Results of the European Photo International Cross-comparison Course as part of the quality assurance of the crown condition assessment 2015 (Photo ICC 2015)

Stefan Meining, Yvonne Morgenstern, Nicole Wellbrock, Nadine Eickenscheidt

Thünen Working Paper 61

Stefan Meining
Dr. Yvonne Morgenstern
Büro für Umweltüberwachung Freiburg
Im Sauergarten 84
79112 Freiburg
Telefon: 07664 – 4037661
E-Mail:
mail@stefanmeining.de

Dr. Nicole Wellbrock
Dr. Nadine Eickenscheidt
Thünen-Institut für Waldökosysteme
Alfred-Möller-Str. 1
16225 Eberswalde
Telefon: 03334 – 3820304
E-Mail:
nicole.wellbrock@thuenen.de,
nadine.eickenscheidt@thuenen.de

Thünen Working Paper 61

Eberswalde/Germany, im August 2016

Abstract

Photo ICCs represent one of different measures for quality assurance of the crown condition survey, which is part of the European forest monitoring. The European Photo ICC 2015 took place between June 23rd and September 29th and was carried out for the three regions Northern, Central and Mediterranean Europe. In total 123 teams participated. The defoliation and assessable crown were assessed on the basis of photos for all main tree species of one region. Half of the photos had already been used at the Photo ICC 2010. The mean deviation of the countries from the weighted median of all countries of one region was evaluated as well as the occurrence of outliers and the specification of the assessable crown. The repeatedly used photos further enabled the evaluation of the assessment continuity. The results reveal a good homogeneity of the defoliation assessment within Europe. The mean deviation of the countries usually lay within a ±10%-interval and most countries only showed few outliers. For some regions and tree species, however, systematic differences in the defoliation assessment among countries were observed. Countries participating in the Photo ICC for two regions, in general displayed the same trend for both regions. Differences in the definition of the assessable crown did not result in larger deviations regarding the defoliation assessment. In Central Europe, the defoliation of beech (*Fagus sylvatica*) and oak (*Quercus robur* und *Q. petraea*) was significantly higher for the same photos in 2015 than in 2010. This observation existed for almost all participating countries. Several reasons for this increase are possible like differences in the quality of the printed photos or varying experience of teams in the defoliation assessment. No significant differences between 2010 and 2015 were found for the investigated tree species of Northern and Mediterranean Europe as well as for the coniferous tree species of Central Europe. The results of the Photo ICC 2015 underline the need to carry out photo courses as regular quality assurance in the crown condition survey. The advantages include the reproducibility of results, the option of testing the continuity of assessment, participation of a larger number of teams and saving of costs and time. Thus, Photo ICCs represent a useful addition to nation-wide and European-wide Field ICCs to ensure data quality in the crown condition survey.

Key words: defoliation, crown condition survey, forest monitoring, quality assurance, international cross-comparison course

Zusammenfassung

Photo-ICCs stellen eine von verschiedenen Maßnahmen zur Qualitätssicherung der Kronenzustandsansprache im Rahmen des europaweit stattfindenden Forstlichen Umweltmonitorings dar. Der europäische Photo-ICC 2015 wurde im Zeitraum vom 23.06. bis 29.09.2015 für die drei Regionen Nord-, Mittel- und Südeuropa durchgeführt. Insgesamt haben 123 Teams an dem Photo-ICC 2015 teilgenommen. Anhand von Fotos wurden die Kronenverlichtung und der Boniturbereich der jeweiligen Hauptbaumarten einer Region bestimmt. Die Hälfte der Fotos fand bereits im Photo-ICC 2010 Verwendung. Bewertet wurde die mittlere Abweichung der Länder vom gewichteten Median aller Länder einer Region, das Vorkommen von Ausreißern sowie die Wahl des Boniturbereichs. Die Wiederholungsfotos ermöglichten außerdem eine Aussage über die Schätzkontinuität. Die Ergebnisse belegen insgesamt eine gute Homogenität der Kronenzustandsansprache innerhalb Europas. Die mittleren Abweichungen bewegten sich i.d.R. im ±10%-Abweichungsbereich und die meisten Länder wiesen nur wenige Ausreißer auf. Allerdings konnten auch systematische Abweichungen einzelner Länder beobachtet werden. Länder die am Photo-ICC für zwei Regionen teilgenommen haben, zeigten meist den gleichen Trend für beide Regionen. Die unterschiedliche Definition des Boniturbereichs führte nicht zu deutlichen Änderungen in der Bewertung der Kronenverlichtung. In Mitteleuropa wurde die Kronenverlichtung der Buche (*Fagus sylvatica*) und Eiche (*Quercus robur* und *Q. petraea*) für dieselben Fotos und für fast jedes teilnehmende Land 2015 signifikant höher eingeschätzt als 2010. Diese Beobachtung kann verschiedene Gründe haben z.B. Unterschiede in der Druckbildqualität oder unterschiedliche Erfahrung in der Ansprache der Teams. Für die betrachteten Baumarten Nord- und Südeuropas sowie für die Nadelbäume Mitteleuropas wurden keine signifikante Abweichung in der Bewertung gefunden. Die Ergebnisse des Photo-ICC 2015 unterstreichen die Notwendigkeit, Photo-ICCs als regelmäßige Qualitätssicherungsmaßnahme in der Kronenzustandsaufnahme durchzuführen. Photo-ICCs sind durch die Reproduzierbarkeit der Ergebnisse, durch die Überprüfung der Schätzkontinuität und durch die hohe Erreichbarkeit teilnehmender Aufnahmeteams in Ergänzung zu den Feld-Schulungen auf Landes- und Europaebene eine sinnvolle Ergänzung zur Sicherung der Datenqualität in der Kronenzustandserhebung.

Schlüsselwörter: Kronenverlichtung, Kronenzustandserhebung, Forstliches Umweltmonitoring, Qualitätssicherung, internationaler Foto-Vergleichskurs

Table of Contents

1 Introduction 1

2 Methods 1

3 Results 6

3.1 Northern Europe 6
3.1.1 North: Mean Defoliation 6
3.1.2 North: Outliers 8
3.1.3 North: Assessable Crown 10
3.1.4 North: Continuity of the Assessment 11

3.2 Central Europe 14
3.2.1 Central: Mean Defoliation 14
3.2.2 Central: Outliers 17
3.2.3 Central: Assessable Crown 19
3.2.4 Central: Continuity of the Assessment 21

3.3 Mediterranean Europe 25
3.3.1 Mediterranean: Mean Defoliation 25
3.3.2 Mediterranean: Outliers 27
3.3.3 Mediterranean: Assessable Crown 30
3.3.4 Mediterranean: Continuity of the Assessment 32

4 Conclusion 34

5 References 36

6 Annex 37

List of Figures

Fig. 1: Countries and number of teams per country which participated in the Photo ICC 2015. 2

Fig. 2: Picture of the Photo ICC 2015 (*Picea abies*) with a scale on both sides for defining the assessable crown. 4

Fig. 3: Linear regression line (black) with 95% confidence interval (indicated by the green and red lines) based on defoliation assessments of all teams (blue points) for one tree species. 5

Fig. 4: Northern Europe - Distribution of the defoliation data for each country and for all countries together (red box) for *Picea abies* (above) and *Pinus sylvestris* (below) using the EU-method for the assessable crown. 7

Fig. 5: Northern Europe – Frequency of outlier classes for *Picea abies* (left) and *Pinus sylvestris* (right). The values were rounded. 8

Fig. 6: Northern Europe - Outlier classification for each team and both tree species, *Picea abies* (left) and *Pinus sylvestris* (right). 9

Fig. 7: Northern Europe – Mean number of positive and negative outliers for each country for *Pinus sylvestris* and *Picea abies*. 10

Fig. 8: Northern Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Picea abies* (left) and *Pinus sylvestris* (right). 10

Fig. 9: Northern Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Picea abies* (left) and *Pinus sylvestris* (right). 11

Fig. 10: Northern Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. 12

Fig. 11: Northern Europe – Defoliation assessment of the same pictures 2010 and 2015 for Picea abies (above) and Pinus sylvestris (below). 13

Fig. 12: Central Europe –Distribution of the defoliation data for each country for *Fagus sylvatica* (above) and *Picea abies* (below) using the EU-method for the assessable crown. 15

Fig. 13: Central Europe –Distribution of the defoliation data for each country for *Pinus sylvestris* (above) and *Quercus robur* (below) using the EU-method for the assessable crown. 16

Fig. 14: Central Europe: Frequency of outlier classes for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below). 17

Fig. 15: Central Europe − Outlier classification for each team and the tree species, *Fagus sylvatica*, *Picea abies*, *Pinus sylvestris* and *Quercus robur* (from left to right). 18

Fig. 16: Central Europe – Mean number of positive and negative outliers for each country for *Fagus sylvatica* and *Pinus sylvestris* (above) and *Picea abies* and *Quercus robur* (below). 19

Fig. 17: Central Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below). 20

Fig. 18: Central Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below). 21

Fig. 19: Central Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. 22

Fig. 20: Central Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Fagus sylvatica* (above) and *Picea abies* (below). 23

Fig. 21: Central Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Pinus sylvestris* (above) and *Quercus robur* (below). 24

Fig. 22: Mediterranean Europe − Distribution of the defoliation data for each country for *Pinus pinaster* (above) and *Pinus sylvestris* (below) using the EU-method for the assessable crown. 26

Fig. 23: Mediterranean Europe − Distribution of the defoliation data for each country for *Quercus ilex* using the EU-method for the assessable crown. 27

Fig. 24: Mediterranean Europe: Frequency of outlier classes for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below). 28

Fig. 25: Mediterranean Europe − Outlier classification for each team and the tree species, *Pinus pinaster*, *Pinus sylvestris* and *Quercus ilex* (from left to right). 29

Fig. 26: Mediterranean Europe − Mean number of positive and negative outliers for each country for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below). 30

Fig. 27: Mediterranean Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below). 31

Fig. 28: Mediterranean Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below). 31

Fig. 29: Mediterranean Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. 32

Fig. 30: Mediterranean Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Pinus pinaster* (above) and *Pinus sylvestris* (below). 33

Fig. 31: Mediterranean Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Quercus ilex*. 34

List of Tables

Tab. 1: European regions and tree species of the Photo ICC 2015. 2

Tab. 2: Classification of the assessment quality using outliers. 5

1 Introduction

The assessment of crown condition is an essential part of the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) which has been carried out in Europe since the mid-1980s. The crown condition is assessed using both monitoring levels: the large scale monitoring (Level I) and the intensive monitoring scale (Level II). Defoliation represents the main parameter of the crown condition assessment. The defoliation assessment is carried out visually using binoculars and the estimate is given in 5% classes from 0% (healthy tree) to 100% (dead tree).

Quality assurance is essential in forest monitoring to ensure a good quality of data, thus several measures of quality assurance have been implemented. The crown condition assessment is conducted by qualified teams that take part in national calibration courses as well as in international comparison courses. International Cross-comparison Courses (ICCs) allow the comparison of differences in tree assessment among several countries (and teams). Field ICCs are important to compare the tree assessment under field conditions looking at different parameters such as defoliation, fructification and biotic or abiotic damages.

In addition to field courses, photo courses (Photo ICCs) provide a good option for additional quality assurance at least for the parameter defoliation. The advantages include the reproducibility of results, the option of testing the continuity of tree assessment, participation of a larger number of teams and saving of costs and time. The present study reports the results of the European Photo ICC in 2015.

2 Methods

The Photo ICC was carried out from June 23rd to September 29th 2015. The evaluations were conducted for three regions: Northern Europe, Central Europe and Mediterranean Europe. In Northern Europe nine countries with 35 teams participated, in Central Europe twelve countries with 66 teams and in Mediterranean Europe three countries with 22 teams. The number of attending teams per country varied from one to 41 (Fig. 1). In total, 123 teams participated in the Photo ICC 2015. In each region different tree species were assessed (Tab. 1).

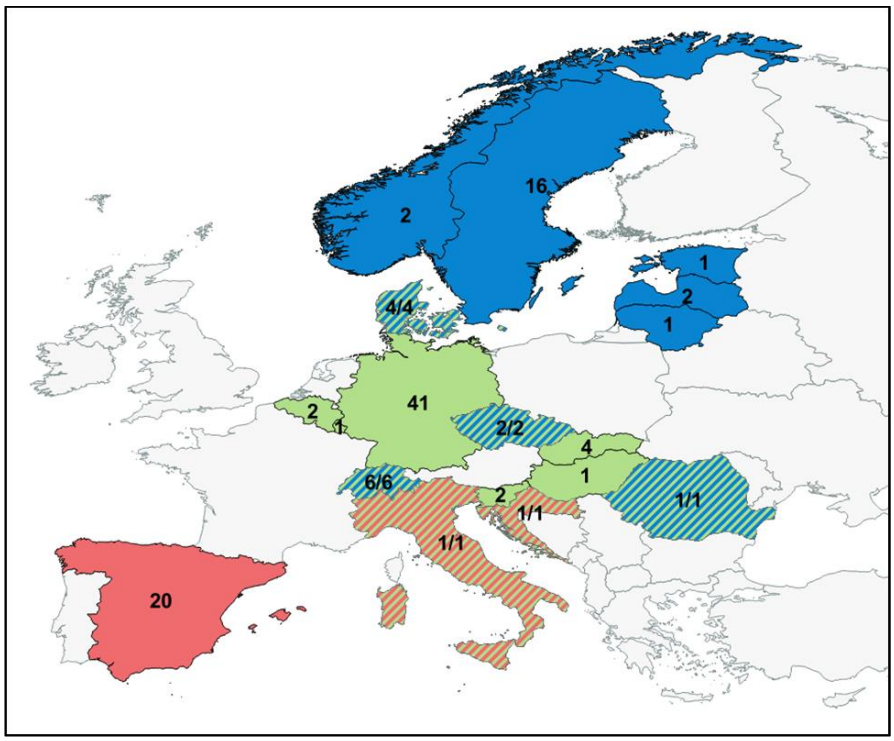


Fig. 1: Countries and number of teams per country which participated in the Photo ICC 2015. The blue colour indicates countries that attended in the Photo ICC of Northern Europe, the green colour represents the Photo ICC of Central Europe and the red colour the Photo ICC of Mediterranean Europe.

Tab. 1: European regions and tree species of the Photo ICC 2015.

Region	Tree Species
Northern Region	Scots pine (*Pinus sylvestris*)
	Norway spruce (*Picea abies)*
Central Europe	European beech (*Fagus sylvatica*)
	Norwy spruce (*Picea abies*)
	Scots pine (*Pinus sylvestris*)
	European oak (*Quercus petraea* and *Q. robur*)
Mediterranean Europe	Scots pine (Pinus sylvestris)
	Maritime pine (Pinus pinaster)
	Mediterranean oak (Quercus ilex)

High quality paper prints were prepared. Every team evaluated the defoliation of 30 pictures for each tree species and specified the assessable crown using the printed scale on both sides of the pictures (Fig. 2). Due to historical reasons some countries use different definitions of the assessable crown. Therefore, the defoliation assessment was done using two definitions of the assessable crown: a national definition and an EU wide definition, which is described in the ICP-Manual “Visual Assessment of Crown Condition and Damaging Agents” (Eichhorn et al. 2010a).

The pictures were selected and pre-assessed by one coordinator for each region: Sören Wulff (Northern Europe), Stefan Meining (Central Europe) and Paola Garcia (Mediterranean Europe).

For data analysis among the states the defoliation value of the EU-method for the assessable crown was used. The difference in defining the assessable crown between national and EU-method and the score of defoliation was evaluated separately. For the determination of outliers routines of the Photo ICC 2010 were used and further developed (Eichhorn et al. 2010b). In this linear model the evaluation of each team is compared to the values of all other teams (Fig. 3). The linear regression and a confidence interval of 95% indicate the assessment of each team. Assessments are classed as outliers if they are outside the specified limit of error (95% confidence interval). The classification of outliers is shown in Tab. 2.

For each species 15 of the 30 pictures were already used in the Photo ICC 2010. Therefore it was possible to have a look at the continuity of the assessment. By judging the results it has to be considered that there were personnel changes between the two surveys, which means that the pictures were not always assessed by the same teams. In this report, the main results are usually presented by country level. Further analyses at team level will be provided separately to the countries for internal review. All evaluations were performed using the statistic software R version 3.2.0 (R Development Core Team 2015).

