FunDivEUROPE

Functional significance of forest biodiversity in Europe

Project number: 265171

Digital cameras for monitoring the temporal dynamics of forest structures

FunDivEUROPE (FP7) field protocol

V1.0

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Content

1 Introduction

Biodiversity and climate research require knowledge on the timing of phenological events, such as plant growth and senescence (Menzel et al., 2006). This kind of knowledge is particularly difficult to obtain at the level of forest plots. New generation of low-cost automated timelapse cameras can now fill the gap. Timelapse photography consists of taking a picture at specified intervals to capture an event occurring over a longer period of time.

2 Scope and application

Timelapse photography will be used in the context of the FunDivEUROPE project to evaluate the independent effects of tree biodiversity and climate (temperature and precipitation) on the timing of phenological events at the observational level of forest plots.

3 Objectives

The objective of this protocol is to quantify the spatial and temporal dynamics of forest structures at the plot level. Time-series of digital images will be recorded at each forest plot from March to October in 2012-2013. Starting (green-up) and ending (green-down) dates, as well as dates of maximum and peak growth will be extracted using image greenness indices. Seasonal change in light interception/reflection patterns across the forest canopy will be quantified using image texture indices. Greenness and texture indices will be calculated for different regions of interest (ROI) in the digital image.

4 Location of measurements and sampling

One camera will be installed to a large (DBH > 10cm) and visually healthy tree, which main trunk is perpendicular to (forms a 90° angle with) the ground slope. The camera will be installed at a height of 2m on the tree side (see the picture at the bottom of p. 13 in the PlantCam user guide) and oriented towards the magnetic North. Within 5m from the camera, there should be no large trees (DBH > 10cm) in the camera's field of view. The laser pointer mounted on the camera should hit the ground at a distance of approximately 25m (turn the arrow to the "Laser aim" position). Thin layers of foam may be inserted on the back of the camera to secure its position on the tree. The camera should be tightly strapped as shown on p. 13 of the used guide (Figure 1).

Figure 1: The included strap and stretch cords can be attached to the mounting points on the back of the camera and used to secure the camera directly to a tree.

NOTE 1: The camera's field of view should be *representative of the species richness and diversity of the plot*. In many cases, the easiest approach will be to choose a large tree at the southern edge of the plot, such that the camera is facing towards plot. The field technician has some flexibility regarding the following setup conditions (the first condition being the most flexible one): i) the perpendicular angle of the tree supporting the camera, ii) the height of the camera on the tree trunk, ii) the distance at which the laser pointer hits the ground, and iv) the northing orientation of the camera.

NOTE 2: If the tree supporting the camera has no FunDivEUROPE ID, the longitude and latitude coordinates of that tree must be recorded, as well as its distance to the plot centre.

NOTE 3: If it is too difficult to tell the distance at which the camera's laser pointer hits the ground, an alternative approach is to use its viewfinder. Using the viewfinder, the technician should insure that the field of view is split in half on the vertical axis; i.e., is showing a *soil-herb-seedling-sapling* ground layer on the bottom half section of the image and a *sapling-understorey-overstorey* canopy layer on the top half section.

NOTE 4: The field technician should make sure that the camera does not overly attract the attention of other forest users not associated to FunDivEUROPE. Grey "duck tape" may be used to cover the sides of the camera before strapping it to the tree.

NOTE 5: An 18% grey card (approximately 0.25 x 0.25 cm in size) within the camera's field of view will be nailed to a tree at a height of about 2m and a distance of about 10 m from the camera lens.

4.1 Field sampling design

The camera will be programmed with the following parameters (turn the arrow to "Setup"): Time lapse interval of three hours; Photo mode; High photo quality mode; 2-shot mode; Daily wakeup at 6am, Daily sleep at 9pm, Imprint information = No; Erase image = No. When done, turn the arrow back to "Auto" to start the program. Finally, set the focus range at 3'+. Make sure that a formatted (image free) 2G SD memory card is inserted.

