



Accounts for recreational and environmental functions of forests — Results of pilot applications





A great deal of additional information on the European Union is available on the Internet. It can be accessed through the Europa server (http://europa.eu.int).

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Preface

This publication summarises the results of pilot studies of a set of accounts for environmental and recreational functions of forests. The accounts are part of the European Framework for Integrated Environmental and Economic Accounting for Forests (IEEAF), which has been developed by the members of the Eurostat Task Force on Forest Accounting.

Special thanks are due to the experts who took part in the pilot studies and the two meetings of the Task Force on Forest Accounting where the results were discussed:

- Denmark: K. Blix and M. Petersen (Statistics Denmark)
- Germany: R. Hoffmann-Kroll and S. Seibel (Federal Statistical Office), M. Dieter and P. Elsasser (Federal Research Centre for Forestry)
- France: O. Colnard, A. Niedzwiedz and J.-L. Peyron (ENGREF) and B. Poupat (IFEN French Environment Institute)
- Austria: U. Arzberger, W. Sekot and M. Stefsky (University of Agricultural Sciences, Vienna)
- Finland: J. Muukkonen and V. Terho (Statistics Finland)
- Sweden: M. Eriksson, L. Norman and M. Wolf (Statistics Sweden), K. Skånberg (National Institute of Economic Research), H. Eriksson (National Board of Forestry)

Several other experts have also contributed to the work of the Task Force and the development of the IEEAF. The pilot studies benefited from financial support provided by the European Commission's Directorate General for the Environment.

The publication was prepared by Steinar Todsen of Eurostat B1, with contributions from Anton Steurer of Eurostat B1 and Gérard Gie of Planistat Europe. It is one of the outputs of Eurostat's Environmental Accounting work, and contributes to various EU-wide and international activities in the context of national accounts and of environmental accounting, including the implementation of the European System of Accounts (ESA 1995) and the new world-wide System of Environmental and Economic Accounting (SEEA).

Eurostat has recently started regular collection of integrated environmental and economic accounts for forests, with focus on the wood-related functions of forests, see European Commission (2002): 'Natural Resource Accounts for Forests – 1999 data'. In the future, Eurostat is planning to gradually expand the collection of forest accounts data to also include some environmental and recreational functions. The pilot studies reported in this publication show that for many of these services the basic data are not yet available, but the situation will probably improve in the future, because of the political and scientific interest in these topics. The accounts for the carbon binding functions of forests are the most developed, and will be included in the next round of forest accounts data collection.

Brian Newson
Head of Unit B1
National accounts methodology,
statistics of own resources



1 Introduction

Forests provide a broad range of benefits to society, in addition to supplying timber and other marketable goods. These additional benefits include the use of forests for recreation, and environmental functions such as the protection of soil and water resources, maintenance of biodiversity and carbon binding.

This publication presents results of pilot accounts for environmental and recreational functions of forests in several EU countries. The accounts cover carbon binding, factors related to biodiversity, recreational functions, protective functions and the health of trees. They were developed by the Eurostat Task Force on Forest Accounting, and are part of the European Framework for Integrated Environmental and Economic Accounting for Forests (IEEAF).

The IEEAF is a comprehensive system of accounts for wood-related as well as environmental and recreational functions of forests, see European Commission (2000) for a description. The forest accounts are part of the development of integrated environmental and economic accounts, and are developed as satellite accounts to the ordinary national accounts, as described in the European System of Accounts (ESA)¹ and the System of National Accounts (SNA)². The definitions and methodology used in the IEEAF are consistent with the new world-wide System of Environmental and Economic Accounting³ (SEEA).

The IEEAF accounts that focus on the wood-related functions of forests may be called the IEEAF 'timber accounts' for short. The aim of these timber accounts is to describe forest-related assets, economic activities and products. Included are asset accounts for wooded land and timber in physical and monetary terms, parts of the production and capital accounts of the forestry and logging industry, as well as physical and monetary supply and use tables for different kinds of wood and wood products. The concepts, definitions and classifications used are generally consistent with those of the national accounts. The results of Eurostat's first regular collection of timber accounts data have recently been published, see European Commission (2002).

