Results of the Forest Condition Survey 2009

Table of Contents

List of Figures

List of Tables

Summary

The crown condition of beech trees showed a sharp deterioration. This was mainly due to the intense fruiting. All other tree species improved.

Over all tree species, **27** % of the forest area was assessed as damaged[1] (damage classes 2 -4), as compared with 26 % in 2008. 37 % were at the warning stage and 36 % were undamaged (2008: 31 %). Mean crown defoliation decreased slightly from 20.4 to 19.7 %.

The main tree species showed the following development:

- **Spruce** *(Picea abies)***:** the area percentage of damaged trees is **26 %** (2008: 30 %). Mean crown defoliation decreased from 20.8 % in 2008 to 19.4 %.
- **Scots pine** *(Pinus sylvestris)*: the area percentage of damaged trees is **13 %** (2008: 18 %). Mean crown defoliation decreased from 18.9 % in 2008 to 15.8 %.
- **Beech** trees *(Fagus sylvatica)* showed a sharp deterioration of their crown condition. The area percentage of damaged trees increased by 20 percentage points and reached **50 %** in 2009. Mean crown defoliation increased from 22.0 to 27.0 %. The intense fruiting in 2009 was conducive to this development. Furthermore, premature senescence and fall of leaves during a drought period in August was observed in some regions.
- **Oaks** (*Quercus petraea and Q. robur*) showed a slight improvement compared with the previous year, however almost half of the trees still show more than 25 % crown defoliation. The area percentage of damaged trees amounts to **48 %** (2008: 52 %). The mean crown defoliation decreased from 28.3 % in 2008 to 26.5 %.

[1] Survey methods, definition of the damage classes and definition of mean crown defoliation are explained in the annex

Results of the survey 2009

The national result 2009 was calculated based on the crown condition data of 10,376 sample trees which were assessed on 424 sampling plots of the national 16 km x 16 km grid. The assessment covers 38 different tree species. However about 85 % of all trees included in the samples belong to the four main tree species: spruce, Scots pine, beech and oak (note that the two oak species *Quercus robur* and *Quercus petraea* are assessed together). The remaining tree species are grouped under the two species groups: “other conifers” and “other broadleaves”. For explanations on the assessment methods see Annex: Forest condition survey: assessment and classification methods.

The results of the Forest Condition Survey 2009 are presented in the following figures and tables. The information on the percentage of forest area covered by the respective tree species or species group stem from Inventory Study 2008, which was carried out to obtain up-to-date forest information for reporting to the Climate secretariat.

All Tree Species

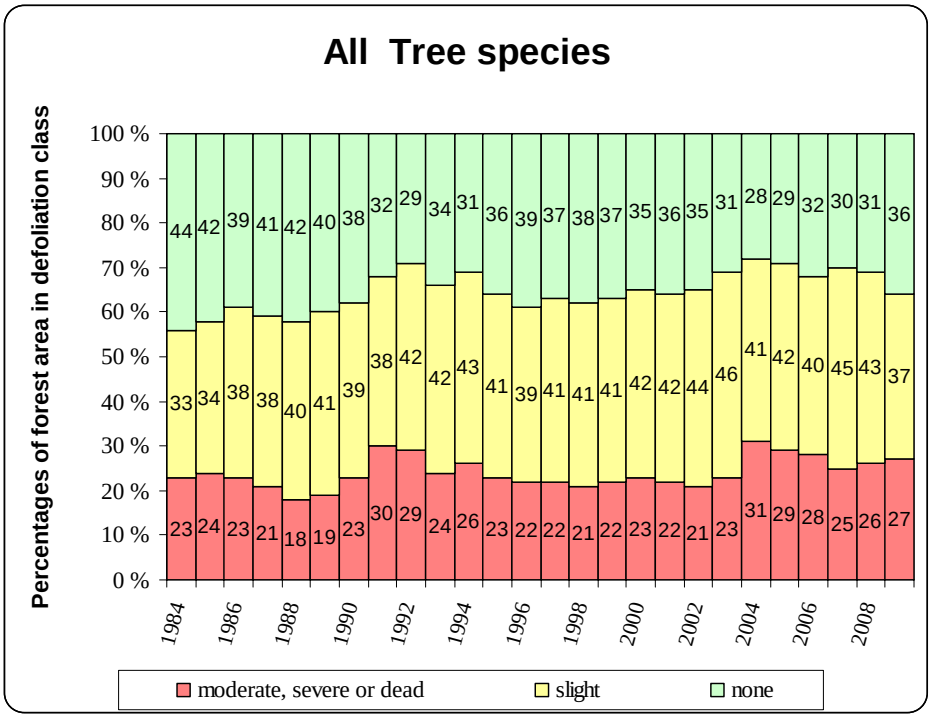

Figure 1: *All Tree Species; development of defoliation classes since 1984 (until 1989 without the new laender; 10,376 trees assessed in 2009)*

Table 1: All tree species: Development of defoliation classes since 1984 [% of forest area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	44	33	23
1985	42	34	24
1986	39	38	23
1987	41	38	21
1988	42	40	18
1989	40	41	19
1990	38	39	23
1991	32	38	30
1992	29	42	29
1993	34	42	24
1994	31	43	26
1995	36	41	23
1996	39	39	22
1997	37	41	22
1998	38	41	21
1999	37	41	22
2000	35	42	23
2001	36	42	22
2002	35	44	21
2003	31	46	23
2004	28	41	31
2005	29	42	29
2006	32	40	28
2007	30	45	25
2008	31	43	26
2009	36	37	27

Table 2: Mean crown defoliation in percent by tree species or species groups

Year	Total/ all species	Spruce	Scots pine	Beech	Oaks	other conifers	other broad-leaves
1984	18.9	21.3	18.0	17.0	15.9	22.2	9.9
1985	17.7	20.0	16.5	15.2	17.5	24.3	10.3
1986	18.1	19.7	16.6	16.6	19.2	25.2	11.9
1987	17.7	17.2	17.2	20.1	19.2	21.7	12.1
1988	16.8	16.9	16.6	17.2	18.8	19.6	12.0
1989	17.2	17.6	16.1	17.0	20.9	19.5	13.3
1990	18.3	18.1	17.6	20.3	19.8	20.1	16.1
1991	21.1	19.9	22.8	20.7	23.4	20.4	19.0
1992	21.2	20.8	19.7	24.8	22.8	20.6	21.4
1993	19.7	20.0	17.0	22.9	25.4	21.8	17.5
1994	20.4	20.6	19.0	21.7	26.7	22.0	17.5
1995	19.2	19.1	16.6	23.9	25.0	21.3	16.2
1996	18.4	17.8	15.8	22.0	28.0	20.3	16.1
1997	18.8	18.7	16.2	22.7	28.2	18.8	15.8
1998	18.3	19.4	15.0	22.0	24.9	18.8	15.1

Year	Total/ all species	Spruce	Scots pine	Beech	Oaks	other conifers	other broad-leaves
1999	18.6	19.0	15.9	23.2	26.2	18.4	14.7
2000	19.3	19.7	16.6	25.6	24.4	18.7	14.5
2001	18.8	20.1	16.4	22.8	24.0	18.1	13.5
2002	19.1	20.2	16.9	22.3	22.5	18.9	15.8
2003	19.9	20.8	17.5	22.7	25.4	19.9	17.6
2004	22.8	23.6	18.5	30.5	28.5	21.0	19.7
2005	21.5	21.8	18.6	27.0	28.1	19.8	18.2
2006	21.0	19.7	18.7	27.7	26.6	19.9	18.2
2007	20.7	20.8	17.6	25.6	28.0	20.3	17.8
2008	20.4	20.8	18.9	22.0	28.3	22.2	16.5
2009	19.7	19.4	15.8	27.0	26.5	19.7	14.9

Conifers

The following figure 2 gives an overview over the development of mean crown defoliation for conifers:

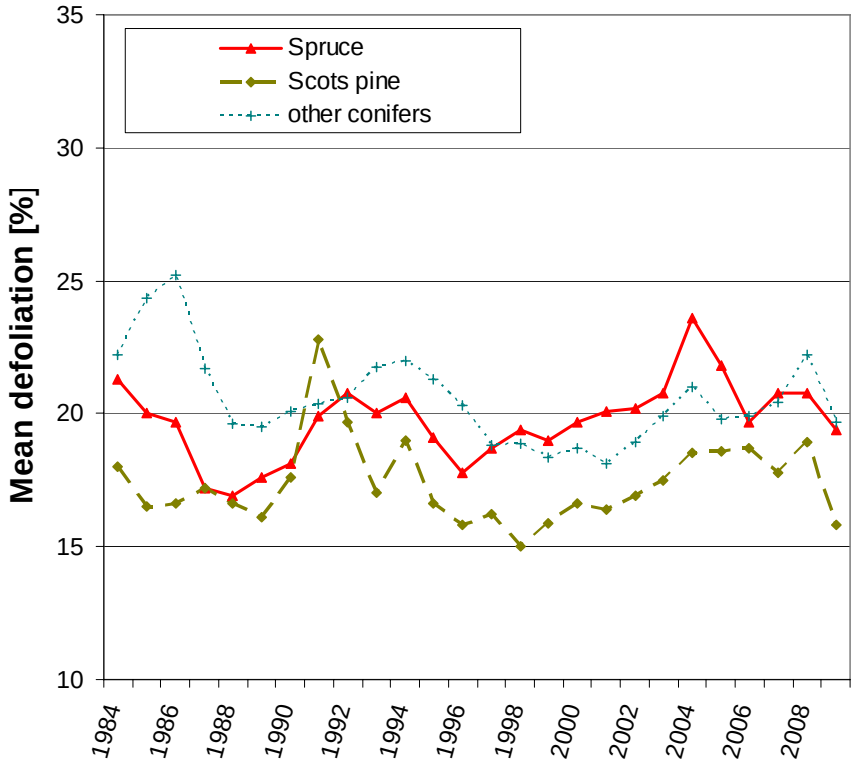

Figure 2 *Development of mean crown defoliation since 1984 for Spruce, Scots pine and other conifers*

Spruce

Scientific name: *Picea abies*

Percentage of forest area: 26 %

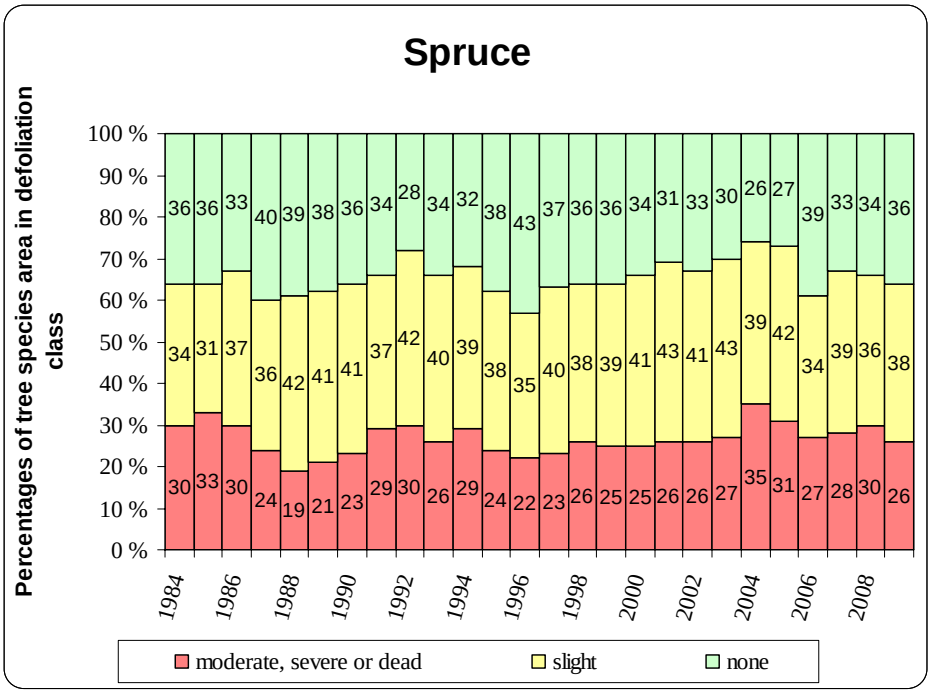

Figure 3: Spruce; Development of defoliation classes since 1984 (until 1989 without new laender; 2,732 sample trees in 2009)

Table 3: Spruce: Development of defoliation classes from 1984 until 2009 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	36	34	30
1985	36	31	33
1986	33	37	30
1987	40	36	24
1988	39	42	19
1989	38	41	21
1990	36	41	23
1991	34	37	29
1992	28	42	30
1993	34	40	26
1994	32	39	29
1995	38	38	24
1996	43	35	22
1997	37	40	23
1998	36	38	26

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1999	36	39	25
2000	34	41	25
2001	31	43	26
2002	33	41	26
2003	30	43	27
2004	26	39	35
2005	27	42	31
2006	39	34	27
2007	33	39	28
2008	34	36	30
2009	36	38	26

The distribution of crown defoliation assessed in 5% steps in 2009 compared with 2008 is shown in figure 4 below.

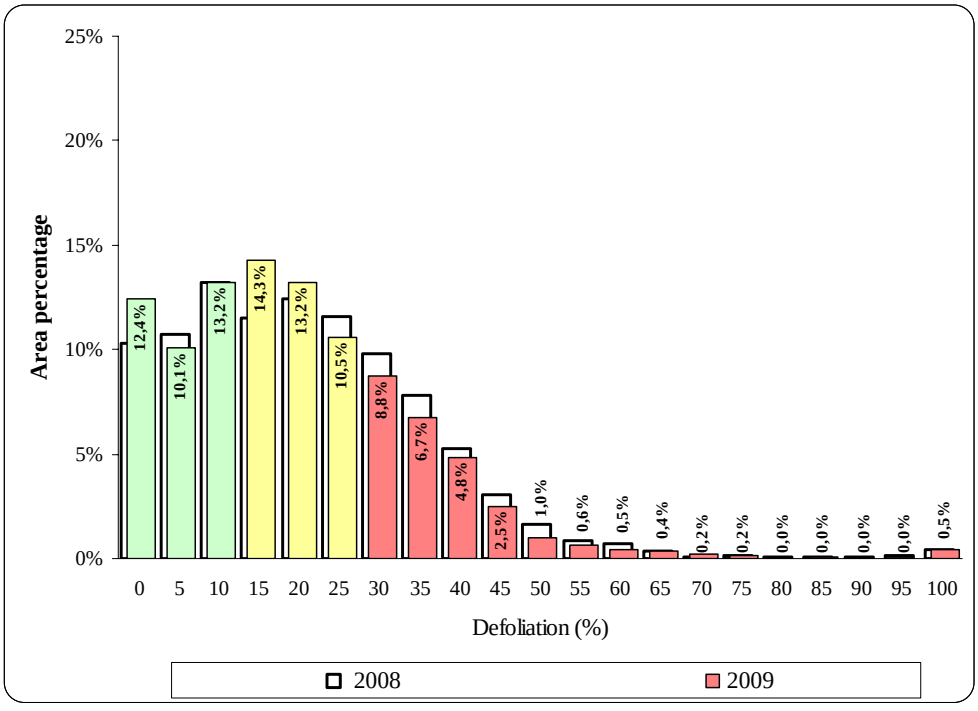

Figure 4: *Spruce: Distribution of crown defoliation assessed in 5 %-steps in 2008 and 2009*
(defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)

Scots pine

Scientific Name: *Pinus sylvestris*

Percentage of forest area: 23 %

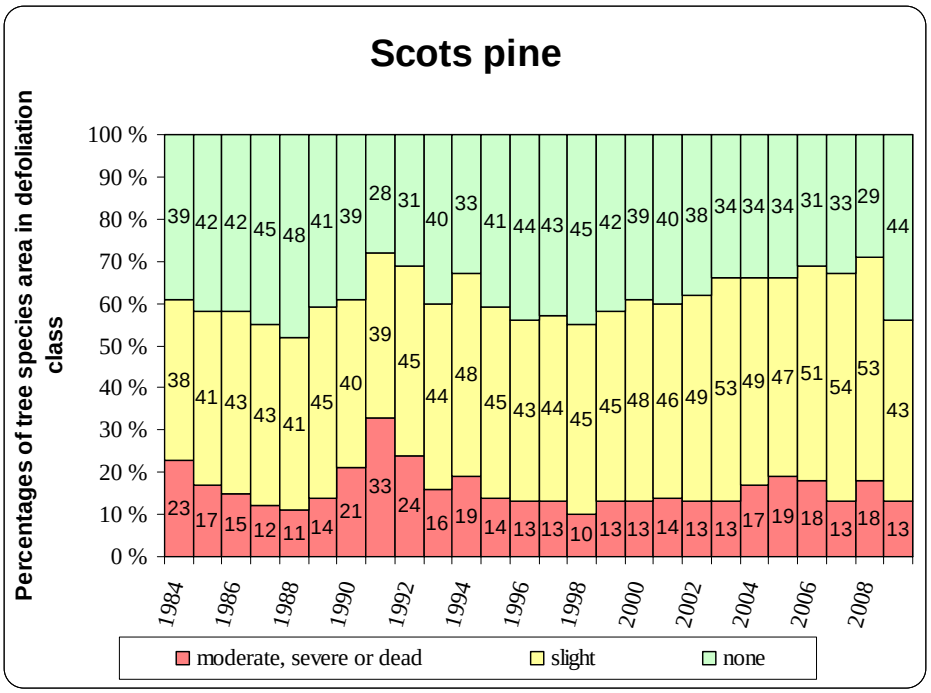

Figure 5: Scots pine; Development of defoliation classes (until 1989 without new laender; 2,800 sample trees in 2009)