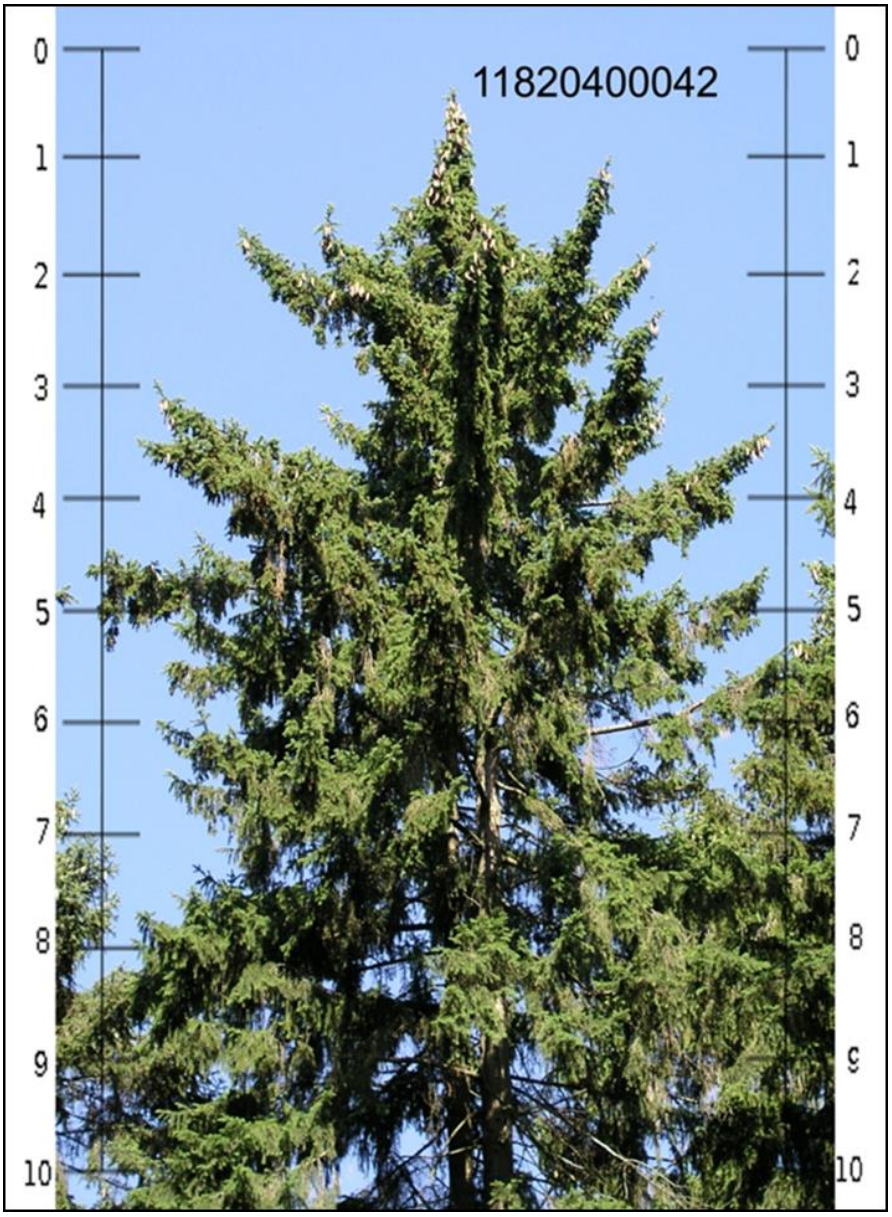


Fig. 2: Picture of the Photo ICC 2015 (*Picea abies*) with a scale on both sides for defining the assessable crown.

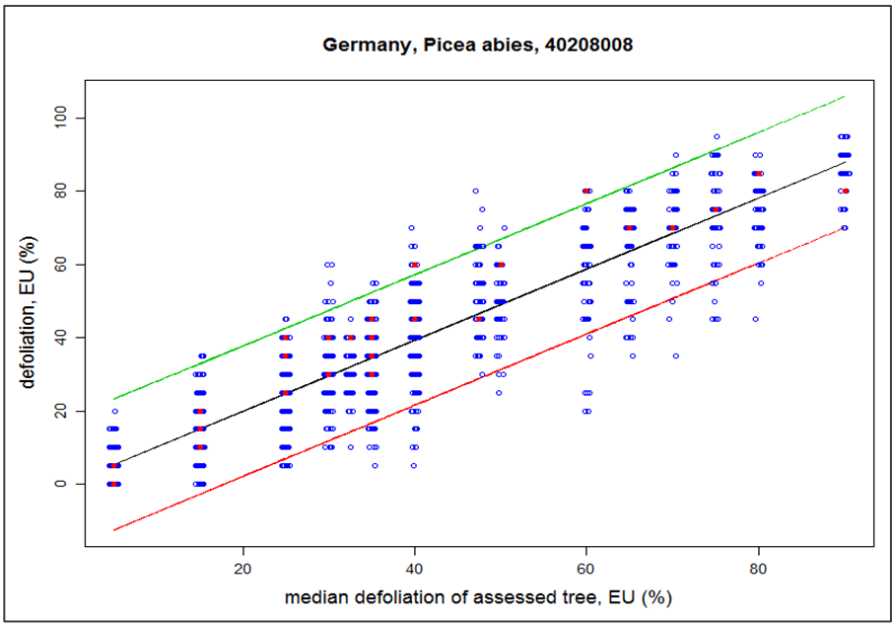


Fig. 3: Linear regression line (black) with 95% confidence interval (indicated by the green and red lines) based on defoliation assessments of all teams (blue points) for one tree species. Values outside the 95% confidence intervals are referred to as outliers. The red points indicate the assessment of the investigated team.

Tab. 2: Classification of the assessment quality using outliers.

scale 1:	0 outliers		very good
scale 2:	1 to 5 outliers		good
scale 3:	6 to 10 outliers		average
scale 4:	11 to 15 outliers		bad
scale 5:	> 16 outliers		very bad

3 Results

3.1 Northern Europe

3.1.1 North: Mean Defoliation

For Northern Europe the species *Picea abies* and *Pinus sylvestris* were assessed by nine different countries and in total 35 teams. The median of defoliation over all countries (weighted by the number of teams) is 36.8% for *Picea abies* and 34.5% for *Pinus sylvestris* (Fig. 4). The median of most countries does not deviate more than ±10% from the median of all countries, regarding both species. However, for both species a higher negative deviation from the overall median is observed for Norway and a higher positive deviation is observed for Romania. For *Picea abies* also the median of Denmark lies more than -10% below the overall median.

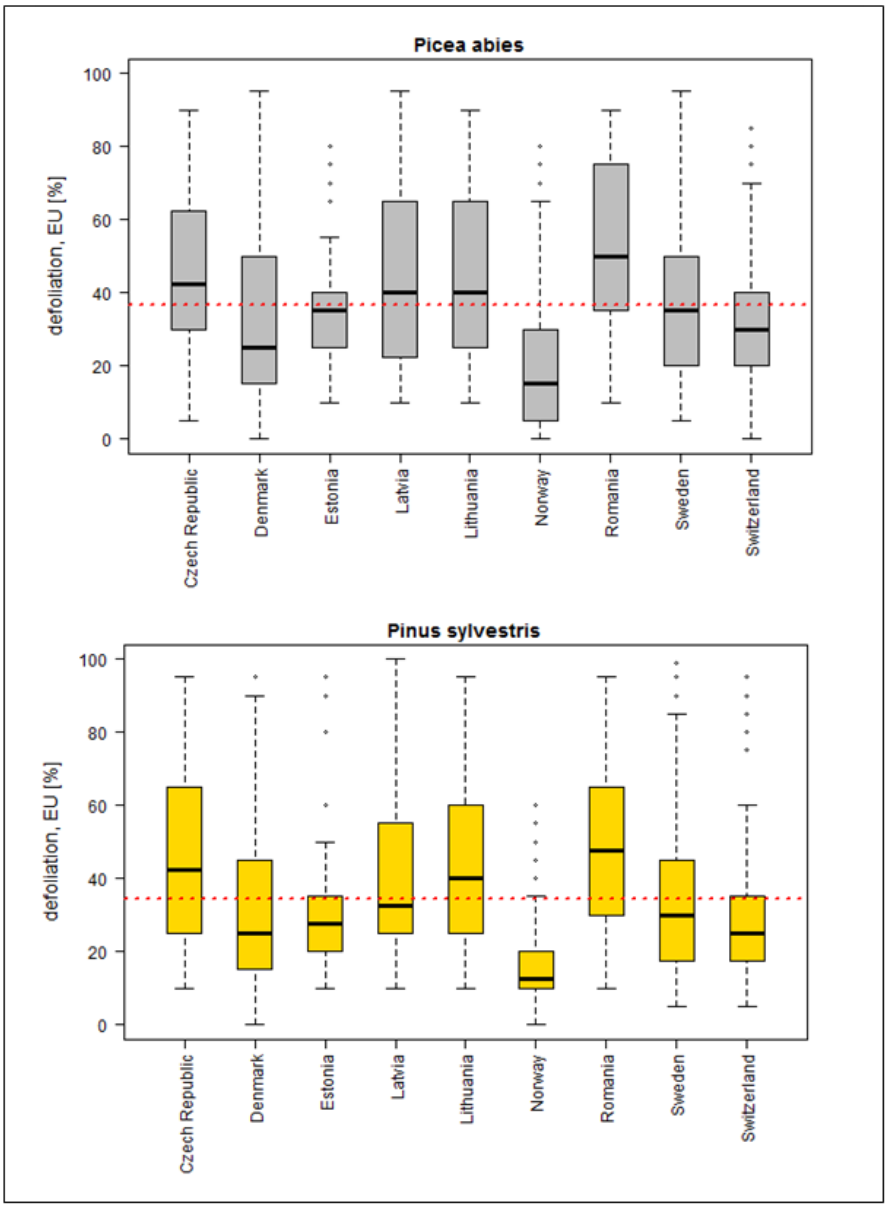


Fig. 4: Northern Europe - Distribution of the defoliation data for each country and for all countries together (red box) for *Picea abies* (above) and *Pinus sylvestris* (below) using the EU-method for the assessable crown. The black line represents the median and the lower and upper border of the box indicates the lower and upper quartile. The dashed red line represents the weighted median of all countries.

3.1.2 North: Outliers

Fig. 5 and Fig. 6 the assessment quality of the teams of Northern Europe is shown using the outlier classification for the assessment. For both species (*Picea abies* and *Picea sylvatica*) the classification classes “very good” to “good” (dark green to light green) are clearly predominating. More than ten outliers do not occur for all countries and both species.

Fig. 7 presents the direction of the outliers per country. Countries having a high number of outliers show a clear direction of outliers, which also corresponds to the position of the observed median compared to the overall median (Fig. 4).

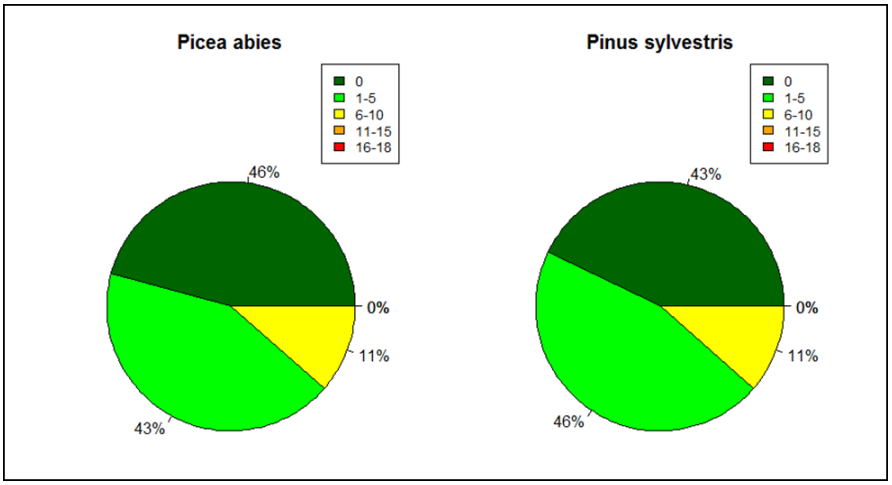


Fig. 5: Northern Europe – Frequency of outlier classes for *Picea abies* (left) and *Pinus sylvestris* (right). The values were rounded.

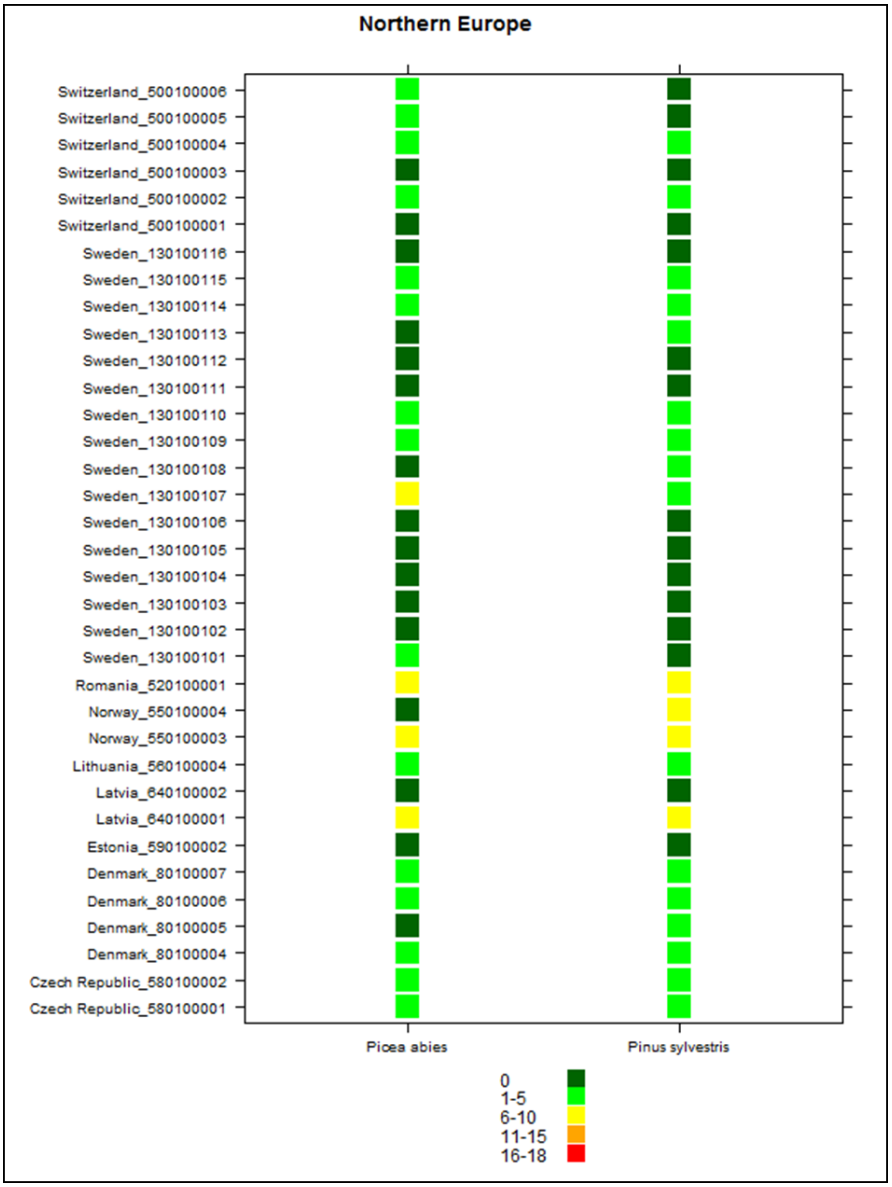


Fig. 6: Northern Europe - Outlier classification for each team and both tree species, *Picea abies* (left) and *Pinus sylvestris* (right).

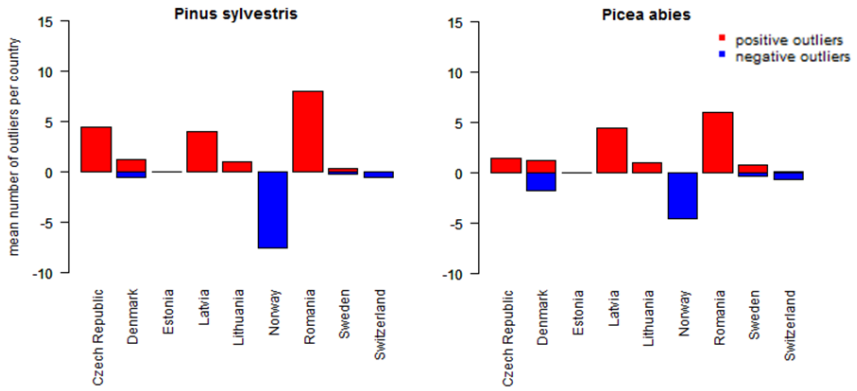


Fig. 7: Northern Europe – Mean number of positive and negative outliers for each country for *Pinus sylvestris* and *Picea abies*.

3.1.3 North: Assessable Crown

Fig. 8 shows the mean score of the assessable crown given by each country according to the national method and the EU-method for both species *Picea abies* and *Pinus sylvestris*. Most countries show differences in defining the assessable crown using the national or the EU-method. Although there are countries with differences in the definition of the assessable crown using the two methods (Fig. 8), the defoliation which was estimated using the two different definitions of the assessable crown only differs in single countries (Estonia, Sweden, Switzerland; Fig. 9).

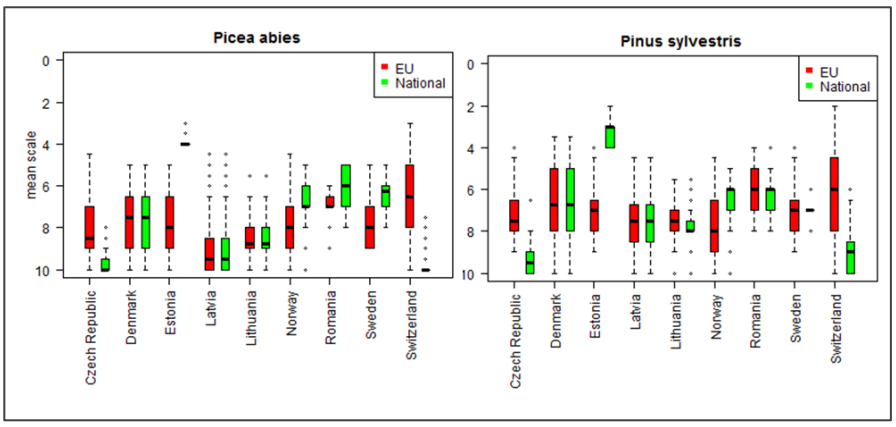


Fig. 8: Northern Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Picea abies* (left) and *Pinus sylvestris* (right).