In contrast to the timber accounts, the accounts for environmental and recreational functions of forests focus on services that are often not directly recorded in the national accounts, but still contribute to production and welfare in various ways. These 'free' services that forests provide may be called 'non-wood' or 'non-ESA' functions for short.

Information on environmental and recreational functions of forests is important for several policy initiatives involving forests and the environment. The EU's 6th Environmental Action Programme addresses the development of forest programmes with qualitative environmental targets for production, biodiversity, impact on water and recreation. Other related policy issues are climate change, focusing on the contribution of forest activities to emissions and removals of CO₂, the protection of soils against erosion and the Helsinki process (MCPFE, Ministerial Conference for the Protection of Forests in Europe).

For a physical description of the non-wood functions of forests, the Task Force on Forest Accounting has proposed a set of nine tables in five main categories:

Main category	Table			
Carbon binding	F1. Carbon balance for woody biomass (1000 tonnes of carbon)			
	F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon)			
Factors linked to	F3. Forest-occurring species at risk or endangered			
biodiversity	F4. Protection of forest and other wooded land (1000 ha)			
	F5. Forest regime (1000 ha)			
Recreational functions	F6. Recreational areas of forest and other wooded land (1000 ha)			
	F7. Recreation visits to forests by main purpose			
Protective functions	F8. Forest and other wooded land with protective functions			
Health of trees	F9. Defoliation of trees by classes and species (%)			

Commission of the European Communities (1996).

² Commission of the European Communities et al (1993).

³ Commission of the European Communities et al (forthcoming).



In order to test the proposed set of non-wood tables, in particular the availability and quality of the basic data, and to determine if some of the tables could be included in Eurostat's annual collection of forest accounts data, five EU countries with important forest resources agreed to take part in a pilot study. Austria, Finland, France and Sweden attempted to fill in the full set (Finland and Sweden used a slightly different, earlier version), while Germany provided estimates of carbon binding. The proposed tables do not include estimates of the monetary value of the environmental and recreational services, but interest in such estimates is high and several of the pilot studies also included some monetary data.

This publication is organised as follows. Section 2 gives a summary of the results and conclusions, while sections 3 to 7 discuss each of the five main categories of functions in more detail. The monetary estimates are summarised in section 8. An overview of the links between the MCPFE indicators and the suggested non-wood forest accounts tables is given in Annex 1. The set of proposed physical tables for non-wood functions is shown in Annex 2.



2 Summary and conclusions

The purpose of the pilot studies was to test the suitability of the proposed accounting framework for the non-wood functions of forests. The availability and quality of the basic data needed for the various physical tables was assessed. The possibilities and problems related to a monetary evaluation of the individual functions were also discussed in several studies.

The data situation for the various physical tables is quite heterogeneous. Carbon binding and the health of trees (defoliation) are well covered by data in all the participating countries, and the results are generally comparable across countries. A simplified version of the defoliation table is already included in Eurostat's standard set of annual timber accounts tables, and the tables for carbon binding will be introduced in 2003. For the other functions included in the accounts, the data availability is more difficult, and the available data is also less comparable.

Regarding the possibilities for integrating the monetary values of the recreational and environmental services into the forest accounting system, the pilot studies show that there are many problems, both conceptual and practical. The most promising areas for monetary valuation are carbon binding and recreation. In both cases, the physical data are relatively well defined (tonnes of carbon stored and number of forest visits, respectively), and there are studies available which can be used to derive average values per physical unit. However, the pilot studies also show that the monetary estimates are highly dependent on the assumptions used and therefore require careful explanation when presented.