Table 4: Scots pine: Development of defoliation classes from 1984 until 2009 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	39	38	23
1985	42	41	17
1986	42	43	15
1987	45	43	12
1988	48	41	11
1989	41	45	14
1990	39	40	21
1991	28	39	33
1992	31	45	24
1993	40	44	16
1994	33	48	19
1995	41	45	14
1996	44	43	13
1997	43	44	13
1998	45	45	10
1999	42	45	13
2000	39	48	13
2001	40	46	14
2002	38	49	13

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
2003	34	53	13
2004	34	49	17
2005	34	47	19
2006	31	51	18
2007	33	54	13
2008	29	53	18
2009	44	43	13

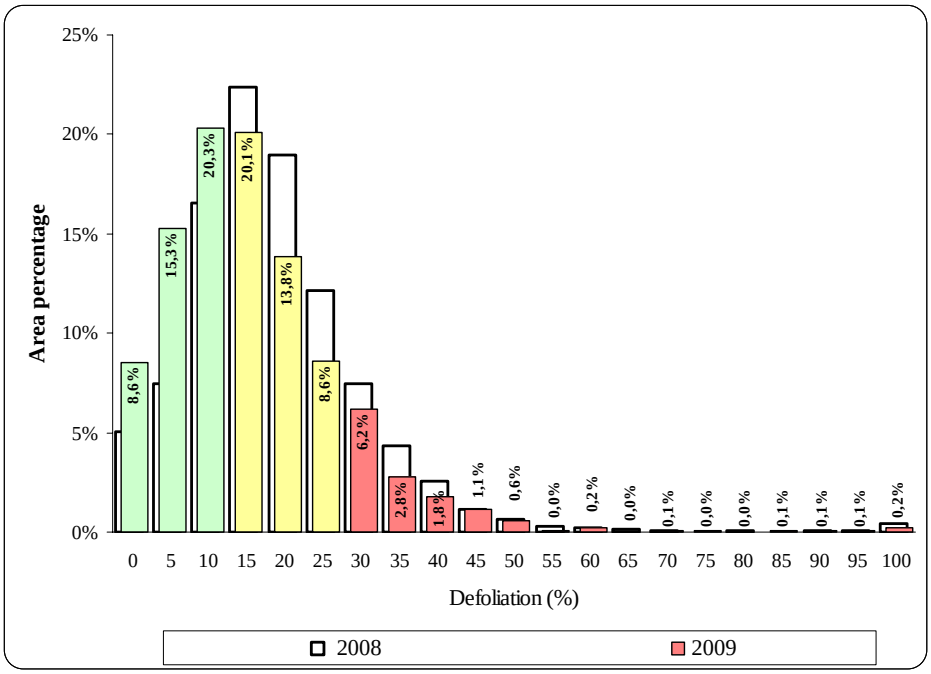

Figure 6: *Scots pine: Distribution of defoliation assessed in 5 %-steps in 2008 and 2009 (defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)*

Other conifers

Percentage of forest area: 7 %.

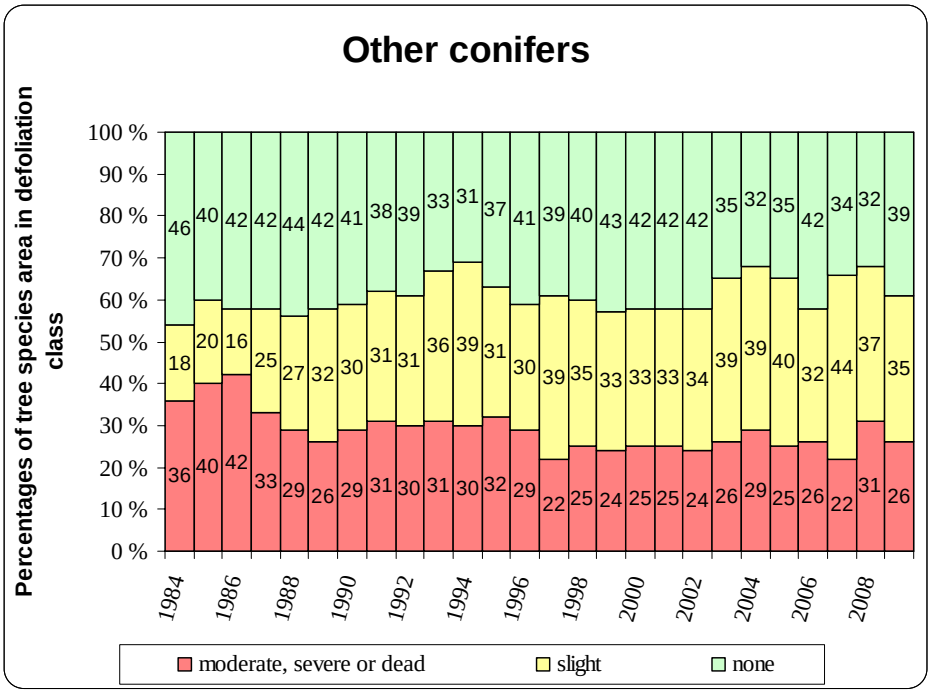

Figure 7: Other conifers; Development of defoliation classes (until 1989 without new laender; 677 sample trees in 2009)

Table 5: Other conifers: Development of defoliation classes since 1984 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	46	18	36
1985	40	20	40
1986	42	16	42
1987	42	25	33
1988	44	27	29
1989	42	32	26
1990	41	30	29
1991	38	31	31
1992	39	31	30
1993	33	36	31
1994	31	39	30
1995	37	31	32
1996	41	30	29
1997	39	39	22
1998	40	35	25
1999	43	33	24
2000	42	33	25
2001	42	33	25
2002	42	34	24

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
2003	35	39	26
2004	32	39	29
2005	35	40	25
2006	42	32	26
2007	34	44	22
2008	32	37	31
2009	39	35	26

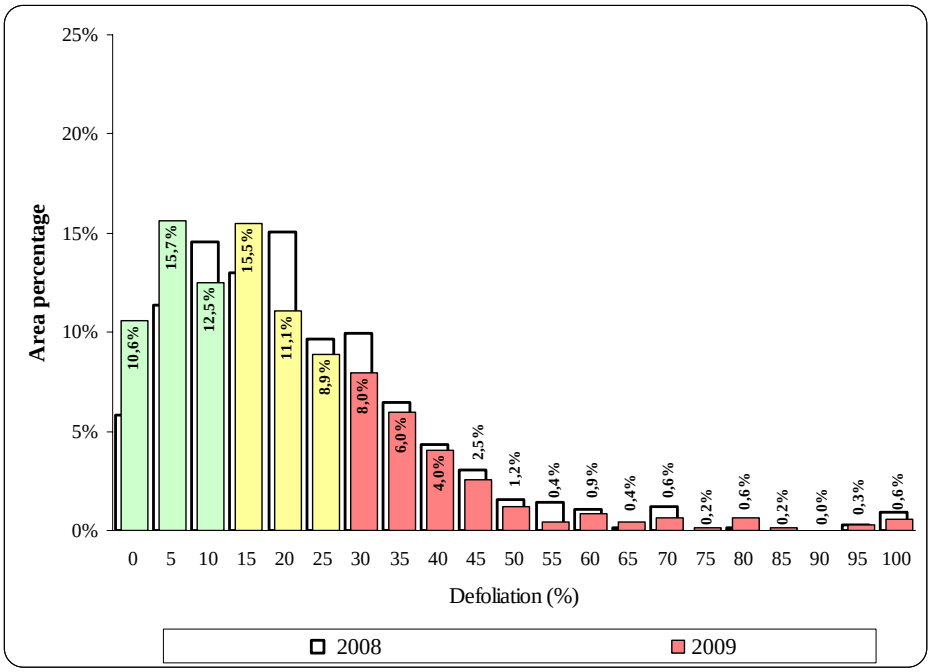

Figure 8: *Other conifers: Distribution of defoliation assessed in 5 %-steps in 2008 and 2009*
(defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)

Broadleaves

Mean defoliation (cf. table 2).