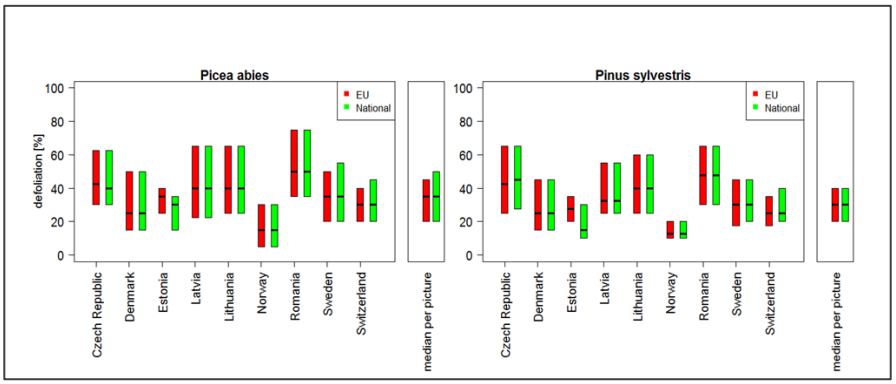


Fig. 9: Northern Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Picea abies* (left) and *Pinus sylvestris* (right).

3.1.4 North: Continuity of the Assessment

Each photo set (30 pictures) of the tree species *Picea abies* and *Pinus sylvestris* for Northern Europe contained 15 pictures which were already assessed during the Photo ICC 2010.

For Northern Europe neither *Picea abies* nor *Pinus sylvestris* shows a significant change in defoliation between the assessment 2010 and 2015 (Fig. 10). For *Picea abies* the coefficient of determination (R^2) is 0.93 and for *Pinus sylvestris* the R^2 is 0.87 (Fig. 11). For both tree species more than 50% of the assessments of the same pictures are within the ±5% range (Fig. 11).

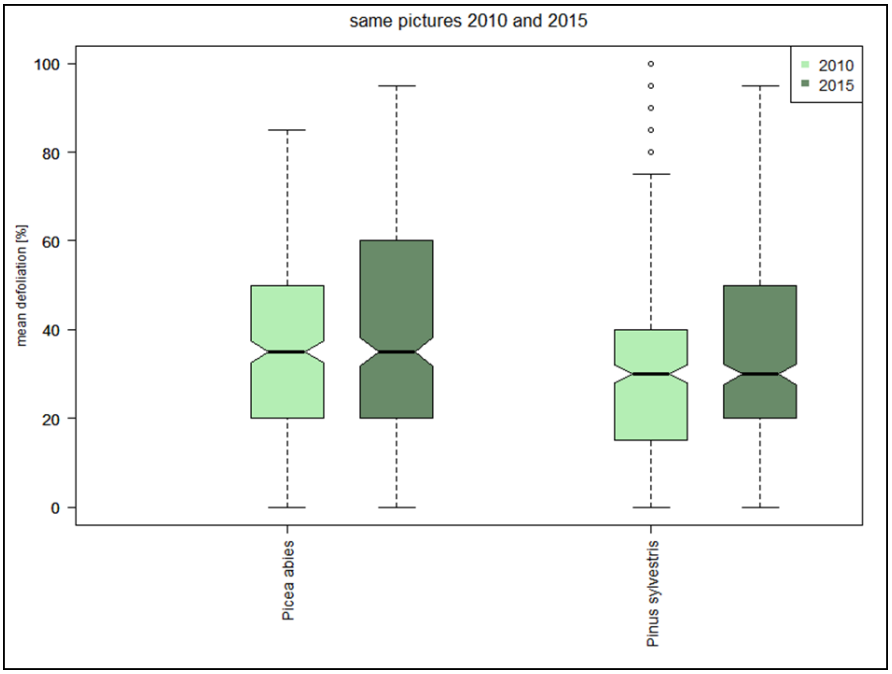


Fig. 10: Northern Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. The notches roughly indicate the 95% confidence interval. Welch two sample t-test: *Picea abies* p=0.714, *Pinus sylvestris* p=0.889.

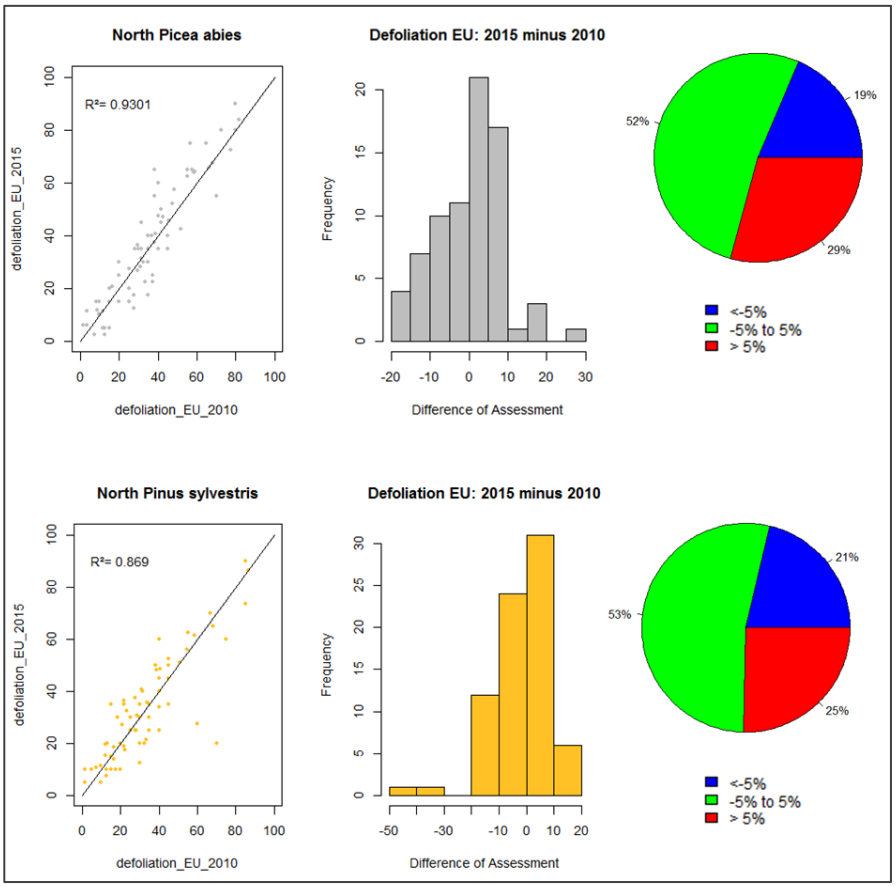


Fig. 11: Northern Europe – Defoliation assessment of the same pictures 2010 and 2015 for Picea abies (above) and Pinus sylvestris (below). Left: Linear regression with 1:1 line and coefficient of determination (R2), middle: Frequency distribution of the differences, right: pie chart of the frequency distribution of the differences divided into three groups.

3.2 Central Europe

3.2.1 Central: Mean Defoliation

For **Central Europe** the species *Fagus sylvatica*, *Picea abies*, *Pinus sylvestris* and *Quercus robur*/*petraea* (in the following only termed *Quercus robur*) were assessed by twelve different countries and 66 different teams. For *Fagus sylvatica* the median of defoliation over all countries (weighted by the number of teams) is 43.3%, for *Picea abies* 36.6%, *Quercus robur* 35.0% and *Pinus sylvestris* 33.5% (Fig. 12 and Fig. 13). Most countries are close to the median of all countries. For *Fagus sylvatica* median deviations of more than ±10% from the overall median are not observed. For *Picea abies* and *Quercus robur* the median of Denmark lies more than −10% below the overall median, whereas for *Pinus sylvestris* larger negative deviations are found for Luxembourg, Denmark and Switzerland and larger positive deviations for Romania.

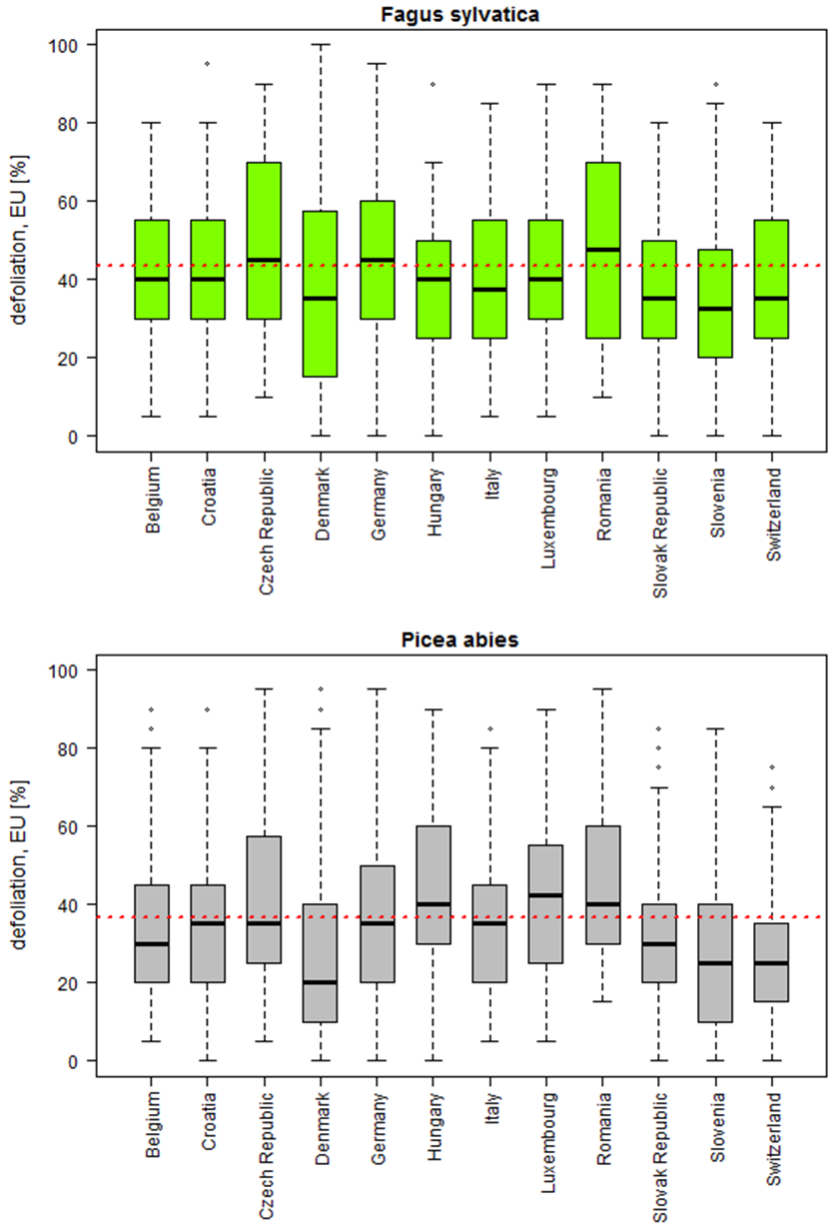


Fig. 12: Central Europe –Distribution of the defoliation data for each country for *Fagus sylvatica* (above) and *Picea abies* (below) using the EU-method for the assessable crown. The black line represents the median and the lower and upper border of the box indicates the lower and upper quartile. The dashed red line represents the weighted median of all countries.

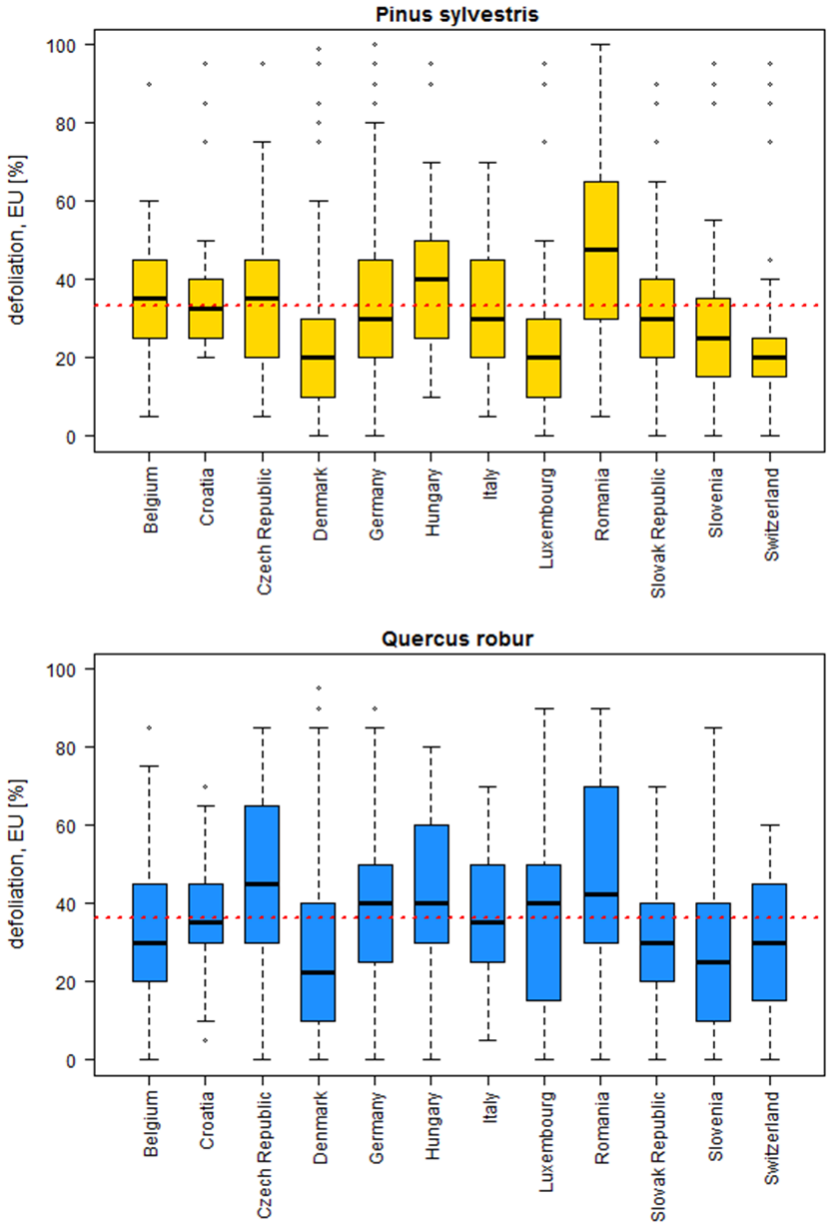


Fig. 13: Central Europe –Distribution of the defoliation data for each country for *Pinus sylvestris* (above) and *Quercus robur* (below) using the EU-method for the assessable crown. The black line represents the median and the lower and upper border of the box indicates the lower and upper quartile. The dashed red line represents the weighted median of all countries.

3.2.2 Central: Outliers

Fig. 14 and Fig. 15 show the assessment quality of the teams of Central Europe using the outlier classification for the assessment.

For all species (*Fagus sylvatica*, *Picea abies*, *Pinus sylvestris* and *Quercus robur*) the classification-classes “very good” to “good” (dark green to light green) are clearly predominating. For *Quercus robur* and *Pinus sylvestris* the proportion of “very good” even amounts to 52% and 48%, respectively. Only small proportions of all outliers are classified with “average”, “bad” or “very bad”. Most teams can be assigned to class 1 or 2 (“very good” or “good”).

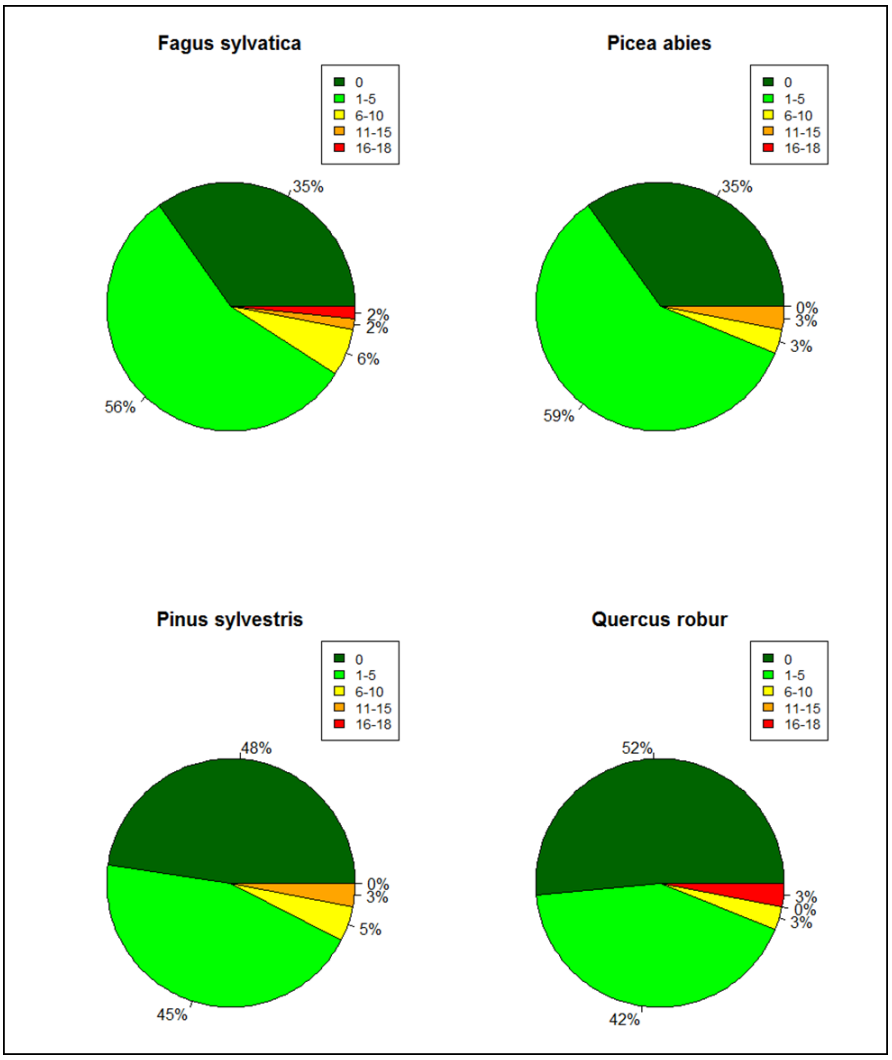


Fig. 14: Central Europe: Frequency of outlier classes for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below). The values were rounded.

