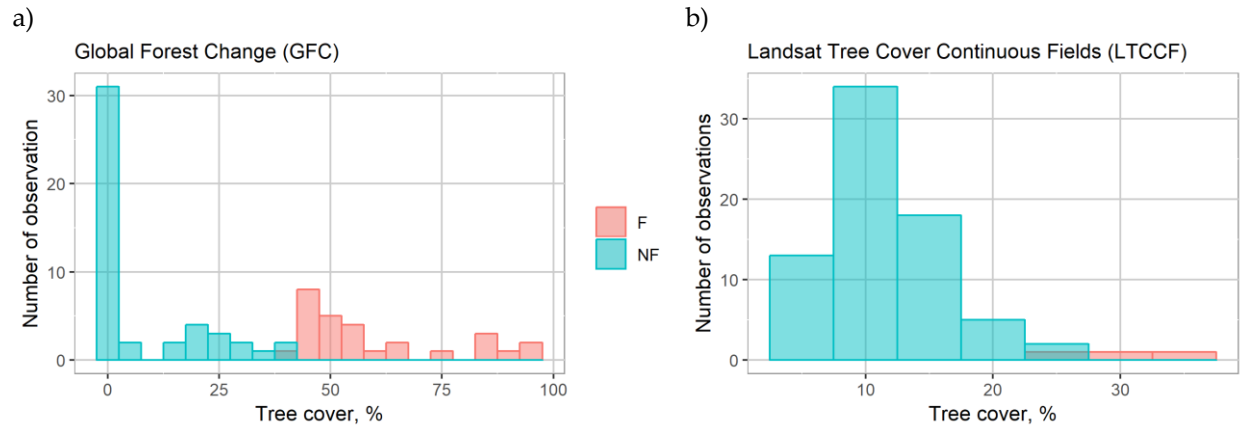


Figure S5. Distribution of tree cover values of windbreaks: a) GFC; b) LTCCF. F represents samples that would be classified as forests, NF – non-forests if a threshold of 40% is applied to GFC and 25% to LTCCF datasets

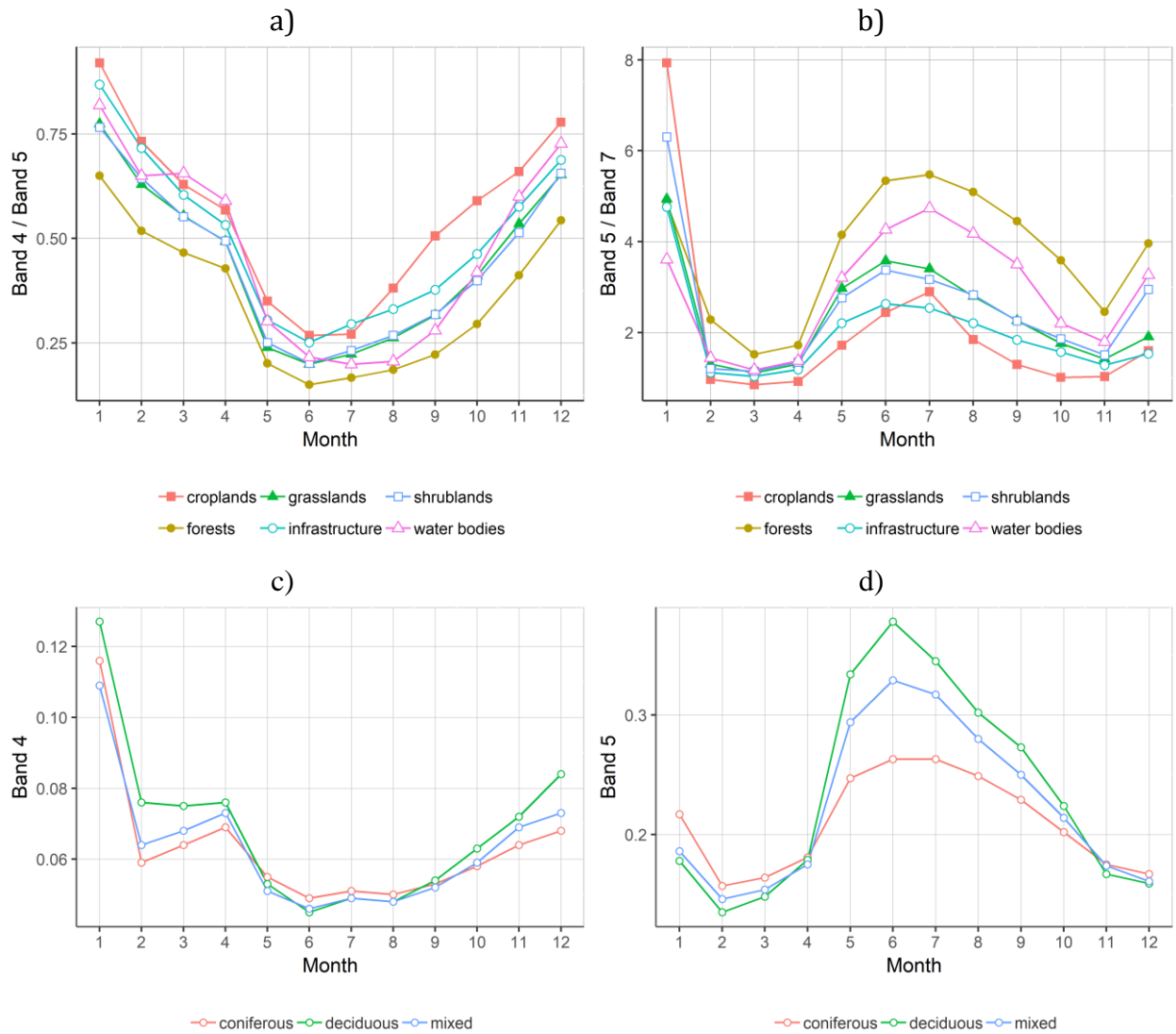


Figure S6. Examples of monthly dynamics of spectral features of Landsat 8 OLI time series: a), b) land cover classes; c), d) groups of forest stands