Beech has replaced oak in 2009 as the tree species with the highest defoliation. Compared to the previous year, the mean defoliation of beech trees increased by 5 percentage points to reach 27 %.

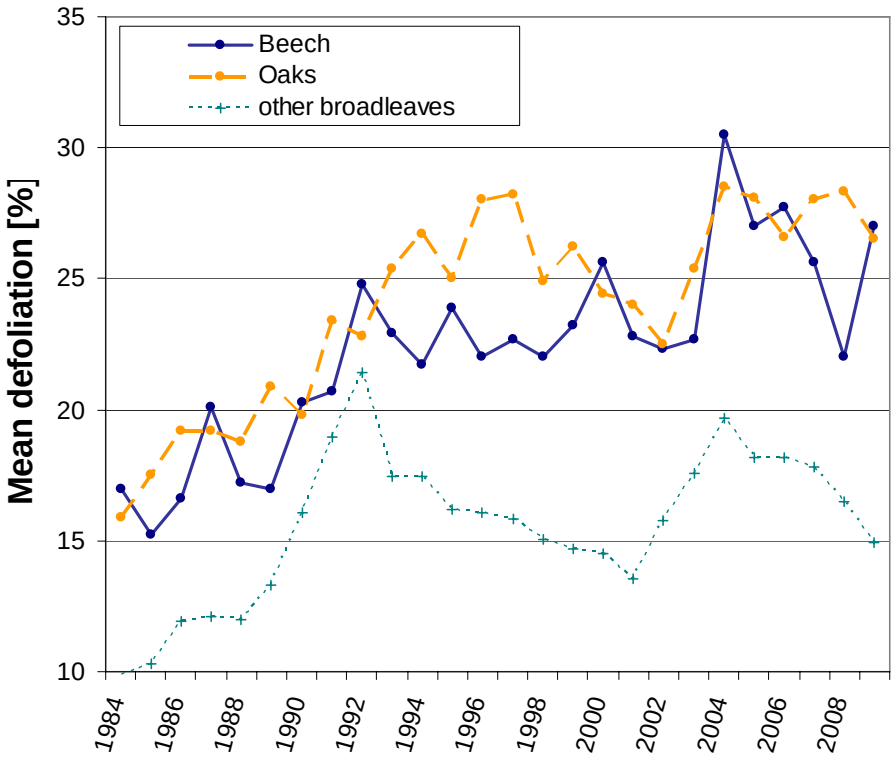

Figure 9: *Development of mean crown defoliation since 1984 for Beech, Oaks and other broadleaves*

Beech

Scientific Name: *Fagus sylvatica*

Percentage of forest area: 16 %

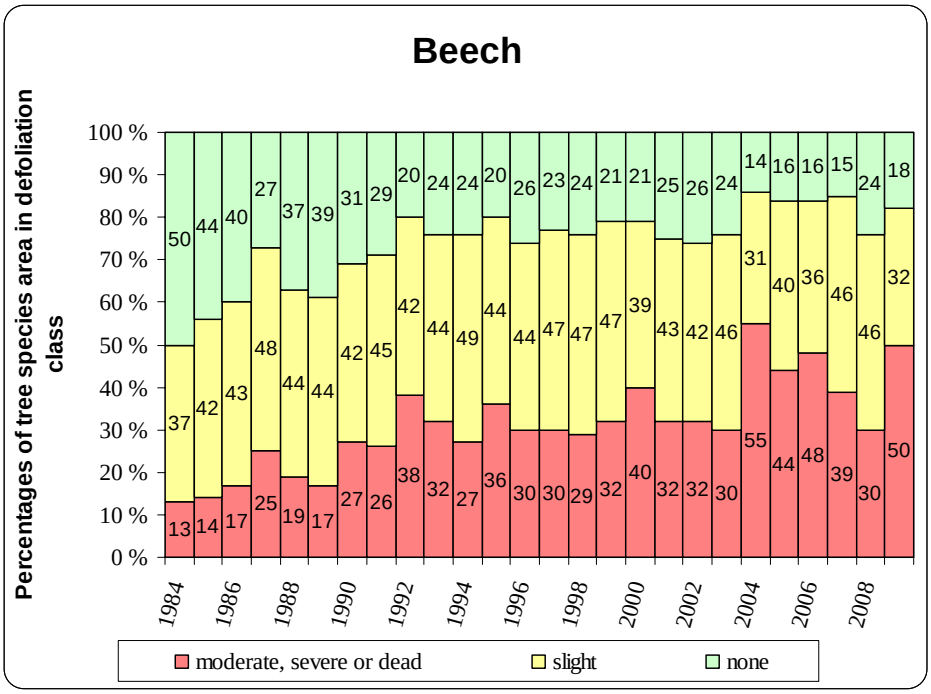

Figure 10: Beech; Development of defoliation classes (until 1989 without new laender; 1,890 sample trees in 2009)

Table 6: Beech: Development of defoliation classes from 1984 until 2009 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	50	37	13
1985	44	42	14
1986	40	43	17
1987	27	48	25
1988	37	44	19
1989	39	44	17
1990	31	42	27
1991	29	45	26
1992	20	42	38
1993	24	44	32
1994	24	49	27
1995	20	44	36
1996	26	44	30
1997	23	47	30
1998	24	47	29
1999	21	47	32

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
2000	21	39	40
2001	25	43	32
2002	26	42	32
2003	24	46	30
2004	14	31	55
2005	16	40	44
2006	16	36	48
2007	15	46	39
2008	24	46	30
2009	18	32	50

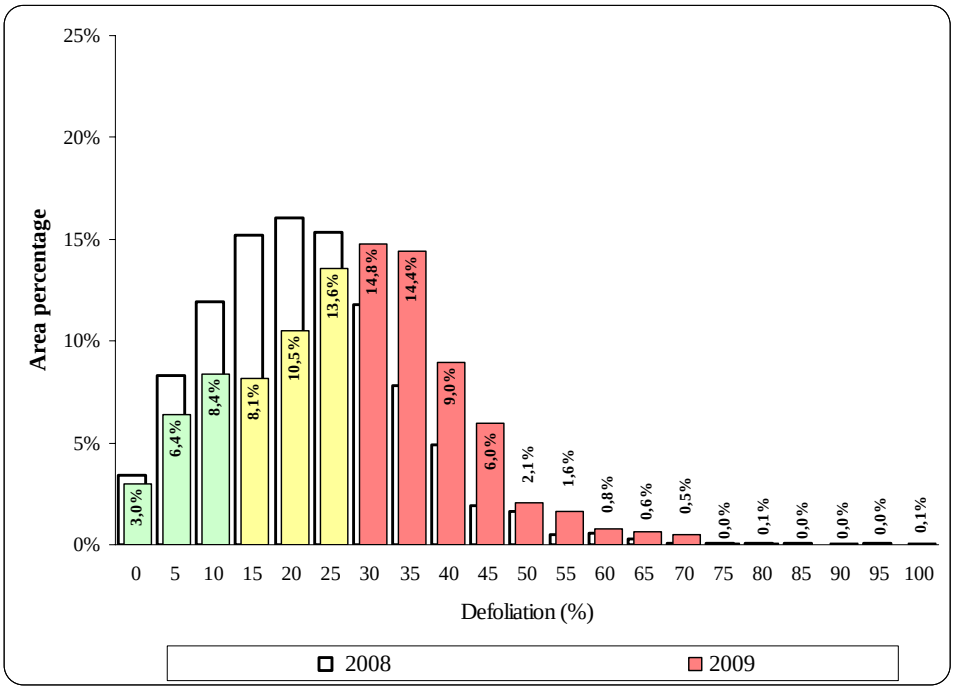

Figure 11: Beech: Distribution of crown defoliation assessed in 5 %-steps (defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)

For beech trees crown condition and fruiting are strongly correlated: trees with abundant fruiting show higher rates of crown defoliation (figure 12). In the past decade, years with intensive fruiting of beech trees older than 60 years were frequent (figure 13). The high frequency of fruiting years influences crown condition (figure 14). In years where a higher percentage of beech trees show abundant fruiting the share of trees in defoliation classes 2 – 4 increases accordingly.