Fig. 16 presents the direction of the outliers per country. In general, the same direction of outliers and of the country median compared to the overall median is observed (e.g. Romania, Switzerland). In case of Denmark besides several negative outliers also positive outliers are found whereas the median deviates notably negatively from the overall median.

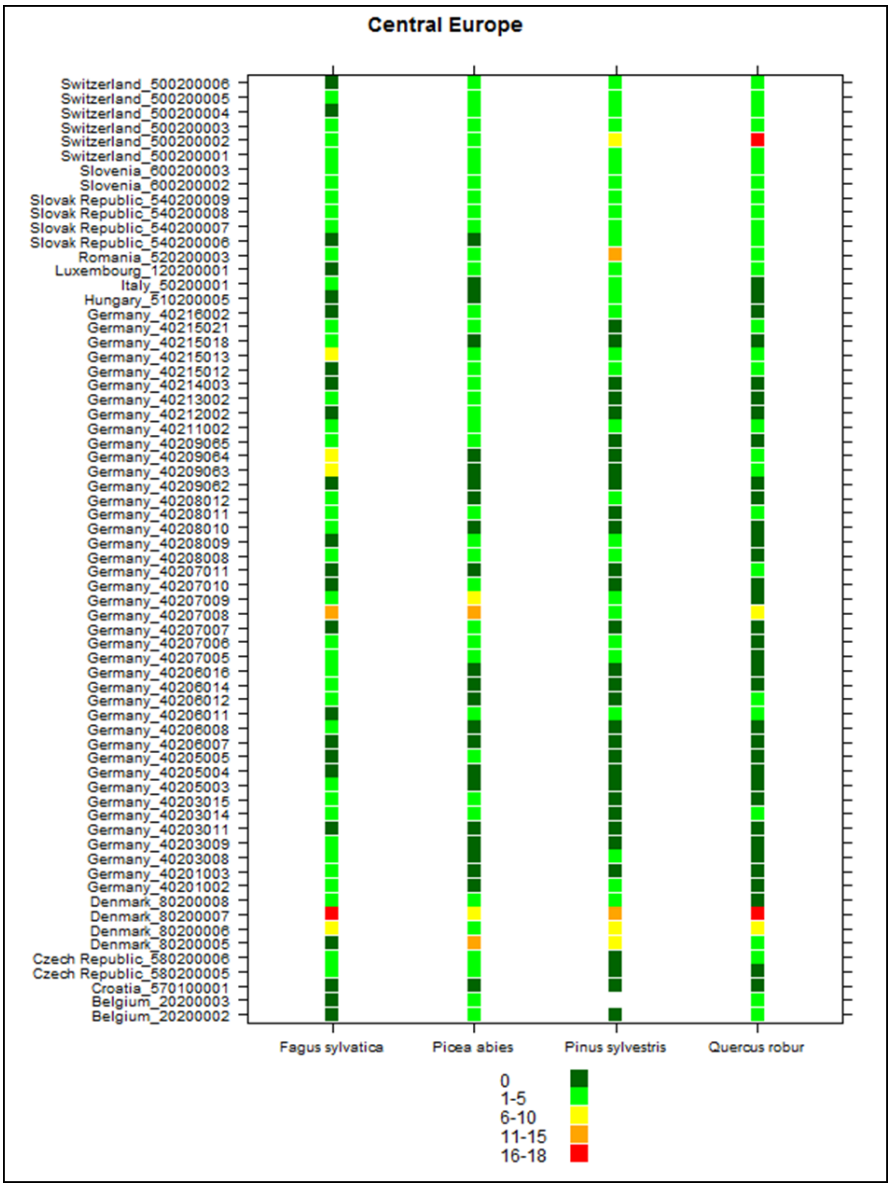


Fig. 15: Central Europe – Outlier classification for each team and the tree species, *Fagus sylvatica*, *Picea abies*, *Pinus sylvestris* and *Quercus robur* (from left to right).

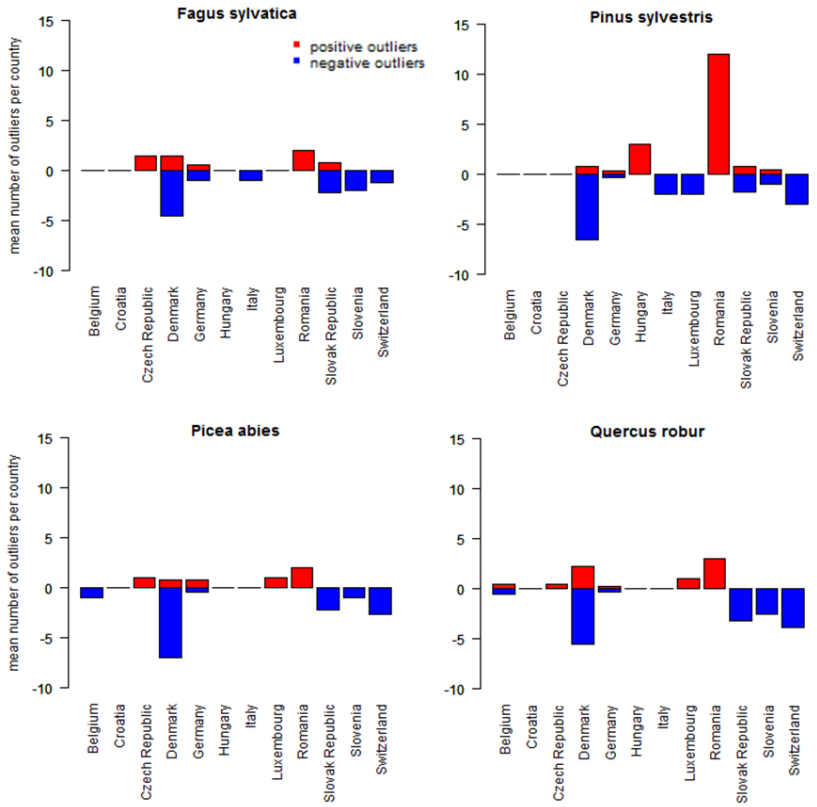


Fig. 16: Central Europe – Mean number of positive and negative outliers for each country for *Fagus sylvatica* and *Pinus sylvestris* (above) and *Picea abies* and *Quercus robur* (below).

3.2.3 Central: Assessable Crown

Fig. 17 shows the mean score of the assessable crown specified by each country according to the national method and the EU-method for the four species. In several countries the assessable crown defined according to the national method considerably differs from the assessable crown defined according to the EU-method (Fig. 17).Comparably low differences, however, are observed regarding the defoliation assessed using the two definitions of the assessable crown (Fig. 18).

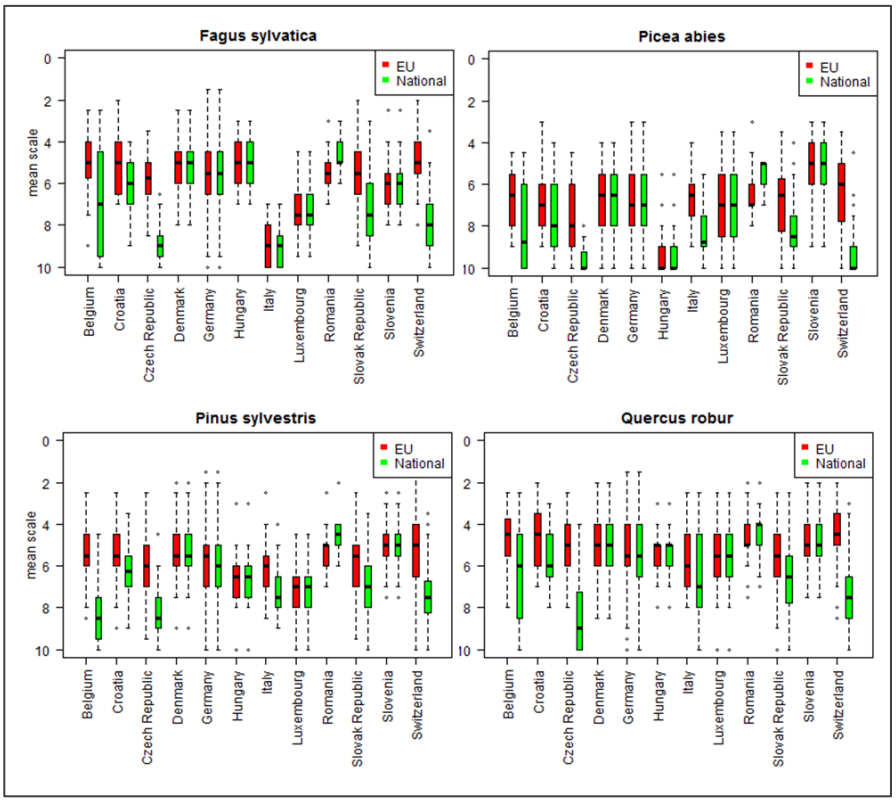


Fig. 17: Central Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below).

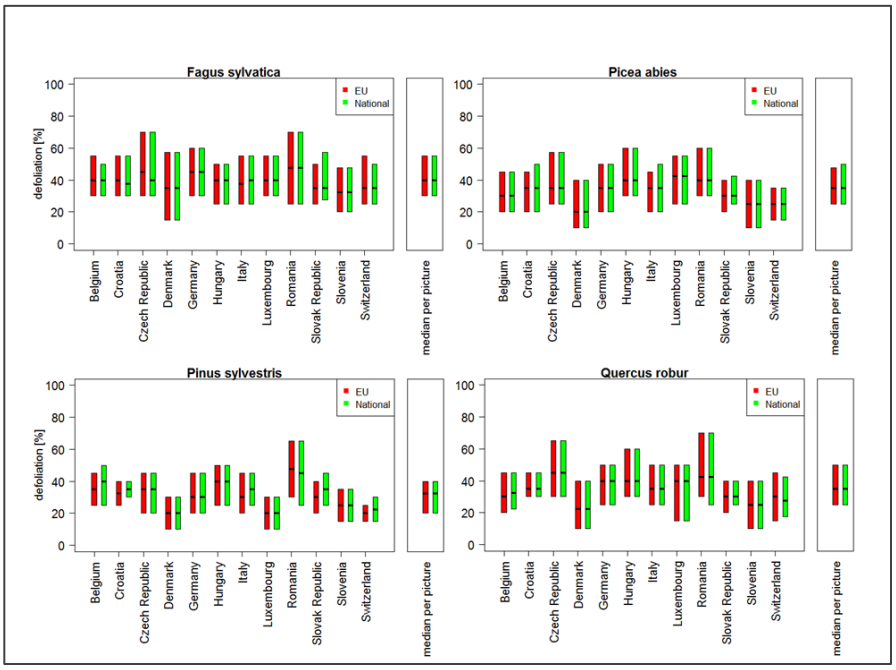


Fig. 18: Central Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Fagus sylvatica* and *Picea abies* (above) and *Pinus sylvestris* and *Quercus robur* (below).

3.2.4 Central: Continuity of the Assessment

Each photo set (30 pictures) of the tree species *Fagus sylvatica*, *Picea abies*, *Pinus sylvestris* and *Quercus robur* for Central Europe contained 15 pictures which were already assessed during the Photo ICC 2010. In Central Europe defoliation of *Fagus sylvatica* and *Quercus robur* significantly increased from 2010 to 2015 regarding the assessment of the same pictures (Fig. 19). The increase is found for almost all countries (see Annex). For *Picea abies* and *Pinus sylvestris* no statistical differences are observed.

The R^2 ranges from 0.79 (*Quercus robur*) to 0.95 (*Picea abies*). For the species *Pinus sylvestris* and *Picea abies* 52% and 48%, respectively, of all assessments are within the range of ±5%. For *Fagus sylvatica* and *Quercus robur* a worse result is recorded with only 32% (*Fagus*) and 39% (*Quercus*) within the ±5% range.

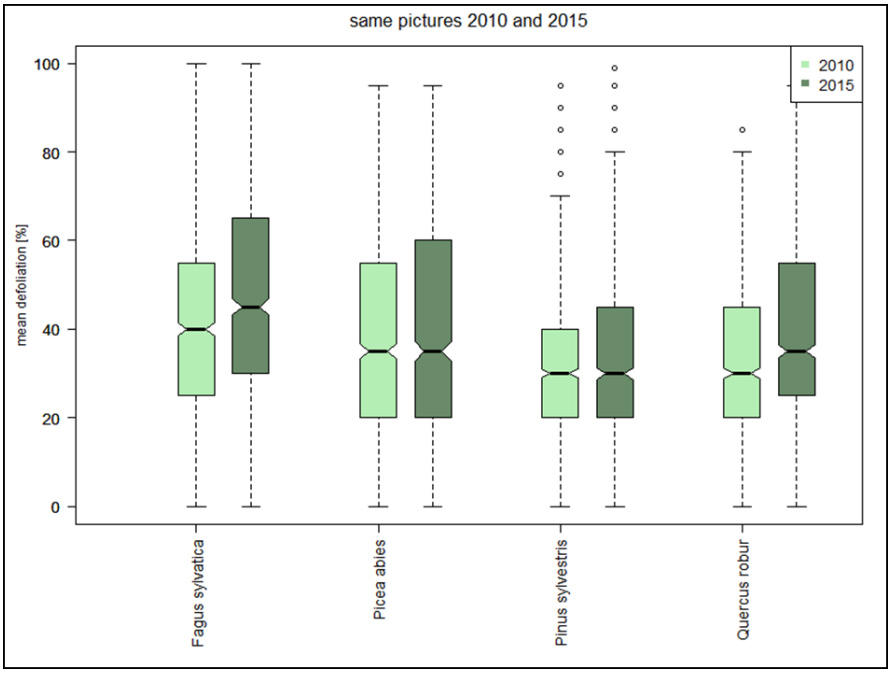


Fig. 19: Central Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. The notches roughly indicate the 95% confidence interval. Welch two sample t-test: *Fagus sylvatica p=0.006, Picea abies* p=0.160, *Pinus sylvestris* p=0.777, *Quercus robur* p=0.017.

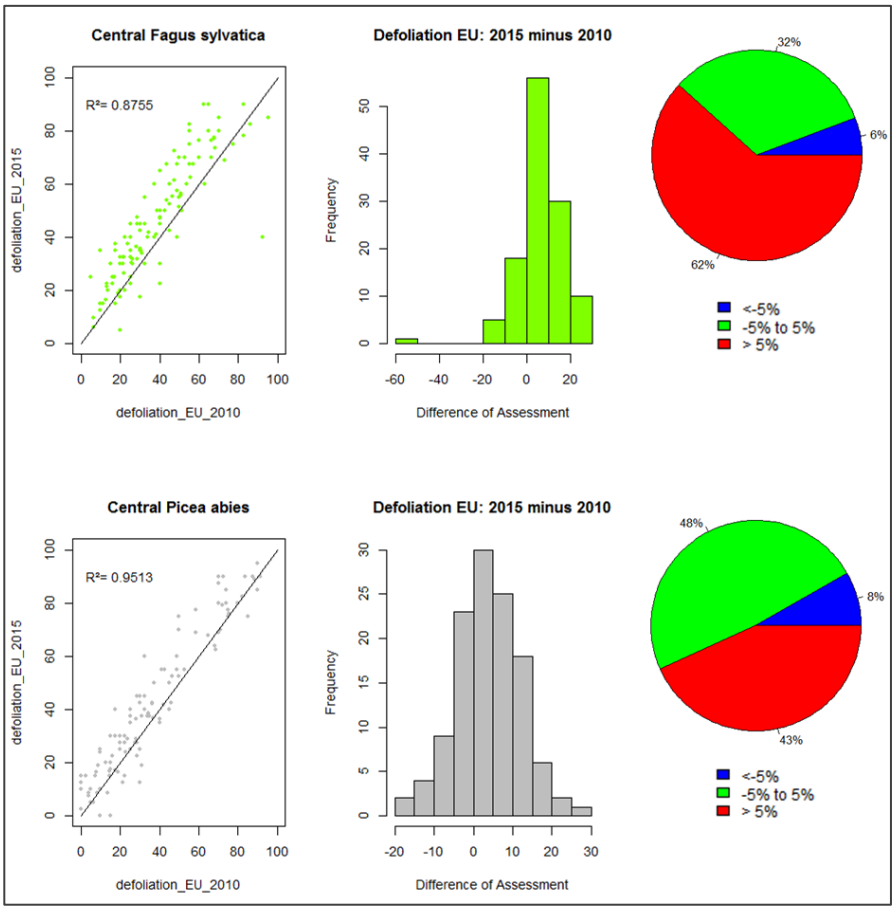


Fig. 20: Central Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Fagus sylvatica* (above) and *Picea abies* (below). Left: Linear regression with 1:1 line and coefficient of determination (R^2), middle: Frequency distribution of the differences, right: pie chart of the frequency distribution of the differences divided into three groups.