Another area where monetary data is generally available is government expenditure on the protection and improvement of forests. These are already covered in the normal national accounts, as government final consumption, gross fixed capital formation, subsidies, transfers etc., but it would be useful to present the forest-related expenditures in more detail in the forest accounts.

The data deficits indicate areas where further development of forestry related statistics could be considered. The data requirements of the Ministerial Conference on the Protection of Forests in Europe, the Kyoto process and several other forest-related policy initiatives may lead to a considerable improvement in data availability in the future.



3 Carbon binding

Forests play an important role in the global carbon cycle. Through the process of photosynthesis, trees and other forest plants take up carbon dioxide from the atmosphere. The carbon is retained for long periods in the forest biomass and soils, and later in wood products, so carbon binding in forest ecosystems contributes to a reduction in the concentration of the greenhouse gas carbon dioxide in the atmosphere.

 ${\rm CO_2}$ emissions are a politically important issue, which is subject to international agreements, in particular the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. As a part of this process, EU countries provide an annual greenhouse gas inventory, according to a standard methodology, see European Environment Agency (2002). This includes an estimate of changes in carbon stored in forest and other woody biomass and in forest land and grassland. Further harmonisation of the forest-related carbon estimates is being discussed by the Intergovernmental Panel on Climate Change (IPCC).

3.1 Proposed tables

Two tables are proposed for carbon binding. Table F1 focuses on stocks and changes in stocks of carbon stored in the woody biomass, while Table F2 includes the whole forest ecosystem, as well as carbon stored in wood products.

Table F1. Carbon balance for woody biomass (1000 tonnes of carbon)

	Opening stock	Gross increment	Total removals	Other changes	Changes in use/status	Closing stock
Total woody biomass 1)						
- Standing timber 2)						
Available for wood supply						
Coniferous						
Broadleaved						
Not available for wood supply						
Coniferous						
Broadleaved						
- Other woody biomass 3)						

¹⁾ The mass of the woody parts (wood, bark, branches, twigs, stumps and roots) of trees, alive and dead, shrubs and bushes, measured to a minimum diameter of 0 mm (d.b.h.). Includes above-stump woody biomass, and stumps and roots. Excludes foliage (TBFRA 2000).

The definitions of the different types of changes are the same as in the asset account for standing timber (Table 2a) in the set of annual timber accounts tables, see European Commission (2002):

Gross increment is the volume of natural growth during the period. It is generally calculated by modelling, based on opening stocks by age and species, biological parameters etc. Annual variations of natural growth may be high due to climatic variations – therefore averages over several years (e.g. 5 years) should be used.

²⁾ Volume of standing trees, living or dead, above-stump measured overbark to top (0 cm). Includes all trees with diameter over 0 cm (d.b.h.) Includes tops of stems, large branches; dead trees lying on the ground which can still be used for fibre or fuel. Excludes small branches, twigs and foliage (TBFRA 2000).

³⁾ The woody biomass not included in standing timber, i.e. small branches and twigs, shrubs and bushes, stumps and roots.



Removals refer to those fellings that are removed from the wooded land and other felling sites during the period. Included are removals of trees felled during an earlier period, and removal of trees killed or damaged by natural causes.

Other changes: they cover all reductions in the volume of standing timber, which are not accounted for in removals. They include thinnings and cleanings left in the forest, and trees killed by natural causes (fire, insect attack, disease, wind-throw, landslide, flooding etc.) that are not removed. Other changes may also include a residual item, reflecting inconsistencies among the other data in the asset account.

Changes in use/status refer to changes in the standing volume due to 'changes in use/status' of the corresponding land area. They are recorded twice: as a decrease in the column corresponding to the initial category and as an increase in the column corresponding to the final category. An example is the timber on land that is reclassified from available for wood supply to not available for wood supply. Changes in use/status may also refer to the occasional removals of standing timber located on land 'not available for wood supply'. In this case a positive flow is recorded on the row 'changes in use/status', which is the counterpart of the negative flow recorded under removals.