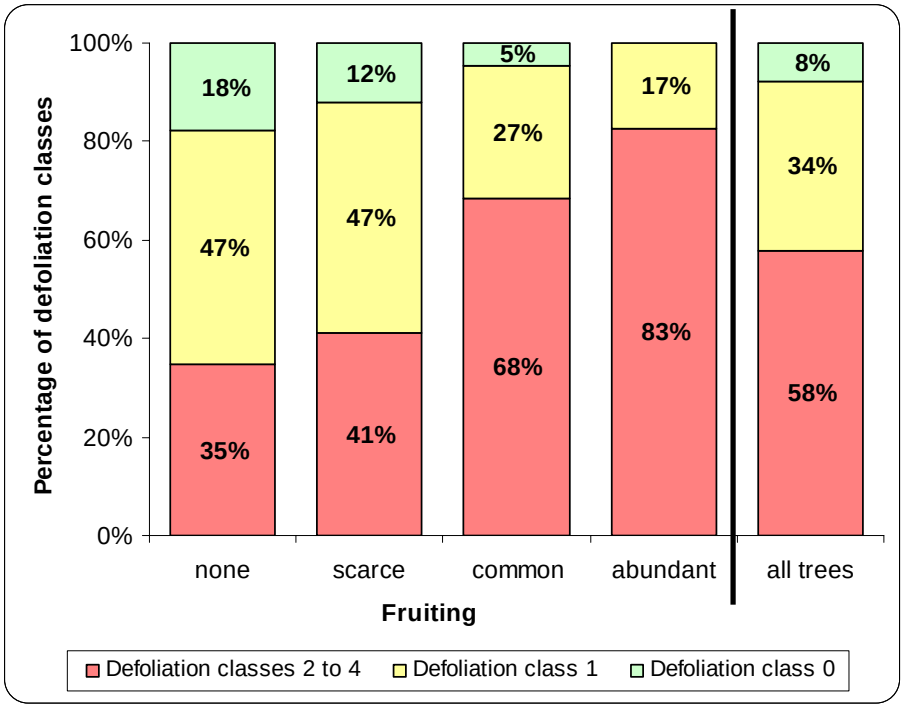

Figure 12: Percentage of defoliation classes for beech trees older than 60 years by fruiting intensity classes in 2009

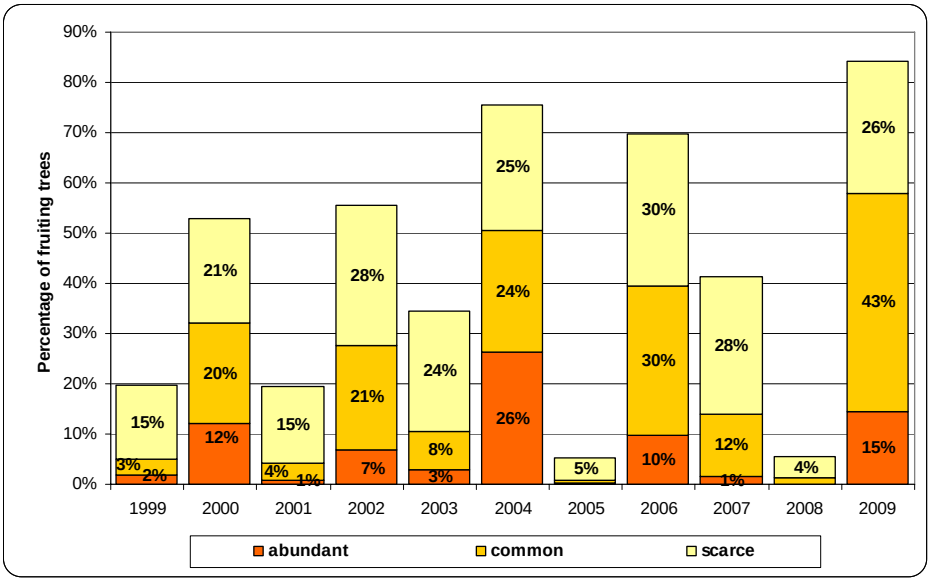

Figure 13: Fruiting of beech trees since 1999

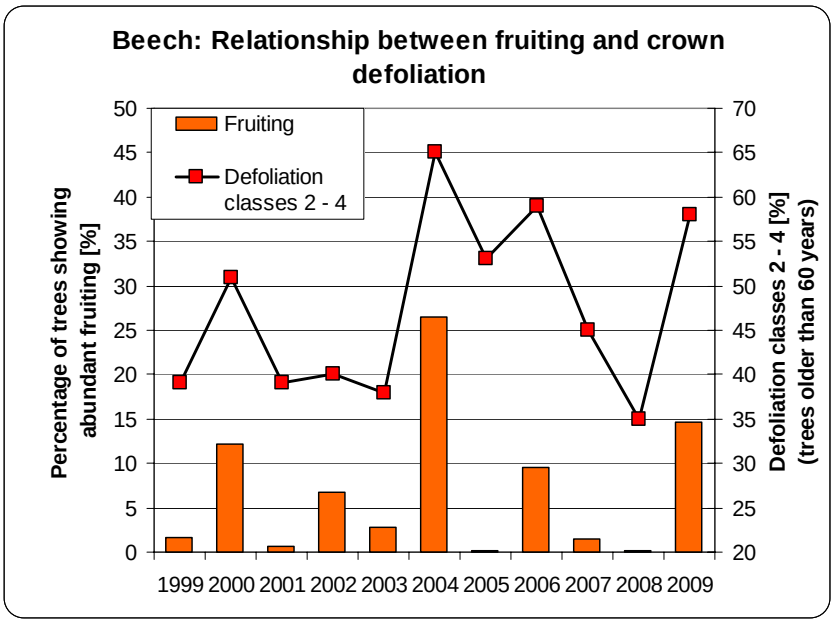

Figure 14: Beech: Relationship between fruiting and crown defoliation

Oaks

Includes European and Sessile oak; the North American Red oak (*Quercus rubra)* is included under “Other broadleaves”.

Scientific names: *Quercus robur, Quercus petraea*

Percentage of forest area (both oak species together): 9 %

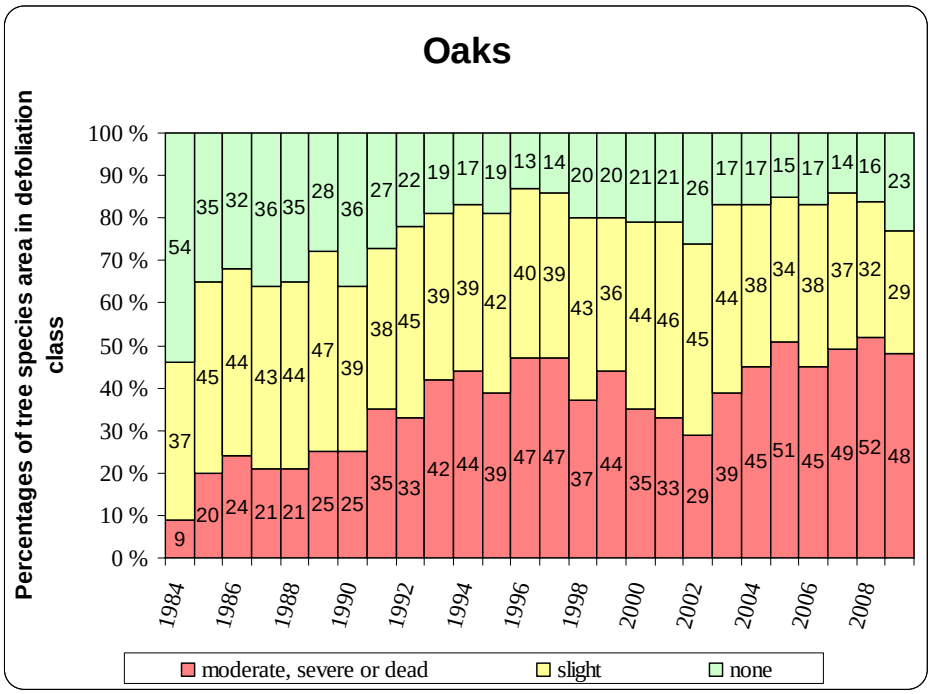

Figure 15: Oaks; Development of defoliation classes (until 1989 without new laender; 850 sample trees in 2009)