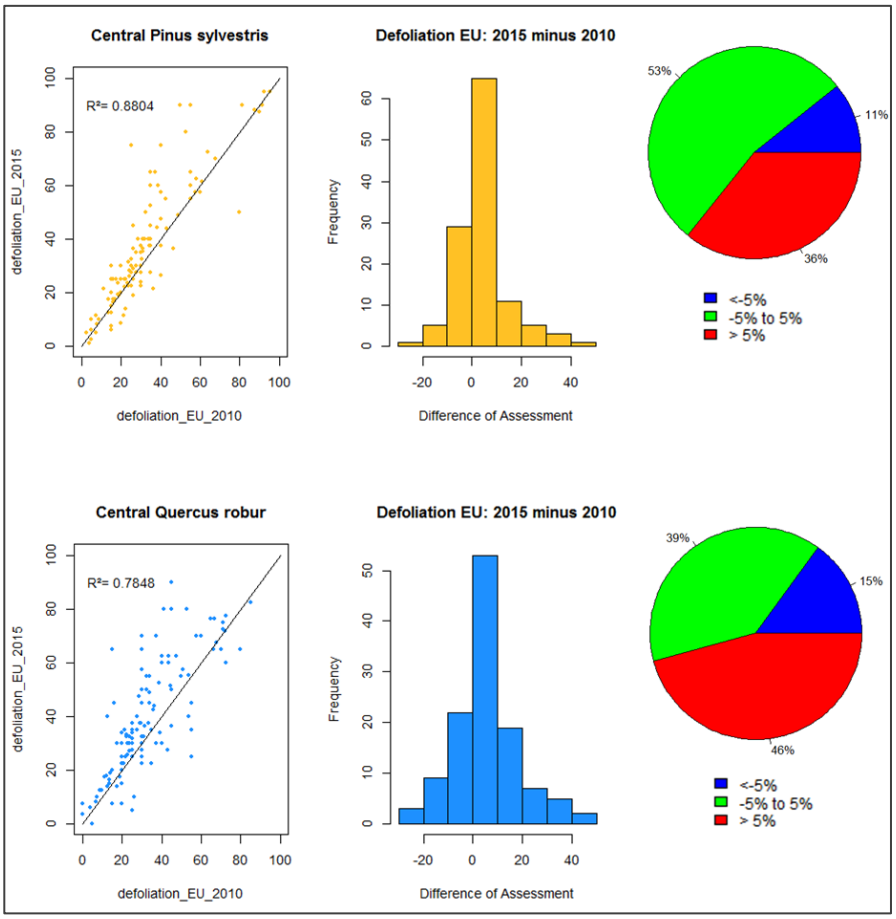


Fig. 21: Central Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Pinus sylvestris* (above) and *Quercus robur* (below). Left: Linear regression with 1:1 line and coefficient of determination (R^2), middle: Frequency distribution of the differences, right: pie chart of the frequency distribution of the differences divided into three groups.

3.3 Mediterranean Europe

3.3.1 Mediterranean: Mean Defoliation

For **Mediterranean Europe** the species *Pinus pinaster*, *Pinus sylvestris* and *Quercus ilex* were assessed by three different countries and in total 22 teams. Most teams (20) belong to Spain. The median defoliation (weighted by the number of teams) for *Pinus pinaster* is 32.8%, for *Pinus sylvestris* the median defoliation is 30.3% and for *Quercus ilex* 27.3%. For all species of the Mediterranean Photo ICC median deviations of more than ±10% from the overall median are not observed. The medians of all three countries are similar. Especially for *Quercus ilex* only small differences between the countries occur.

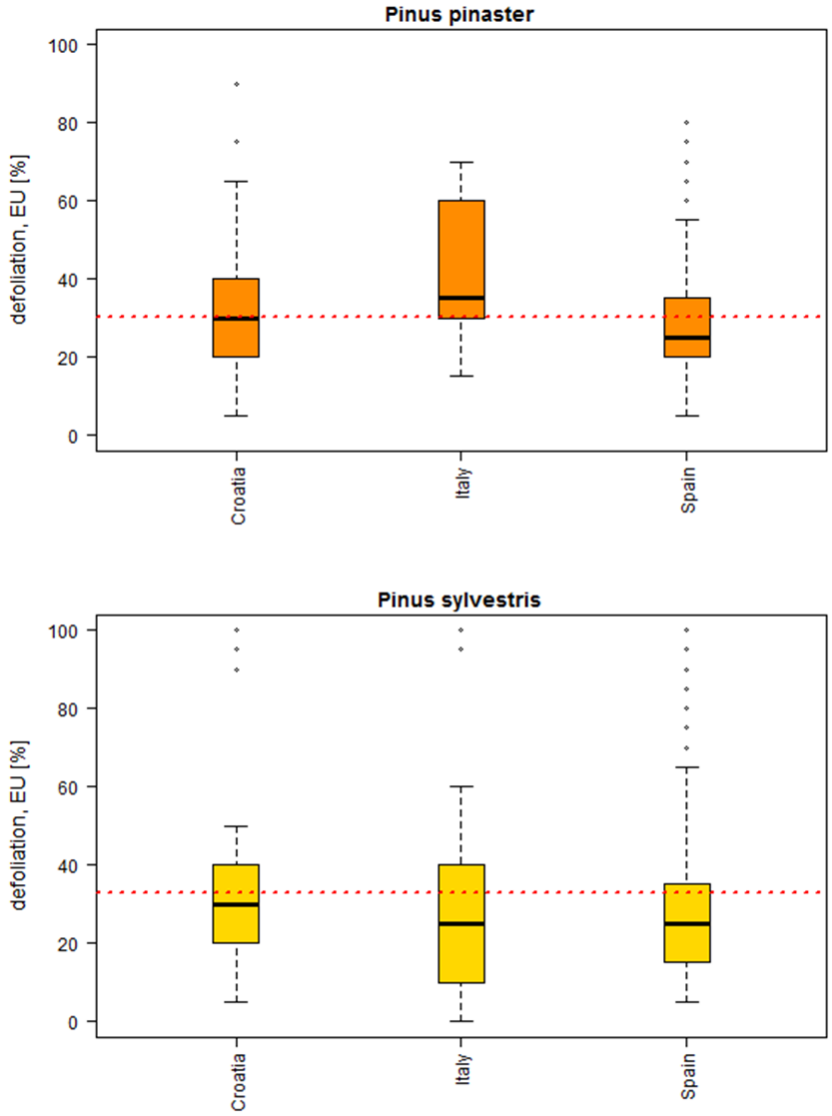


Fig. 22: Mediterranean Europe – Distribution of the defoliation data for each country for *Pinus pinaster* (above) and *Pinus sylvestris* (below) using the EU-method for the assessable crown. The black line represents the median and the lower and upper border of the box indicates the lower and upper quartile. The dashed red line represents the weighted median of all countries.

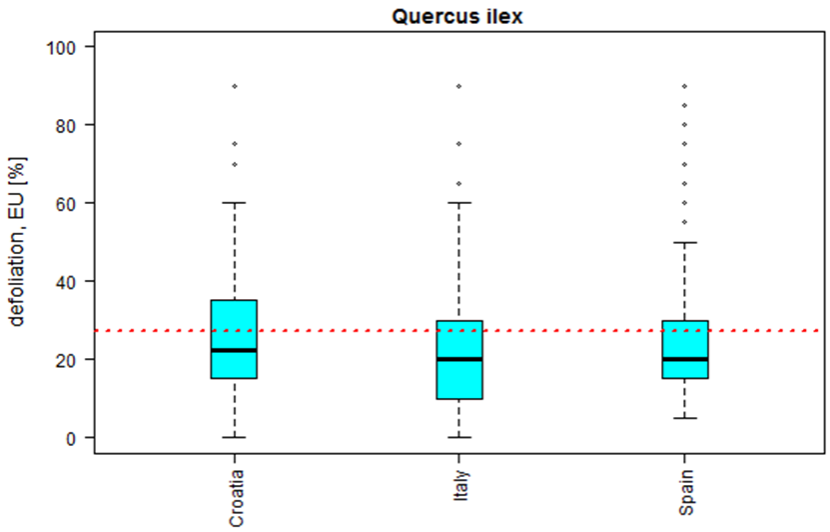


Fig. 23: Mediterranean Europe – Distribution of the defoliation data for each country for *Quercus ilex* using the EU-method for the assessable crown. The black line represents the median and the lower and upper border of the box indicates the lower and upper quartile. The dashed red line represents the weighted median of all countries.

3.3.2 Mediterranean: Outliers

In Fig. 24 and Fig. 25 the assessment quality of the teams of Mediterranean Europe is shown using the outlier classification for the assessment.

For all species (*Pinus pinaster*, *Pinus sylvestris* and *Quercus ilex*) the classification classes “very good” to “good” (dark green to light green) are clearly predominating. For *Quercus ilex* only 5% of all assessments are classified as “average”, the rest are classified as “very good” or “good”. In Fig. 26 the direction of the outliers per country is shown. For Italy some positive outliers are found for *Pinus pinaster*. The median of Italy for this tree species is as well higher compared to the overall median.

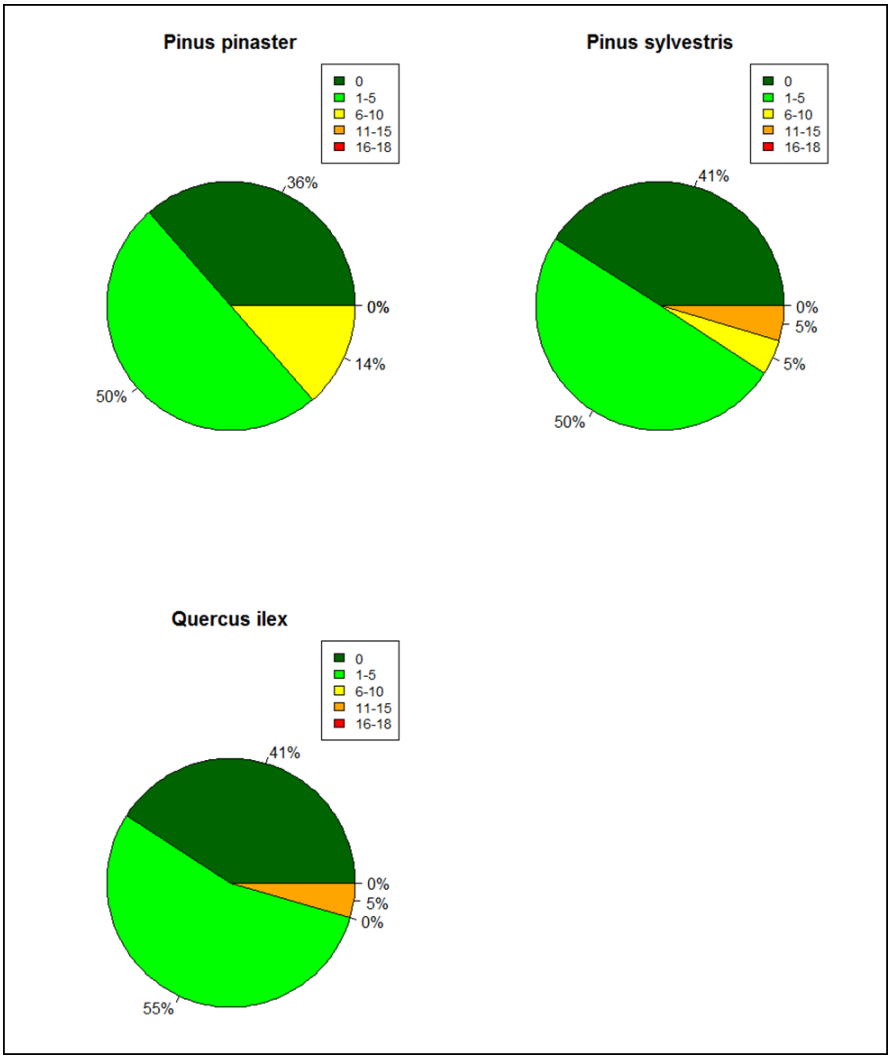


Fig. 24: Mediterranean Europe: Frequency of outlier classes for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below). The values were rounded.



Fig. 25: Mediterranean Europe – Outlier classification for each team and the tree species, *Pinus pinaster*, *Pinus sylvestris* and *Quercus ilex* (from left to right).

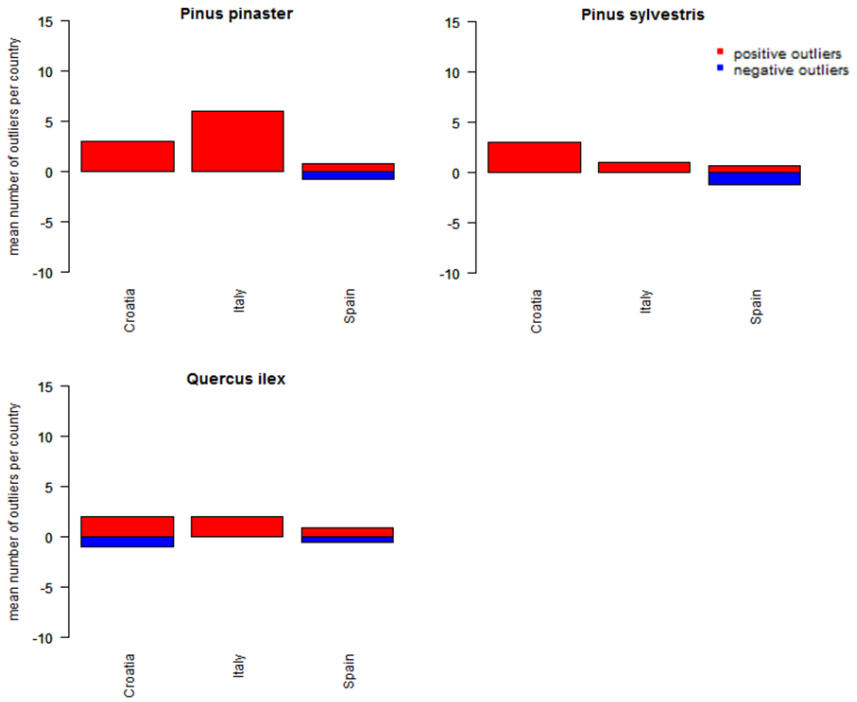


Fig. 26: Mediterranean Europe – Mean number of positive and negative outliers for each country for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below).

3.3.3 Mediterranean: Assessable Crown

Fig. 27 shows the mean score of the assessable crown specified by each country according to the national method and the EU-method for the three species. The team of Italy does not show a difference in the mean assessable crown defined according to the two methods. The teams of Spain and Croatia pull down the assessable crown when using their national methods compared to the EU-method. For these countries the defoliation estimated using the national definition of the assessable crown is slightly higher than the defoliation estimated using the EU-definition (Fig. 28).

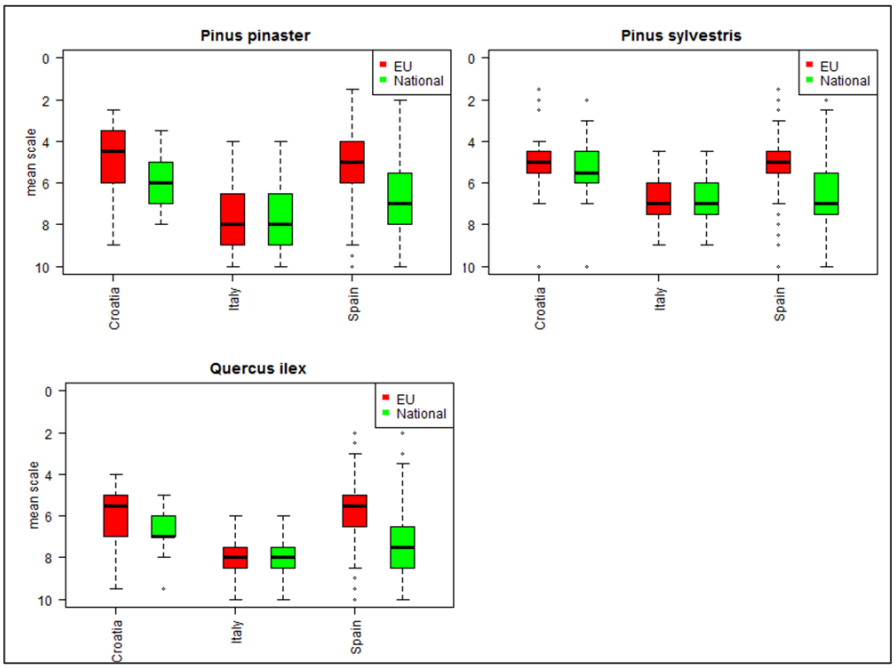


Fig. 27: Mediterranean Europe – Mean score for the assessable crown given by each country using the national method and the EU-method for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below).

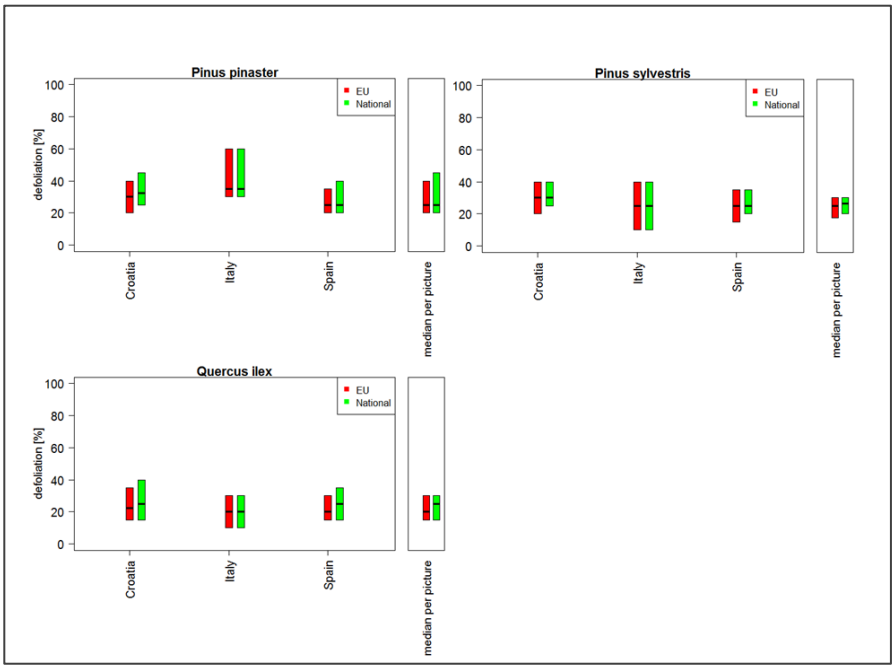


Fig. 28: Mediterranean Europe – Mean defoliation estimated by each country using the national method and the EU-method for defining the assessable crown for *Pinus pinaster* and *Pinus sylvestris* (above) and *Quercus ilex* (below).