Table F1 is to be provided for a reference period of five to ten years by using standard conversion factors. The conversion factors from volume of woody biomass to tonnes of carbon should be reported in a note to the table.

Table F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon)

	Opening stock	Changes in carbon stored	Closing stock
Forest ecosystem			
Standing timber			
Other woody biomass			
Other biomass in forest 1)			
Forest soils			
Total in forest ecosystem			
Wood products in the econd	omy (for memo	ry)	
- Construction materials 2)			
- Wooden furniture 3)			
- Paper 4)			
- Other wood products 5)			

¹⁾ Includes needles and leaves and ground vegetation.

2) Mainly products in CPA 20 - Wood and products of wood and cork (except furniture):

CPA 2002 code	Description
20.1	Wood, sawn, planed or impregnated
20.2	Veneer sheets; plywood, laminboard; particle board, fibre board and other panels and boards
20.3	Builders joinery and carpentry, of wood

3) This group consists mainly of products in CPA 36.1 – Furniture:

CPA 2002 code	Description
36.11.12	Seats, primarily with wooden frames
36.12.12	Wooden furniture of a kind used in offices
36.12.13	Wooden furniture for shops
36.13.10 (part)	Kitchen furniture
36.14.12	Wooden furniture of a kind used in the bedroom, in the dining room and in the
	living room
36.14.13	Wooden furniture, n.e.c.

4) This group consists mainly of products in:

CPA 2002 code	CPA 2002 code Description						
21.2	Articles of paper and paperboard						
22.1	Books, newspapers and other printed matter and recorded media						

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5) For example:

,							
CPA 2002 code	Description						
20.4	Wooden containers						
20.51	Other products of wood						

Depending on national definitions, additional rows may have to be added to the table. The table is to be provided for a reference period of five to ten years. The data for standing timber and other woody biomass should be taken from Table F1.

3.2 Results of the pilot studies

3.2.1 Austria

The carbon storage data in the Austrian pilot study (Sekot et al. 2002) are based on a study by the Federal Environment Agency (FEA), see Weiss et al. (2000). Table 1 shows the results for woody biomass. The conversion factors from volume of wood to tonnes of carbon were:

1 m³ wood = 0.19 tonne carbon for coniferous trees

1 m³ wood = 0.25 tonne carbon for broadleaved trees

There may have been minor 'other changes' and 'changes in use/status' in Austria between 1990 and 1996, but no data are available for these items.

In the future, FEA is planning to update the carbon data for woody biomass on an annual basis.

Table 1: F1. Carbon balance for woody biomass (1000 tonnes of carbon), Austria, 1990-1996

	Opening stock 1990	Gross increment	Total removals	Other changes	Changes in use/status	Closing stock 1996
Total woody biomass	320 000	50 000	36 000	:	:	334 000
- Standing timber	255 000	39 000	28 000	:	:	266 000
Available for wood supply	244 000	39 000	28 000	:	:	255 000
Coniferous	187 000	29 000	22 000	:	:	194 000
Broadleaved	57 000	10 000	6 000	:	:	61 000
Not available for wood supply	11 000	:	0	:	:	11 000
Coniferous	:	:	:	:	:	:
Broadleaved	:	:	:	:	:	:
- Other woody biomass	65 000	11 000	8 000	:	:	68 000

Table 2 shows the results for the whole forest ecosystem. Other biomass in forest includes evergreen needles but not leaves. Leaves are part of the trees in summer, but part of the soil in winter, and the soil estimates were assumed to have been made during the winter. No data is available for carbon in ground vegetation in Austria, but the amount is assumed to be negligible.

The data for carbon in forest soils are also from the FEA study, based on a forest soil inventory from the late 1980s. The increase of 7 million tonnes includes also the original soil carbon stock of newly afforested land, e.g. former agricultural land. Without these additions the increase in soil carbon would be about 3.5 million tonnes over the six-year period. No data is available for carbon stored in wood products.