Table 7: Oaks: Development of defoliation classes from 1984 to 2009 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	54	37	9
1985	35	45	20
1986	32	44	24
1987	36	43	21
1988	35	44	21
1989	28	47	25
1990	36	39	25
1991	27	38	35
1992	22	45	33
1993	19	39	42
1994	17	39	44
1995	19	42	39
1996	13	40	47
1997	14	39	47
1998	20	43	37

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1999	20	36	44
2000	21	44	35
2001	21	46	33
2002	26	45	29
2003	17	44	39
2004	17	38	45
2005	15	34	51
2006	17	38	45
2007	14	37	49
2008	16	32	52
2009	23	29	48

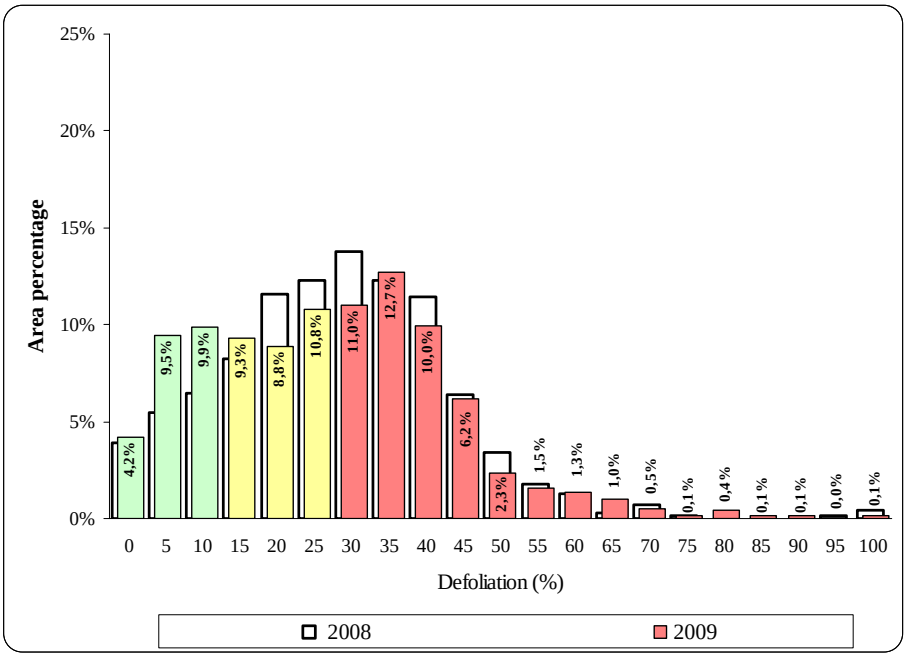

Figure 16: Oaks: Distribution of crown defoliation assessed in 5 %-steps (defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)

Other broadleaves

Percentage of forest area: about 17 %

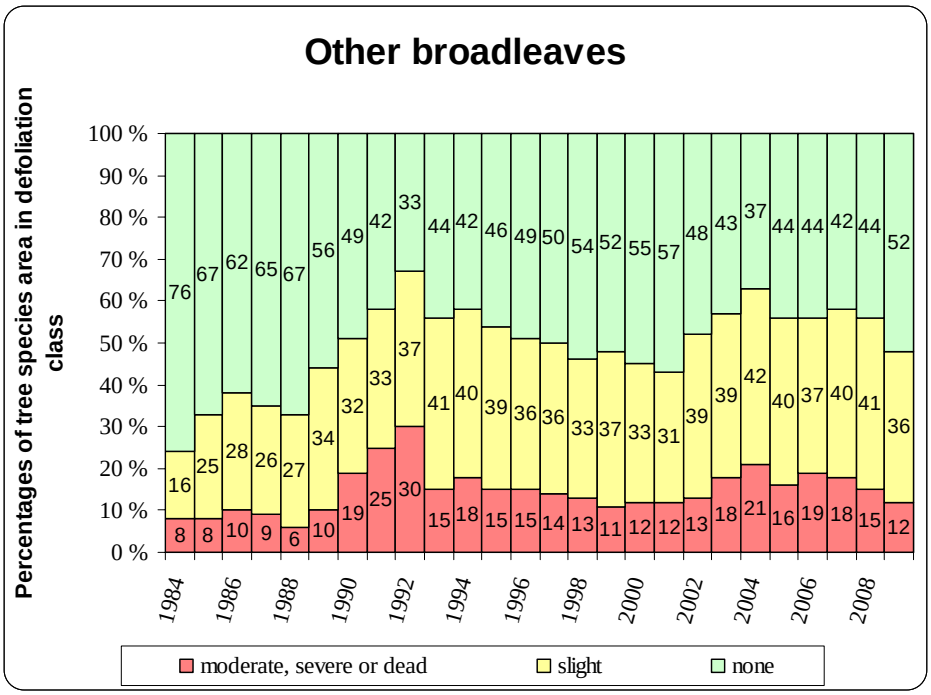

Figure 17: Other broadleaves; Development of defoliation classes (until 1989 without new laender; 1,427 sample trees in 2009)

Table 8: Other broadleaves: Development of defoliation classes since 1984 [% of area]

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
1984	76	16	8
1985	67	25	8
1986	62	28	10
1987	65	26	9
1988	67	27	6
1989	56	34	10
1990	49	32	19
1991	42	33	25
1992	33	37	30
1993	44	41	15
1994	42	40	18
1995	46	39	15
1996	49	36	15
1997	50	36	14
1998	54	33	13
1999	52	37	11
2000	55	33	12
2001	57	31	12
2002	48	39	13

Year	0 (undamaged)	1 (warning stage)	2 – 4 (damaged)
2003	43	39	18
2004	37	42	21
2005	44	40	16
2006	44	37	19
2007	42	40	18
2008	44	41	15
2009	52	36	12

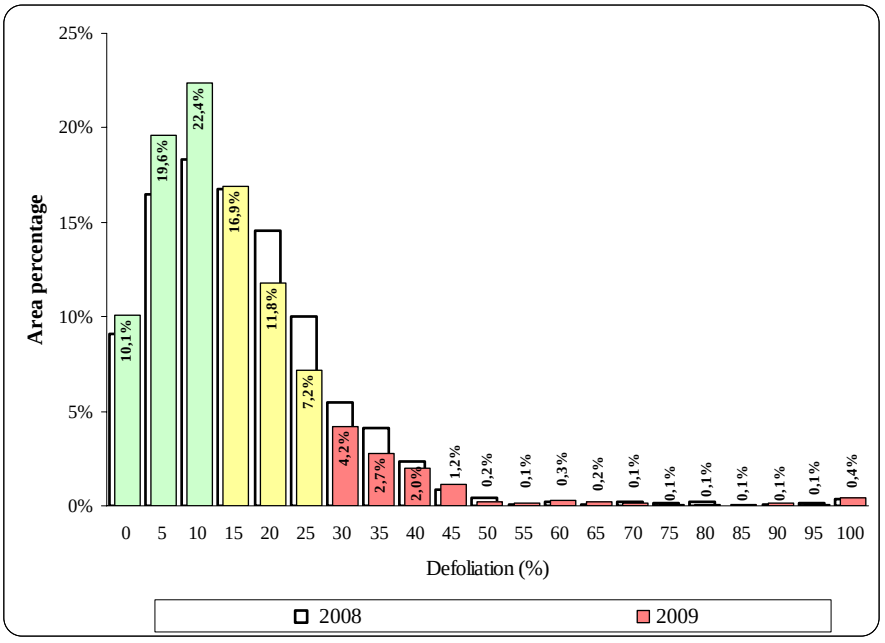

Figure 18: Other broadleaves: Distribution of defoliation assessed in 5 %-steps (defoliation class 0 green, defoliation class 1 yellow, defoliation classes 2 – 4 red)