3.3.4 Mediterranean: Continuity of the Assessment

Each photo set (30 pictures) of the tree species *Pinus pinaster*, *Pinus sylvestris* and *Quercus ilex* for Mediterranean Europe contained 15 pictures which were already assessed during the Photo ICC 2010.

The Photo ICC 2015 of Mediterranean Europe reveals no significant change for any tree species. For *Quercus ilex* the R^2 is 0.98, for *Pinus sylvestris* 0.97 and for *Pinus pinaster* 0.93. For all tree species more than 50% of all assessments are within the ±5% range. For *Quercus ilex* even more than 80% are in this range.

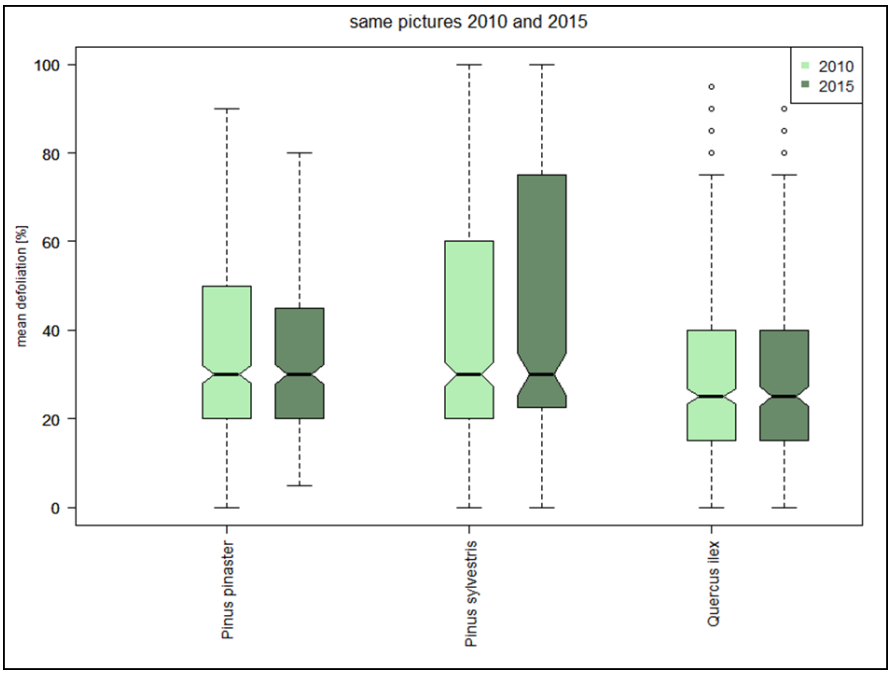


Fig. 29: Mediterranean Europe – Boxplots of the defoliation estimated for the same pictures in 2010 and 2015. The notches roughly indicate the 95% confidence interval. Welch two sample t-test: *Pinus pinaster* p=0.413, *Pinus sylvestris* p=0.467, *Quercus ilex* p=0.942.

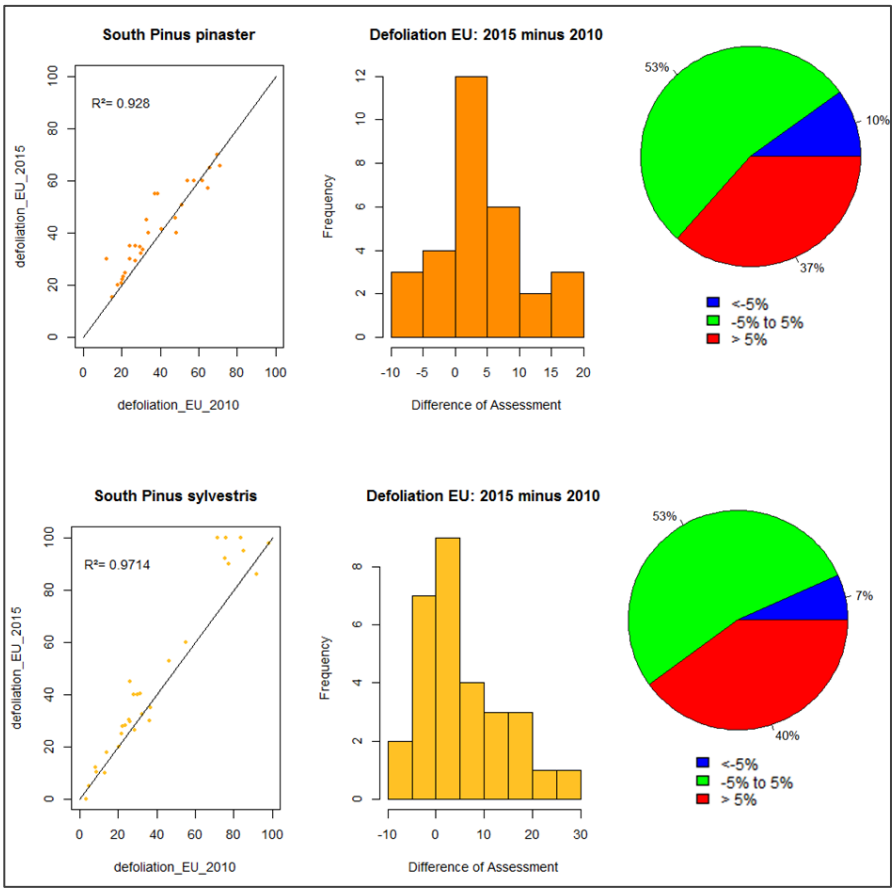


Fig. 30: Mediterranean Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Pinus pinaster* (above) and *Pinus sylvestris* (below).Left: Linear regression with 1:1 line and coefficient of determination (R^2), middle: Frequency distribution of the differences, right: pie chart of the frequency distribution of the differences divided into three groups.

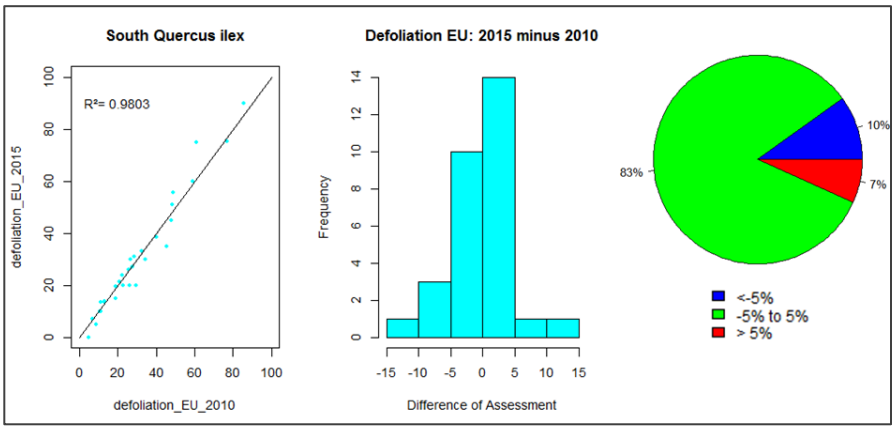


Fig. 31: Mediterranean Europe – Defoliation assessment of the same pictures 2010 and 2015 for *Quercus ilex*. Left: Linear regression with 1:1 line and coefficient of determination (R^2), middle: Frequency distribution of the differences, right: pie chart of the frequency distribution of the differences divided into three groups.

4 Conclusion

In total, 123 Teams from 18 European countries participated in the Photo ICC 2015. The large number of participants reflects the high interest in an additional quality assurance measure for the visual tree assessment. In the Mediterranean region only three countries were able to participate.

Due to differences between the visual tree assessment in the field and the photo assessment a transfer of the results of the Photo ICC to the results of the annual crown condition assessment in the field should be done with caution. Substantial parts of the visual tree assessment such as determination of biotic and abiotic damage and fructification are not clearly possible in a two-dimensional picture. Furthermore, information about the stand and the location is missing and the possibility to zoom in for details is not given. On the other hand, the Photo ICC provides a lot of advantages in addition to the Field ICC. Besides the saving of costs, which represents the main reason for a higher number of participating teams and countries, the main advantage is the reuse of photos in several years in order to proof the continuity of the defoliation assessment over time. Moreover, it is possible to compare the country specific definitions of the assessable crown with the European definition. In conclusion, the Photo ICC is de-centralistic, requires little time and is high value for money (Eichhorn et al. 2010b).

For some regions and tree species the results of the Photo ICC 2015 show systematic differences in the defoliation assessment among countries. The median of defoliation differs between 10% to 35% among the countries depending on the region and the tree species. In total most of the

participating teams in all European regions show a small number of outliers. The difference in defining the assessable crown has often been mentioned to be a frequent cause of systematic differences in the assessment of crown defoliation. However, the results of the Photo ICC show that despite differences in the definition of the assessable crown among countries, differences in the defoliation assessment on average are low.

Some countries participated in the Photo ICC for different regions. Czech Republic, Denmark, Romania and Switzerland took part in the courses for the Northern and Central Region, Italy and Croatia in the courses for the Central and Mediterranean Region. The level and direction of the deviation from the median is about the same for these countries in the different regions.

The results of the continuity study reveal no significant change in the assessment of defoliation for Northern and Mediterranean Europe. On average the teams assessed the same pictures in 2010 and 2015 within the same range of defoliation. In contrast, for Central Europe the results show a significant increase in the defoliation of *Fagus sylvatica* and *Quercus robur* from the survey in 2010 to the survey in 2015. This can be caused by many different factors, e.g. quality of the pictures, continuous assessment criteria or experience of the teams. The information of the Photo ICC should be used to review the assessment of the teams to ensure a consistent assessment of crown condition with high quality. Therefore, it is recommended to carry out the Photo ICC at regular intervals in addition to the Field ICC.

5 References

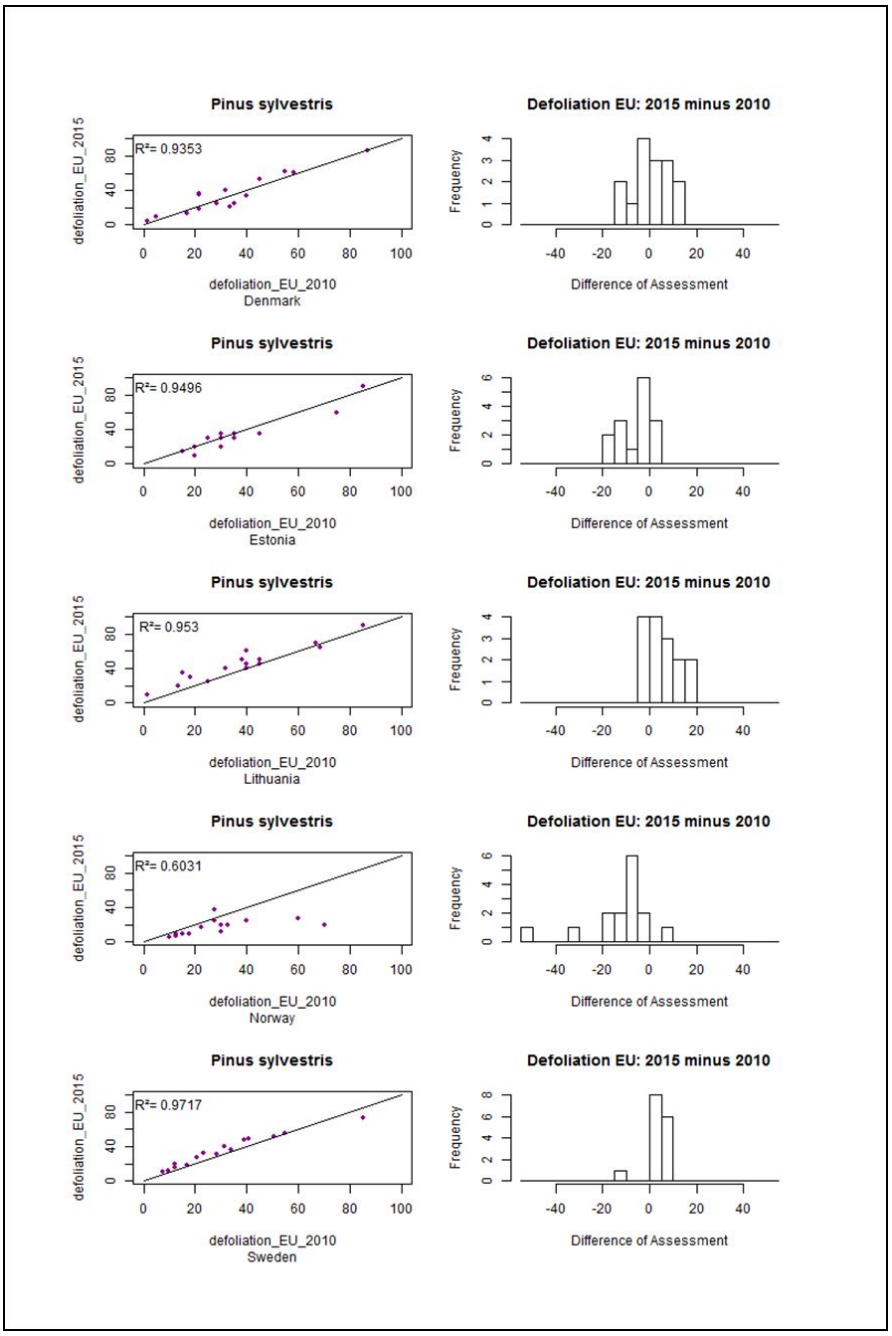
Eichhorn, J., Roskams, P., Ferretti, M., Mues, V., Szepesi, A., & Durrant, D. (2010a) Visual Assessment of Crown Condition and Damaging Agents. In UNECE (Ed.), Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. Hamburg, Germany: UNECE, ICP Forests Programme Co-ordinating Centre. 49 p.

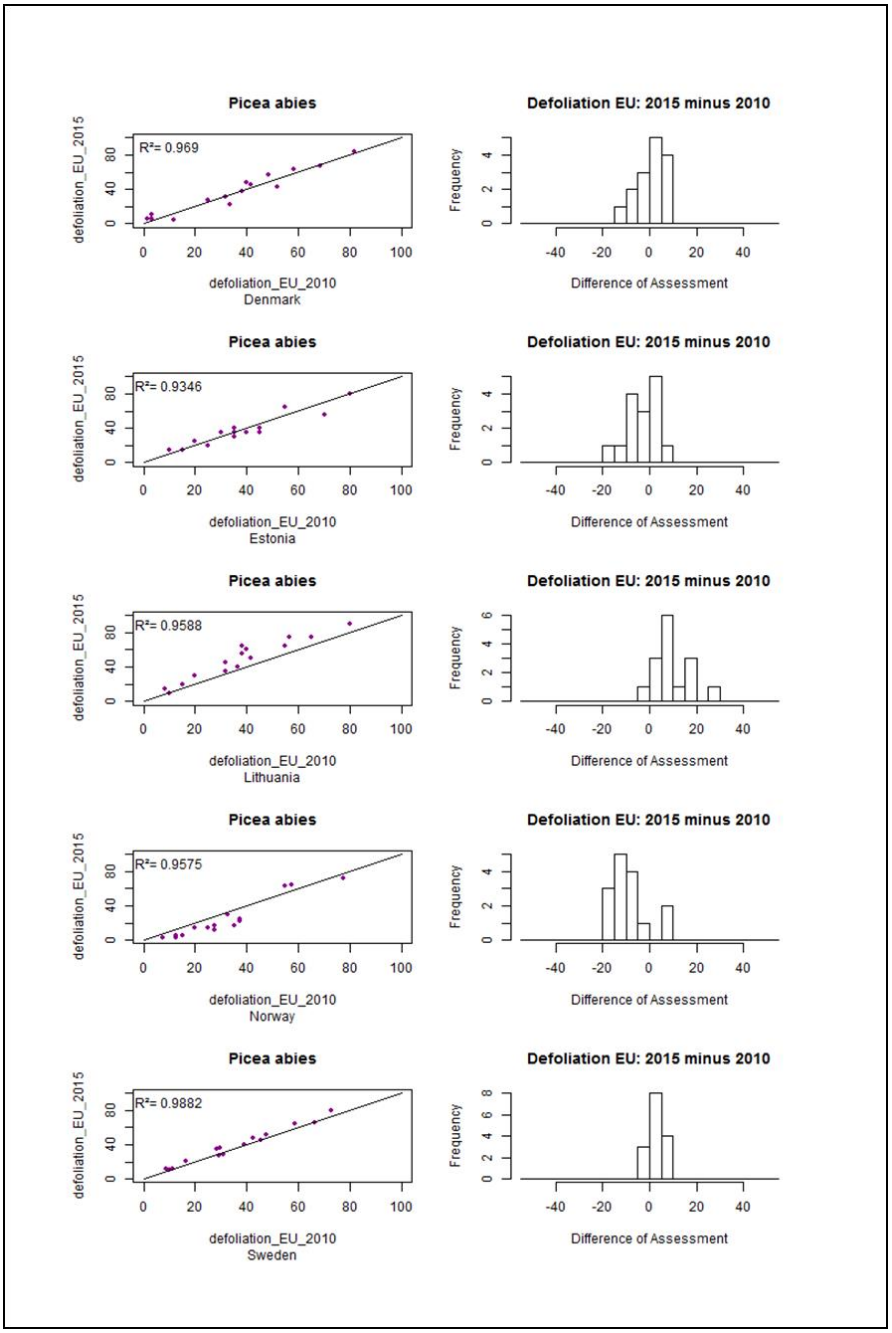
Eichhorn, J., Bauer, A., Bohacova, L., Dammann, I., Garcia, P., Weymar, J., Wulff, S. (2010b) Photo Intercalibration Course (Photo ICC), exercise in 2010. Further Development and Implementation of an EU-Level Forest Monitoring System - FUTMON

R Development Core Team. (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org.