4.2 Number of replicates

Over March-October period, each camera will take 819 images (29 weeks x 7 days x 7 time intervals x 2 shots).

4.3 Sampling scheme

One camera will be installed on each Exploratory plot. The functionality of all cameras will be verified in the computer lab.

4.4 Sampling equipment

PlantCam timelapse camera Model WSCA04-00106 (Wingscapes, Alabaster, AL, USA).

4.5 Frequency of sampling

A minimum of two visits per year will be needed. A first visit will be necessary for strapping the cameras in March and another visit for dismounting them in October.

5 Measurements

Regions of interest (ROI) in a given image will be selected at the computer lab following the field season. These ROI should at least include four regions: i) the whole image, ii) one overstorey canopy layer, iii) one understorey canopy layer, and iv) one non-vegetated ground layer. Image reflectances will be corrected using the 18% grey card. Various image greenness (e.g., Lebourgeois et al., 2008; Richardson et al., 2009) and texture (e.g., Amadasun and King, 1989; Proulx and Parrott, 2008) indices will be calculated on the ROI to provide proxy measures of primary production, patterns of light interception/reflection, and litterfall decomposition.

For each ROI time-series, the mean and variance of log-transformed indices will be calculated. Mean values will be used as *aggregated measures* of forest primary production, light interception/reflection pattern, and litterfall decomposition. Variance values will be used as reciprocal measures of *temporal stability* in forest primary production, light interception/reflection pattern, and litterfall decomposition. These measures will be made available to the FunDivEUROPE project database for further validation and modelling analyses (see section 8 b).

6 Data template

Sampling protocol: FunDiv T.II.5_Template1

Plot_ID	Plot_Diversity	CamDate	Temperature	CamOrientation	CamTechnician	CamTree_ID	CamTree_Lat	CamTree_Long	CamTree_Dist	GreyCard

Metadata T.II.5_Template1

Plot_ID	FunDiv ID of the plot
Plot_Diversity	FunDiv Diversity Level
CamDate	Year/Month/Day
Temperature	Ambiant air temperature on that date
CamOrientation	Degrees East or West of magnetic North (Azimuth)
CamTechnician	Name of the field technician
CamTree_ID	FunDiv ID of the tree (if available)
CamTree_Lat	Degree latitude
CamTree_Long	Degree longitute
CamTree_Dist	Shortest distance of the CamTree to plot centre
GreyCard	Was the 18% grey card nailed? (Yes or No)

Sampling protocol: FunDiv T.II.5_Template 2

Plot_ID	Date	DayTime	ROI_1_Text_1	ROI_X_Text_1	ROI_1_Text_Y	ROI_X_Text_Y	ROI_1_Green_1	ROI_X_Green_1	ROI_1_Green_Z	ROI_X_Green_Z

Metadata T.II.5_Template2

Plot_ID	FunDiv ID of the plot
Date	Date of the image (Year/Month/Day)
DayTime	Hour of the image (0-24)
ROI...	Regions of Interest (1-X) in the image of a given plot
Text...	Texture indices (1-Y) for a given ROI of a given plot
Green...	Greenness indices (1-Z) for a given ROI of a given plot

7 References

Amadasun M, King R (1989) Textural features corresponding to textural properties. IEEE Transactions on Systems, Man, and Cybernetics 19: 1264-1274.

Lebourgeois V, Bégué A, Labbé S, Mallavan B, Prévot L, Roux B (2008) Can commercial digital cameras be used as multispectral sensors? A crop monitoring test. Sensors 8: 7300-7322.

Menzel A et al. (2006) European phenological response to climate change matches the warming pattern. Global Change Biology 12: 1969-1976.

Proulx R, Parrott L (2008) Measures of structural complexity in digital images for monitoring the ecological signature of an old-growth forest ecosystem. Ecological Indicators 8: 270-284.

Richardson AD, Braswell BH, Hollinger DY, Jenkin JP, Ollinger SV (2009) Near-surface remote sensing of spatial and temporal variation in canopy phenology. Ecological Applications 19: 1417-1428.