Influence of tree age on defoliation

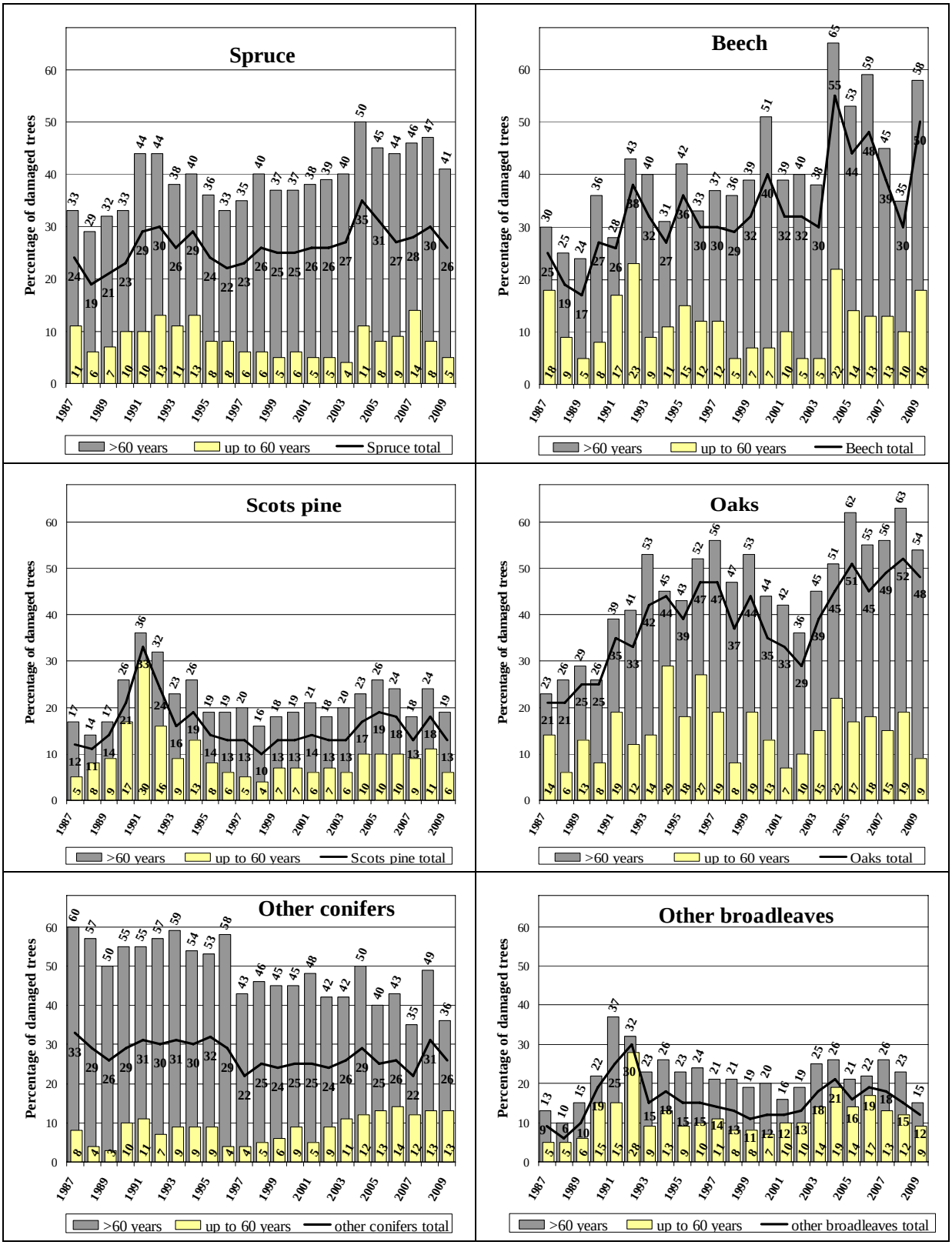

Figure 19: Development of the percentage of damaged trees (defoliation classes 2 – 4) by tree species and age classes

Older trees are in general more affected by crown defoliation than younger ones. This can be seen in figure 19 which shows the percentages of defoliation classes 2 – 4 separately for young trees (up to 60 years) and older trees.

Forest Condition in the German laender

While the national results are based on the data from the national 16kmx16km-grid, the *laender* use denser grids to gain reliable information at regional level. The following table shows the main results as communicated by the *laender* to the Federal Ministry of Food, Agriculture and Consumer Protection.

Table 9: Forest condition in the German *laender* 2009

Percentage of defoliation classes 2 to 4 and change compared with 2008

Land	**All Tree species** Area percentage [%] (*Change in percentage points)*	**Spruce** Area percentage [%] (*Change in percentage points)*	**Scots Pine** Area percentage [%] (*Change in percentage points)*	**Beech** Area percentage [%] (*Change in percentage points)*	**Oaks** Area percentage [%] (*Change in percentage points)*	**Grid** Grid width [km²]
Baden-Württemberg	**42** *(+7)*	**31** *(±0)*	**41** *(±0)*	**70** *(+29)*	**65** *(+1)*	8x8
Bayern	**29** *(+1)*	**20** *(-9)*	**23** *(-6)*	**51** *(+29)*	**58** *(+13)*	16x16[2]
Berlin	**29** *(±0)*	**o. A.**	**16** *(-8)*	**o. A.**	**73** *(+16)*	2x2
Brandenburg	**5**	**o. A.**	**3**	**29**	**26**	16x 16[3]
Bremen	**9** *(+3)*	**26** *(+11)*	**2** *(±0)*	**15** *(+5)*	**19** *(+9)*	0,2x0,1
Hamburg	**o. A.**	**o. A.**	**o. A.**	**o. A.**	**o. A.**	16x16
Hessen	**30** *(+7)*	**23** *(+1)*	**24** *(+1)*	**47** *(+21)*	**25** *(-4)*	8x8[4]
Mecklenburg-Vorpommern	**19** *(-3)*	**26** *(±0)*	**15** *(-6)*	**29** *(+13)*	**29** *(-5)*	8x8
Niedersachsen	**18** *(+2)*	**28** *(+4)*	**3** *(-1)*	**42** *(+11)*	**40** *(+4)*	8x8[5]
Nordrhein-Westfalen	**21** *(-4)*	**15** *(-5)*	**14** *(-6)*	**33** *(+8)*	**39** *(-12)*	4x4
Rheinland-Pfalz	**28** *(-3)*	**26** *(+7)*	**10** *(-10)*	**45** *(+3)*	**46** *(-14)*	4x4
Saarland	**35** *(-2)*	**23** *(-6)*	**57** *(-10)*	**44** *(+ 10)*	**47** *(-6)*	2x4
Sachsen	**18** *(+1)*	**20** *(+5)*	**8** *(-3)*	**53** *(+22)*	**45** *(+12)*	4x4
Sachsen-Anhalt	**15** *(-3)*	**30** *(-3)*	**3** *(-3)*	**44** *(+6)*	**40** *(-3)*	4x4
Schleswig-Holstein	**30** *(+2)*	**44** *(±0)*	**6** *(-2)*	**50** *(+22)*	**31** *(+4)*	8x8
Thüringen	**35** *(+1)*	**27***(-2)*	**46** *(-5)*	**41** *(+11)*	**58** *(+6)*	4x4
Germany	**27** ***(+1)***	**26** ***(-4)***	**13** ***(-5)***	**50** ***(+20)***	**48** ***(-4)***	**16x16**

o. A.: no information; sample size too small

[2] denser grid for silver fir and oaks
[3] revision of the grid in 2009 (therefore comparisons of the results with the previous years require care)
[4] denser grid (4x4) in the Rhine-Main-Region
[5] additional plots in a 4x4 km-grid for beech and oak (all plots where at least 6 beech or oak trees can be found)

The changes reported here may deviate from the difference between the results published in the respective years. Slight differences are due to rounding.

More information on forest condition at the *laender* level can be found in the forest condition reports of the individual *laender*.

Annex

Environmental monitoring of forest ecosystems

Co-operation beyond the boundaries of the EU

The national forest condition survey is part of the **environmental monitoring of forest ecosystems**. It has been developed since the 80s to monitor and describe environmental changes and their impact on forest ecosystems. Environmental problems do not stop at national borders. When this was recognised, this was the beginning of cross-border co-operation, even across the "iron curtain" which still separated Europe at the time.

In 1985 the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was founded within the framework of the UN-ECE Convention on Long-Range Trans-boundary Air Pollution (CLRTAP). Today 41 countries assess inputs of air-born pollutants in forests, crown-condition of forest trees and many other parameters influencing forest condition, using methods standardized at European level. They also co-operate with similar monitoring programmes in North America and Asia. The environmental monitoring of forest ecosystems includes large scale assessments on a **systematic grid** (referred to as "**Level I**") and **intensive monitoring** of various environmental parameters on a number of permanent plots (**Level II**). More information under www.icp-forests.org .