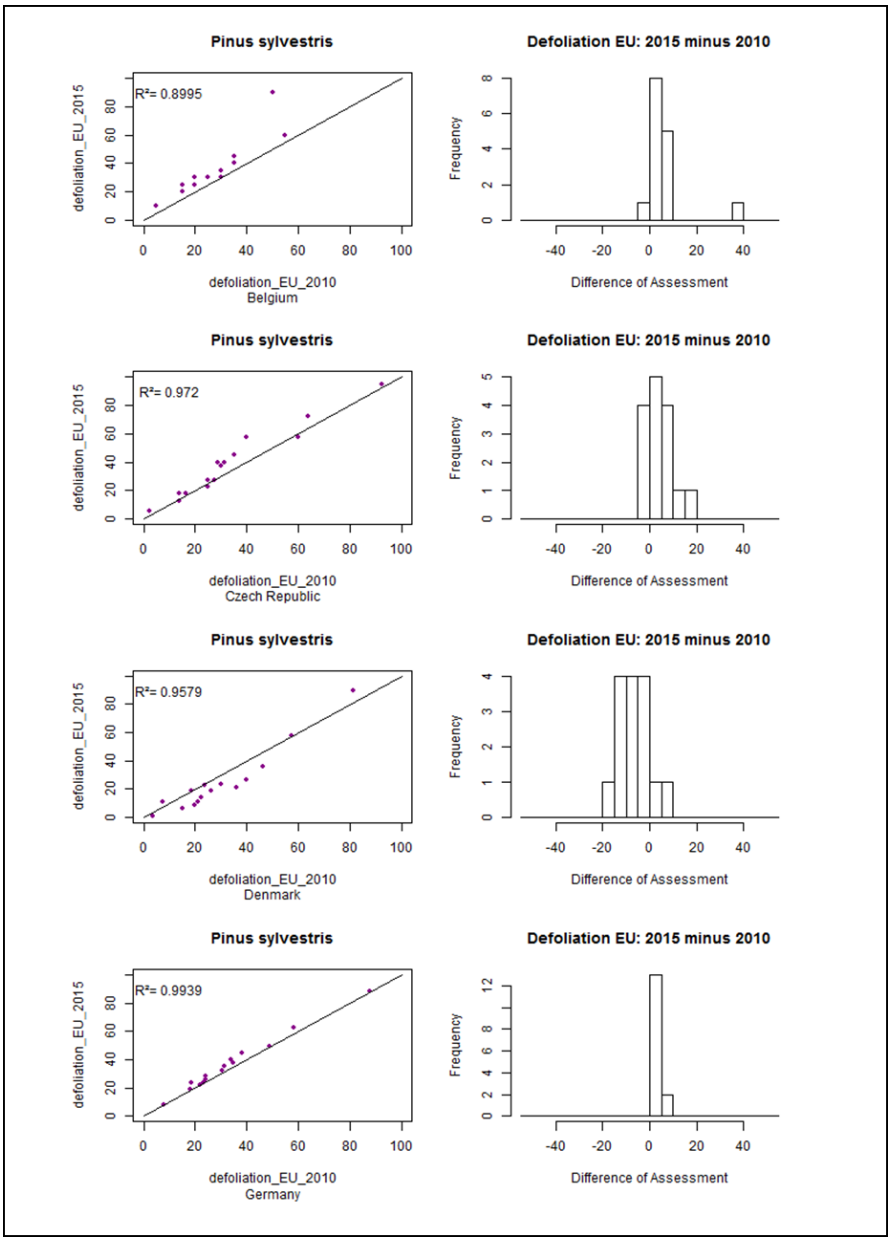
6 Annex

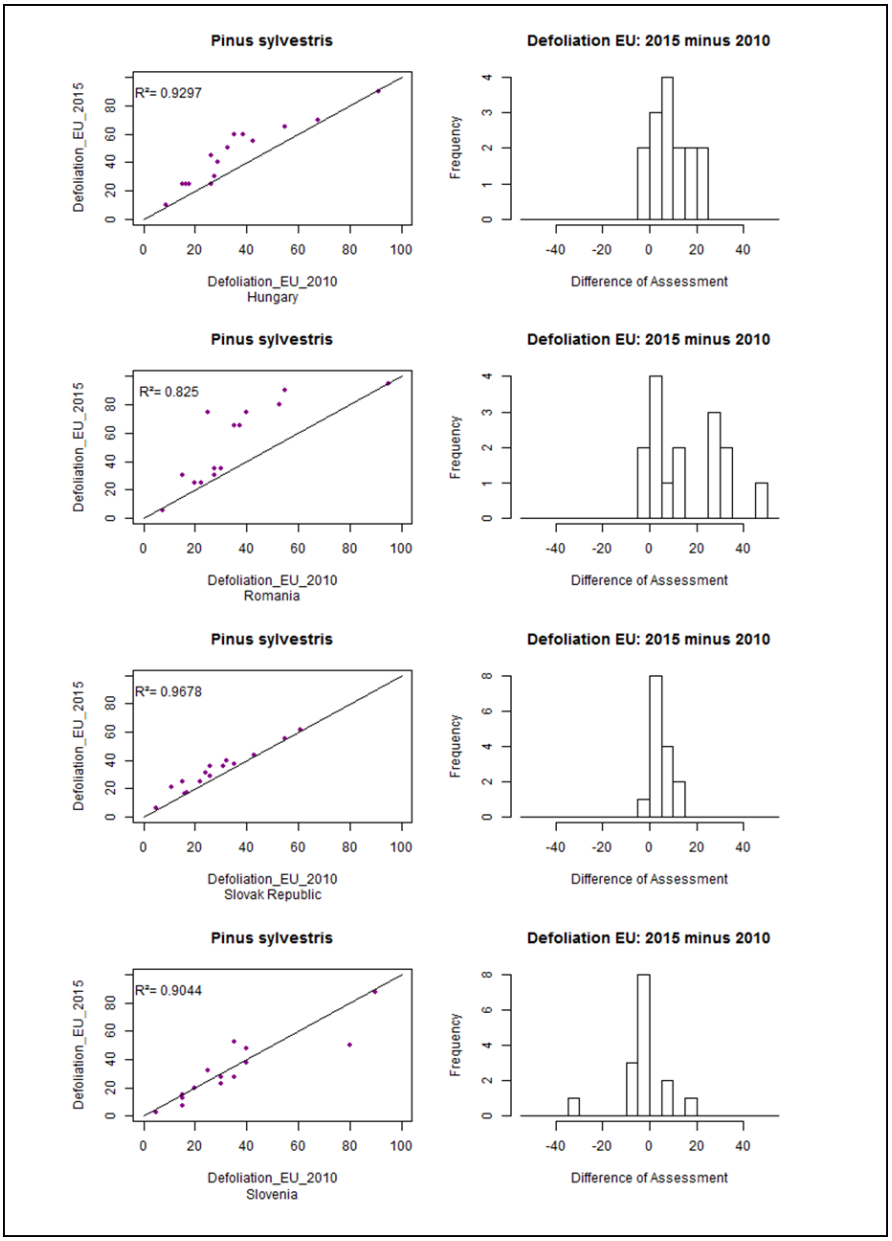
Annex 1: Assessment of the same pictures 2010 and 2015 (Northern Europe).

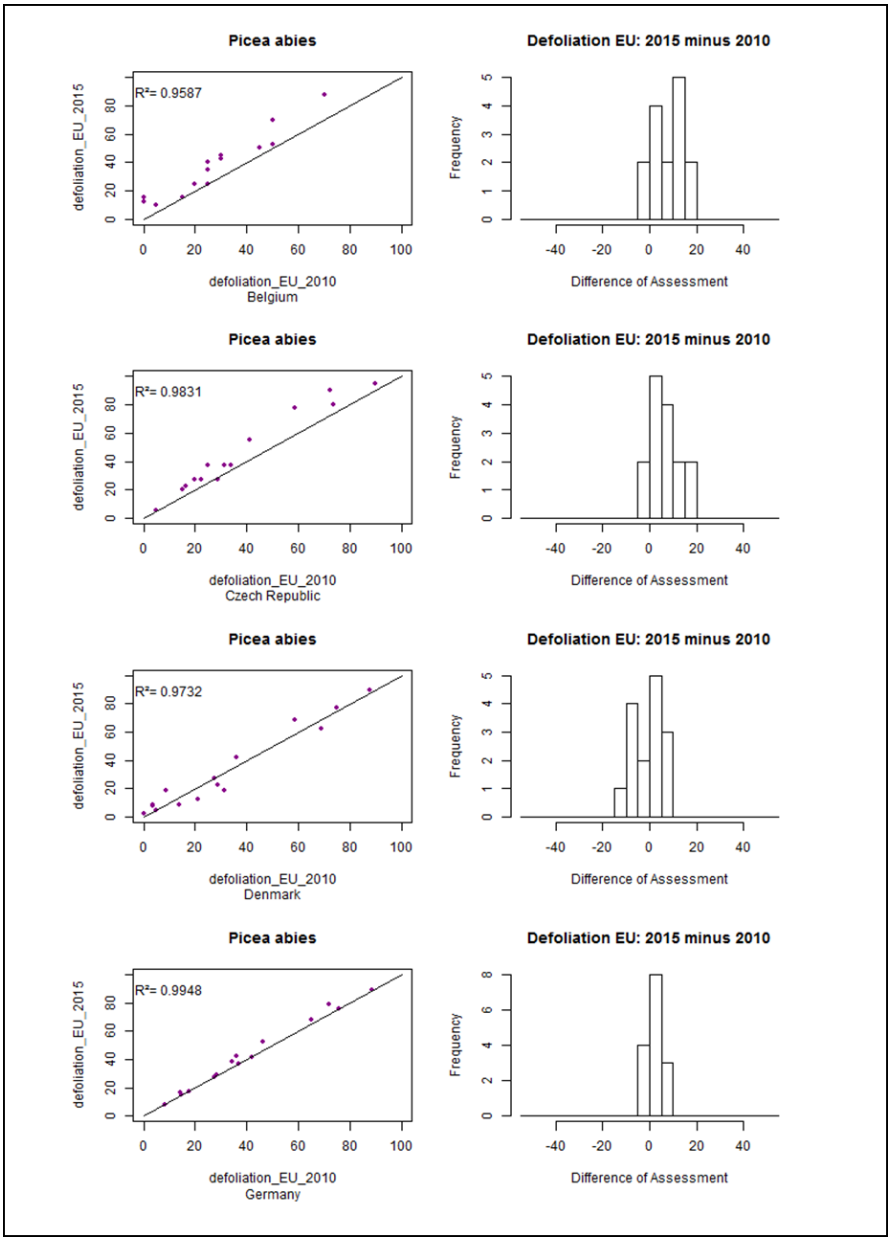


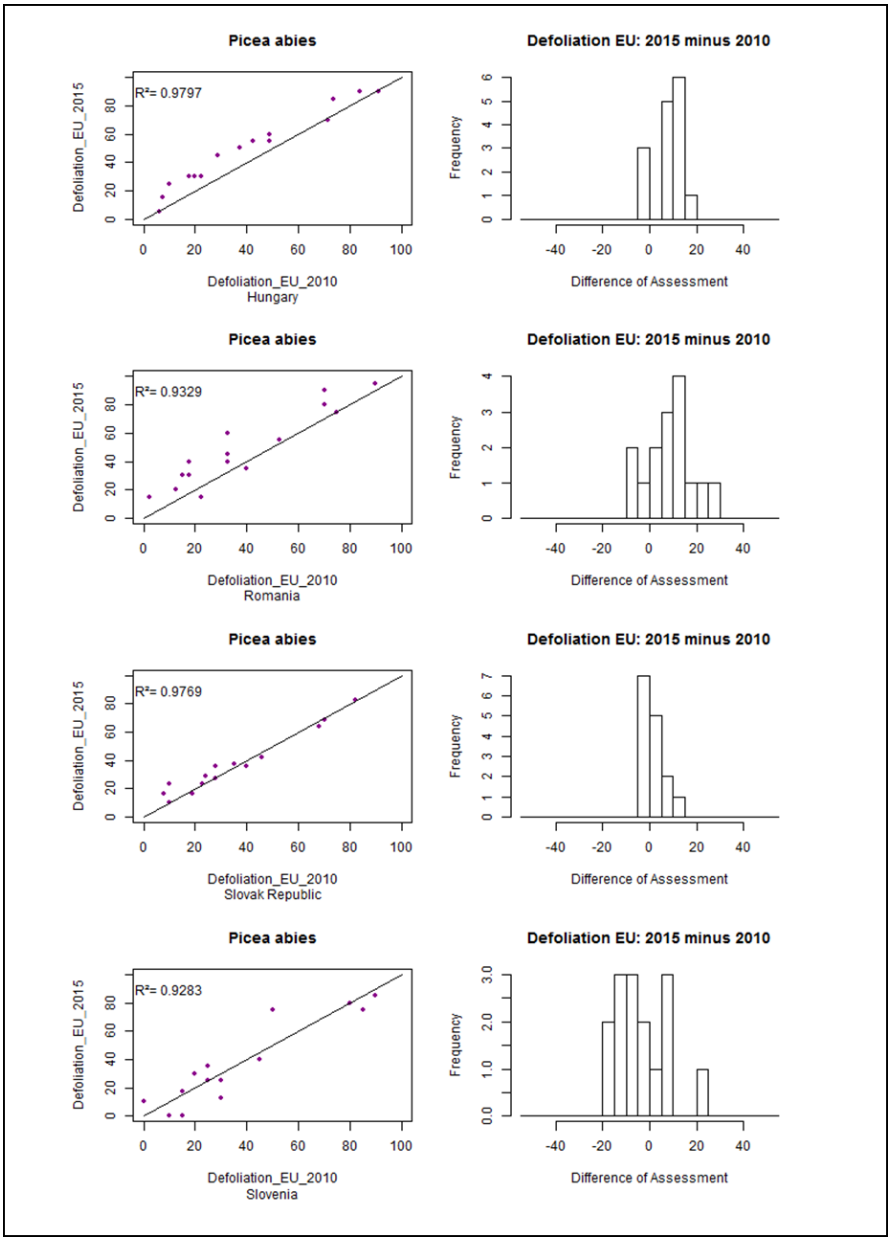

Picea abies
R²= 0.969
defoliation_EU_2015
defoliation_EU_2010
Denmark
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9346
defoliation_EU_2015
defoliation_EU_2010
Estonia
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9588
defoliation_EU_2015
defoliation_EU_2010
Lithuania
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9575
defoliation_EU_2015
defoliation_EU_2010
Norway
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9882
defoliation_EU_2015
defoliation_EU_2010
Sweden
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment

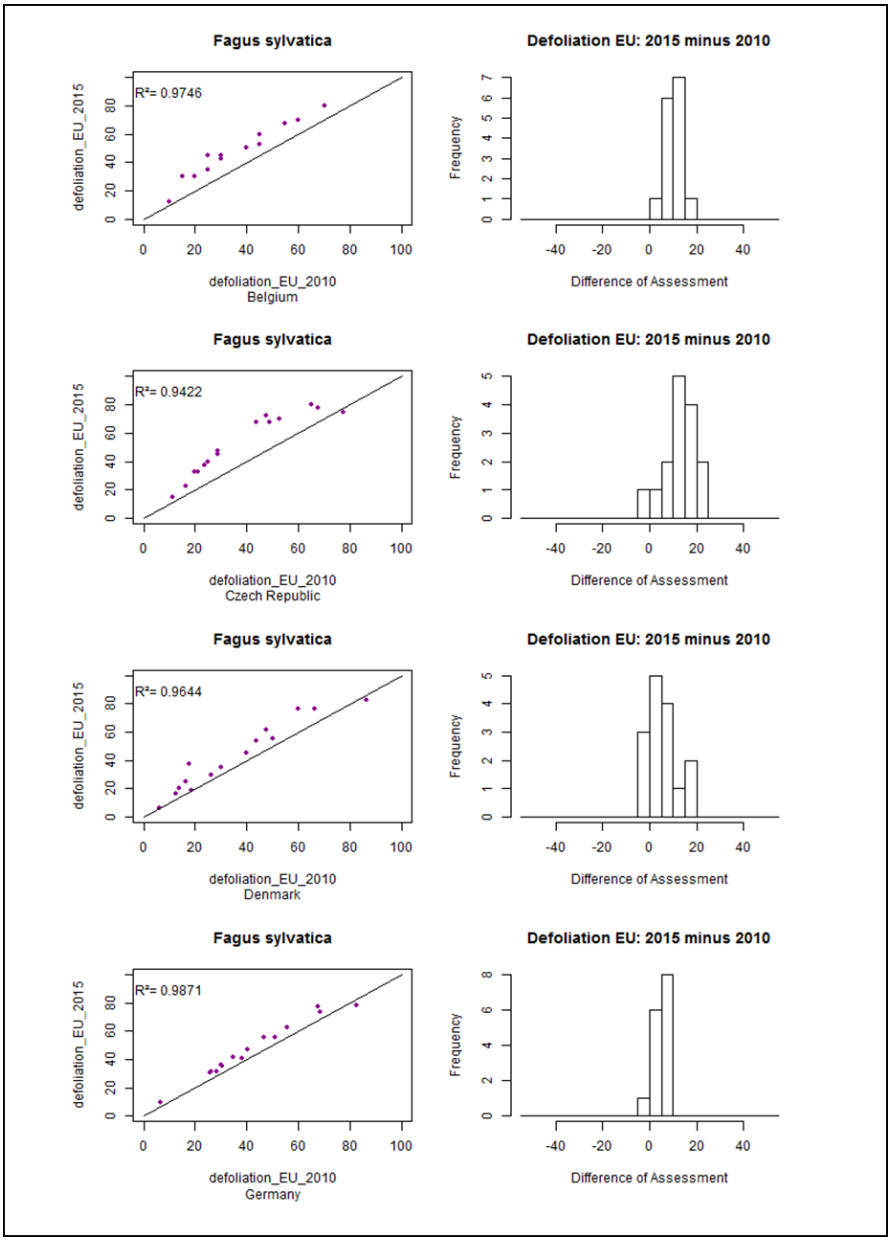
Annex 2: Assessment of the same pictures 2010 and 2015 (Central Europe).