Co-operation in the EU

Since 1986 the European Union has been contributing to the monitoring of forests. A number of regulations have provided the basis for financial support of the assessments and evaluations carried out by the Member States and ICP Forests, most recently the "Forest Focus" Regulation (Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003, concerning monitoring of forests and environmental interaction. Official Journal of the European Union, L 324/1).
http://europa.eu/legislation_summaries/agriculture/environment/l28125_en.htm

The LIFE+ Regulation has provided a new basis for the support of the monitoring of forests. LIFE is the acronym of "**L**' **I**nstrument **f**inancier pour l' **e**nvironnement" – "Financial instrument for the Environment". This instrument was created in 1992 and its primary scope was to support environmental and nature conservation projects. The LIFE+ Regulation entered into force in 2007 and has broadened its scope, allowing it to also support projects in the field of forest monitoring. The "Forest Focus" Regulation expired at the end of 2006.
http://ec.europa.eu/environment/life/index.htm

„FutMon“ – a LIFE+ - Project for the further development of forest monitoring in Europe

The LIFE+ project on “Further Development and Implementation of an EU-level Forest Monitoring System (FutMon)” has been accepted by the European Commission and currently has 37 partner organisations cooperating in it from 23 EU Member States. The project is co-ordinated by the Institute of World Forestry which belongs to the Johann Heinrich von Thünen Institute. The *laender* institutions responsible for forest monitoring in Germany are FutMon project partners.

Building on the tried-and-tested elements of environmental monitoring of forest ecosystems – such as the large scale assessments on systematic grids and the intensive monitoring on permanent plots – which are being continued, the project aims to develop and test new methods. These methods allow for a deeper understanding of traditional questions of forest monitoring, such as air pollution effects on the nutrient budgets and the growth of forests, and will contribute answers to new issues in the field of forest health, biological diversity and climate change. The project is due to run from 1st January 2009 to 31 December 2010. The assessment of crown condition on the 16kmx16km grid is a part of the project. For more information cf. http://www.futmon.org/index.htm

Forest monitoring in Germany

In Germany, forest monitoring is implemented by the *laender*. They are responsible for large-scale assessments on the **systematic grid** (referred to as “**Level I**”) and **intensive monitoring** on permanent plots (**Level II**). The assessments are co-ordinated at federal level and the Institute for forest ecology and forest inventory of the Johann Heinrich von Thünen Institute is responsible for national evaluations and accompanying studies.

The **crown condition survey** which takes place every year is one of the periodic large-scale assessments conducted on the Level-I-grid. For more information see next chapter.

The national **Forest Soil Inventory** also takes place on the Level-I grid. The grid width for this survey is 8 km x 8 km. It is a joint project by the Federal Government and the laender aimed at improving knowledge on the status of forest soils and changes in this status over time. This knowledge is needed to develop and evaluate measures to prevent soil deterioration. The first national forest soil inventory took place between 1987 and 1993. The field sampling of the second one took place from 2006 to 2008. The data evaluation is still ongoing.

The **intensive monitoring** on permanent plots (**Level II**) has been developed and implemented since the 90s to complement the large-scale assessment of forest condition. It aims to give insights into cause-effect-relationships and impacts on forest condition. The programme on level II plots includes the measurement of air pollutant concentrations, deposition of air-borne pollutants in forests, meteorological measurements, acid and element

concentrations in soils and soil solution. The periodic measurement of element contents in leaves and needles allows assessments to be made of the nutritional status of forests. Measurements of soil moisture and the calculation of water budgets will allow water supply and risk from drought stress to be assessed. Furthermore, biological parameters are assessed such as growth in height and stem diameter of the trees, the amount and composition of litter-fall, phenological observations and the composition of soil vegetation. The assessment of crown condition and of damage symptoms is conducted every year on level II plots in the same period as the respective survey takes place on the large scale grid.

Forest condition survey - assessment and classification methods

The national forest condition survey takes place yearly in July and August on a 16 km x 16 km grid. At national level, it yields reliable representative information on the main tree species. The national grid is a sub-sample of the denser grids established by the *laender* to gain information at regional level. The most common plot design is a 4-point cross-cluster oriented along the main compass directions at a distance of 25 m from the grid point. On each of the four sub-plots, the 6 nearest trees are chosen, resulting in 24 sample trees per plot.[6]

Forest condition has been assessed annually in the old *laender* since 1984 and in the new *laender* since 1990. The statistical sampling of crown condition on a systematic permanent grid is currently the only method allowing to large-scale and timely information on the vitality of forests to be obtained at national level at reasonable costs. Crown condition is considered an indicator of tree vitality. Defoliation is defined as a loss of leaves or needles as compared to a reference tree with full foliage and assessed in 5% steps. The results of the survey can be expressed as **mean defoliation**, i.e. the average defoliation found on all sample trees.

The 5 %classes can also be aggregated to defoliation classes of different bandwidth (cf. table 9). A defoliation of more than 25 % is conventionally taken as a threshold for damage. Therefore, defoliation classes 2, 3 and 4 are often presented together and referred to as “damaged”.

Table 10: Definition of defoliation classes

Defoliation class	Needle-/leaf loss	degree of defoliation
0	0 – 10 %	none
1	11 – 25 %	slight (warning stage)
2	26 – 60 %	moderate
3	61 – 99 %	severe
4	100 %	dead

In addition to defoliation, further characteristics of the crown (e. g. the degree of flowering and fruiting) as well as the presence of symptoms of abiotic and biotic damage are assessed.

[6] some laender use slightly different but comparable plot designs

The assessment methods are standardised at European level and are described in detail in the ICP Forests manual (http://www.icp-forests.org/Manual.htm).

Accuracy of the forest condition assessment 2009

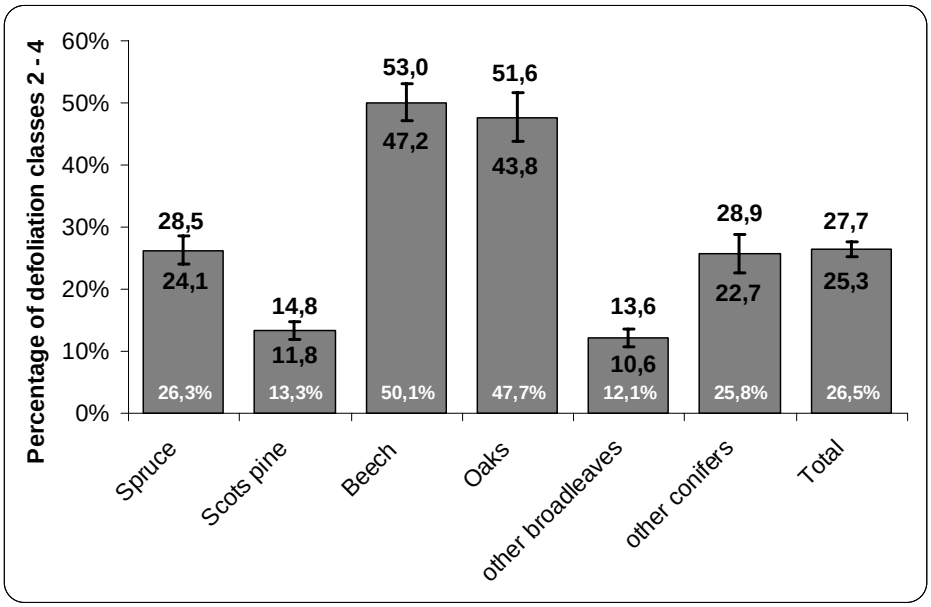

Figure 20: Percentages of Defoliation classes 2 to 4 by tree species in 2009; the whiskers show the standard error

The whiskers show the borders within which the true value can be expected with a probability of 68 %.

Table 11: Percentages of Defoliation classes 2 to 4 by tree species in 2009: Mean and Standard error

Tree Species	Mean [%]	Standard error [percentage points]
Spruce *(Picea abies)*	26.3	±2.2
Scots pine *(Pinus sylvestris)*	13.3	±1.5
Beech *(Fagus sylvatica)*	50.1	±2.9
Oaks *(Quercus petraea, Q. robur)*	47.7	±3.9
other broadleaves	12.1	±1.5
other conifers	25.8	±3.1
Total (all tree species)	**26.5**	**±1.2**