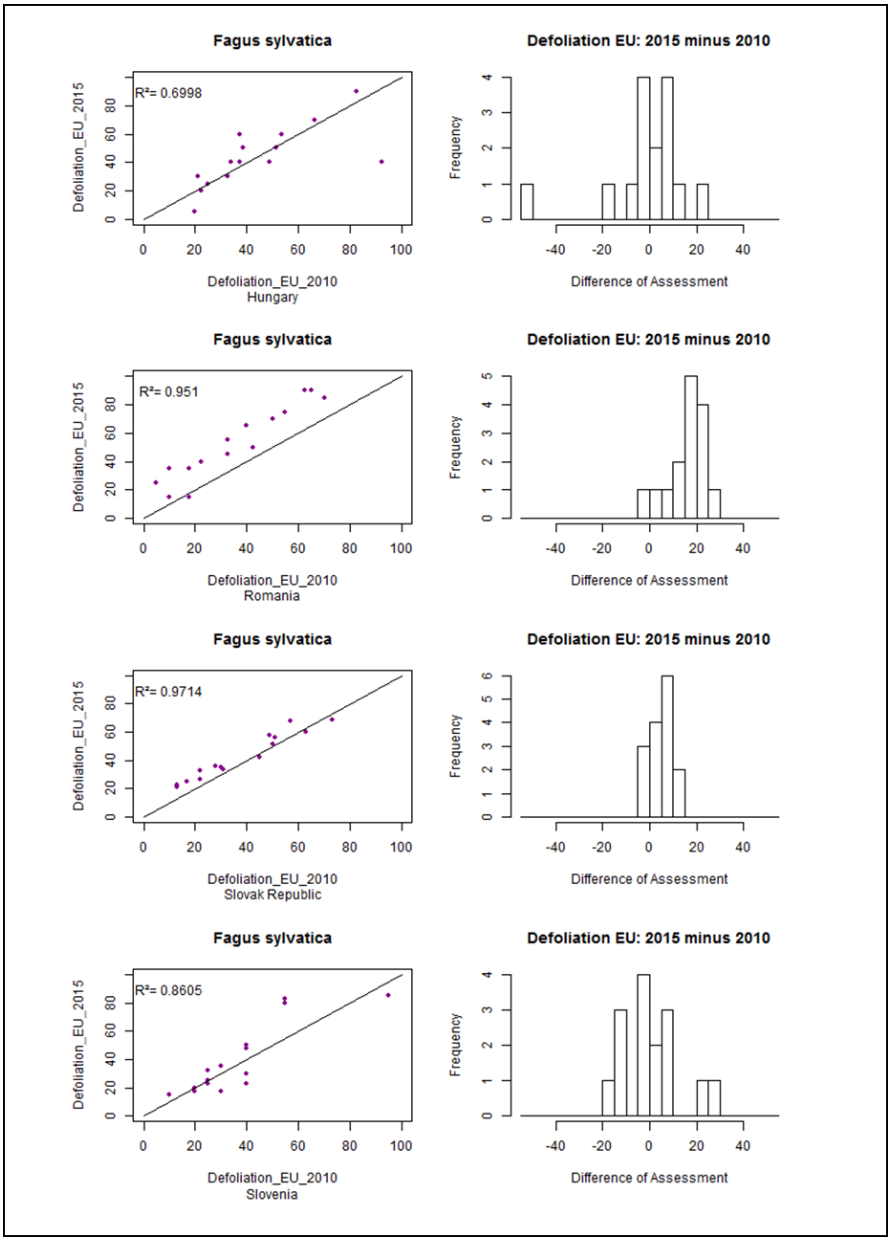


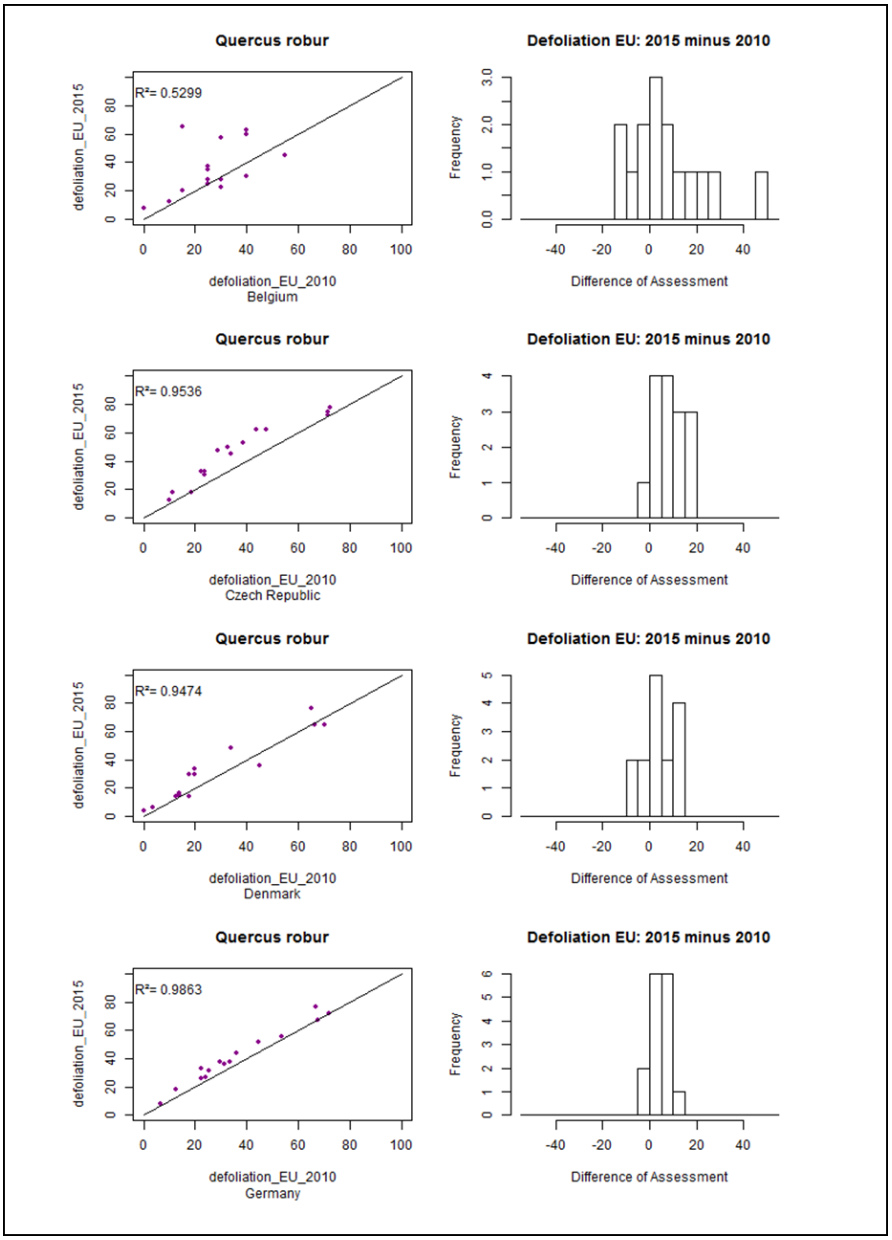

Pinus sylvestris
R²= 0.9297
Defoliation_EU_2015
Defoliation_EU_2010
Hungary
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Pinus sylvestris
R²= 0.825
Defoliation_EU_2015
Defoliation_EU_2010
Romania
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Pinus sylvestris
R²= 0.9678
Defoliation_EU_2015
Defoliation_EU_2010
Slovak Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Pinus sylvestris
R²= 0.9044
Defoliation_EU_2015
Defoliation_EU_2010
Slovenia
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment

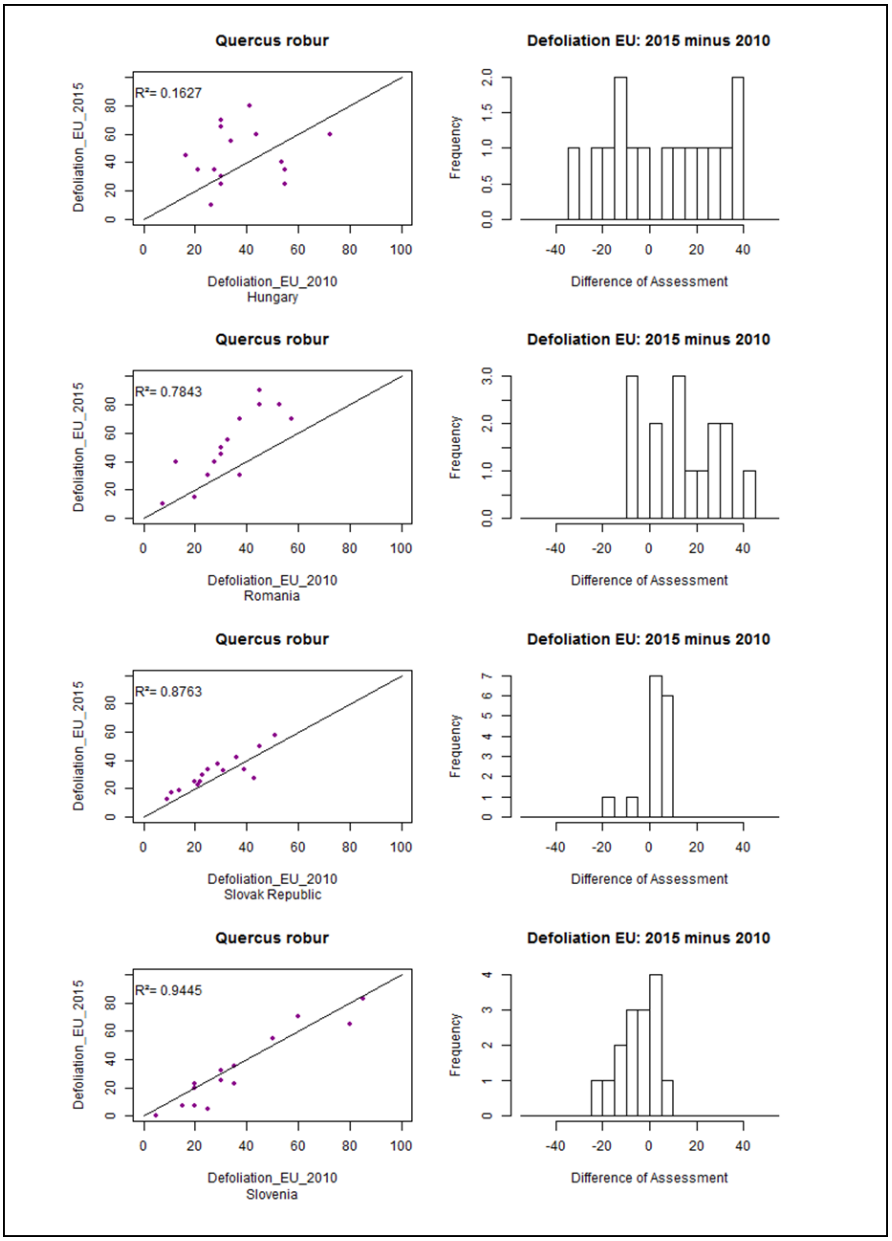

Picea abies
R²= 0.9587
defoliation_EU_2015
defoliation_EU_2010
Belgium
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9831
defoliation_EU_2015
defoliation_EU_2010
Czech Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9732
defoliation_EU_2015
defoliation_EU_2010
Denmark
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9948
defoliation_EU_2015
defoliation_EU_2010
Germany
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment


Picea abies
R²= 0.9797
Defoliation_EU_2015
Defoliation_EU_2010
Hungary
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9329
Defoliation_EU_2015
Defoliation_EU_2010
Romania
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9769
Defoliation_EU_2015
Defoliation_EU_2010
Slovak Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Picea abies
R²= 0.9283
Defoliation_EU_2015
Defoliation_EU_2010
Slovenia
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment

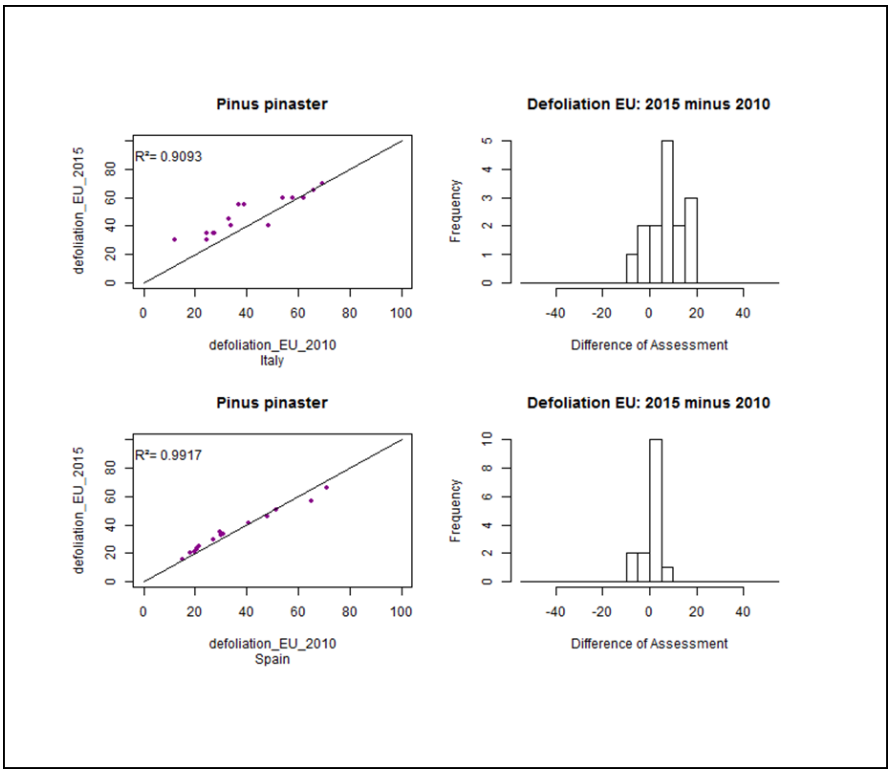

Fagus sylvatica
R²= 0.9746
defoliation_EU_2015
defoliation_EU_2010
Belgium
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.9422
defoliation_EU_2015
defoliation_EU_2010
Czech Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.9644
defoliation_EU_2015
defoliation_EU_2010
Denmark
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.9871
defoliation_EU_2015
defoliation_EU_2010
Germany
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment


Fagus sylvatica
R²= 0.6998
Defoliation_EU_2015
Defoliation_EU_2010
Hungary
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.951
Defoliation_EU_2015
Defoliation_EU_2010
Romania
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.9714
Defoliation_EU_2015
Defoliation_EU_2010
Slovak Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Fagus sylvatica
R²= 0.8605
Defoliation_EU_2015
Defoliation_EU_2010
Slovenia
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment


Quercus robur
R²= 0.5299
defoliation_EU_2015
defoliation_EU_2010
Belgium
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.9536
defoliation_EU_2015
defoliation_EU_2010
Czech Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.9474
defoliation_EU_2015
defoliation_EU_2010
Denmark
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.9863
defoliation_EU_2015
defoliation_EU_2010
Germany
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment


Quercus robur
R²= 0.1627
Defoliation_EU_2015
Defoliation_EU_2010
Hungary
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.7843
Defoliation_EU_2015
Defoliation_EU_2010
Romania
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.8763
Defoliation_EU_2015
Defoliation_EU_2010
Slovak Republic
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment
Quercus robur
R²= 0.9445
Defoliation_EU_2015
Defoliation_EU_2010
Slovenia
Defoliation EU: 2015 minus 2010
Frequency
Difference of Assessment

Annex 3: Assessment of the same pictures 2010 and 2015 (Mediterranean Europe).



Bibliografische Information:
Die Deutsche Nationalbibliothek verzeichnet diese Publikationen in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet unter www.dnb.de abrufbar.

Bibliographic information:
The Deutsche Nationalbibliothek (German National Library) lists this publication in the German National Bibliographie; detailed bibliographic data is available on the Internet at www.dnb.de

Bereits in dieser Reihe erschienene Bände finden Sie im Internet unter www.thuenen.de

Volumes already published in this series are available on the Internet at www.thuenen.de

Zitationsvorschlag – *Suggested source citation:*

Meining S, Morgenstern Y, Wellbrock N, Eickenscheidt N (2016) Results of the European Photo International Cross-comparison Course as part of the quality assurance of the crown condition assessment 2015 (Photo ICC 2015). Braunschweig: Johann Heinrich von Thünen-Institut, 53 p, Thünen Working Paper 61, DOI:10.3220/WP1469775066000

Die Verantwortung für die Inhalte liegt bei den jeweiligen Verfassern bzw. Verfasserinnen.

The respective authors are responsible for the content of their publications.

THÜNEN

Thünen Working Paper 61

Herausgeber/Redaktionsanschrift – *Editor/address*
Johann Heinrich von Thünen-Institut
Bundesallee 50
38116 Braunschweig
Germany

thuenen-working-paper@thuenen.de
www.thuenen.de

DOI:10.3220/WP1469775066000
urn:nbn:de:gbv:253-201607-dn057012-8