Table 2: F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon), Austria, 1990-1996

	Opening stock Changes in 1990 carbon stored		Closing stock 1996
Forest ecosystem	1990	carbon stored	1990
Standing timber	255 000	11 000	266 000
Other woody biomass	65 000	3 000	68 000
Other biomass in forest	11 000	-1 000	10 000
Forest soils	463 000	7 000	470 000
Total in forest ecosystem	794 000	20 000	814 000
Wood products in the econd	omy (for memo	ry)	
- Construction materials			
- Wooden furniture			
- Paper			
- Other wood products			

3.2.2 Finland

In the Finnish pilot study (Muukkonen and Terho 2002), carbon balances for stem wood were calculated by applying conversion factors to the volume data for stem wood by tree species for 1998. The conversion factors from volume of wood to tonnes of carbon were:

1 m³ wood = 0.20 tonne carbon for coniferous trees

1 m³ wood = 0.25 tonne carbon for broadleaved trees

The carbon in other woody biomass was estimated by applying expansion factors to the stem wood data. For pine trees, the carbon in other woody biomass was assumed to be a share of 0.57 of the carbon in the stem wood, for spruce the share was 0.86 and for broadleaves 0.68. There are plans to develop more accurate, age structure dependent expansion factors in the future.

Table 3: F1. Carbon balance for woody biomass (1000 tonnes of carbon), Finland, 1998

	Opening	Gross	Total	Other	Changes	Closing	Total	Change
	stock	increment	removals	changes	in use/	stock	change	in %
				(1)	status			of opening
								stock
Total woody biomass	680 600	26 600	-21 600	-3 100	0	682 500	1 900	0.3
- Stem wood on wooded land	407 800	15 900	-12 800	-1 800	0	409 100	1 300	0.3
Available for wood supply	391 400	15 600	-12 800	-1 800	0	392 400	1 000	0.3
Coniferous	307 800	11 600	-10 300	-1 000	0	308 100	300	0.1
Broadleaved	83 600	4 000	-2 500	- 800	0	84 300	700	0.8
Not avail. for wood supply	16 400	300	0	0	0	16 700	300	1.8
Coniferous	12 900	200	0	0	0	13 100	200	1.6
Broadleaved	3 500	100	0	0	0	3 600	100	2.9
- Other woody biomass	272 800	10 700	-8 800	-1 300	0	273 400	600	0.2
Available for wood supply	261 800	10 500	-8 800	-1 300	0	262 200	400	0.2
Not avail. for wood supply	11 000	200	0	0	0	11 200	200	1.8

¹⁾ Natural losses and silvicultural waste

The increment used in Table F1 is based on the timber accounts, and is an average of the five-year period 1995-1999. The official Finnish greenhouse gas reporting uses an average over a longer period, which results in a different figure for the carbon absorbed by forest growth (27.3 million tonnes in the greenhouse gas reporting and 26.6 million tonnes in the estimates based on the timber accounts). In the future, the official greenhouse gas reporting data will be used for Table F1 as well. The advantages of this are that data availability will be good (greenhouse gas data are updated annually) and that dissemination of different figures can be avoided.

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The data in Table F2 are from several sources: timber accounts, greenhouse gas calculations and studies on carbon budgets of forest ecosystems. Tree biomass is calculated by multiplying stem wood volumes by expansion factors, as described for Table F1. Disaggregation of 'Other tree biomass' into branches and twigs, needles and leaves, and roots is based on a study published in 1991 (Karjalainen et al. 1991). Estimates of carbon in ground vegetation and in forest soils are from the same study. The change in forest soils is estimated by assuming that the percentage change of carbon is the same as the percentage change of area of forests and other wooded land.

A large 5-year research programme on stocks and flows of carbon on mineral soils and peatlands was started by the Finnish Forest Research Institute in 2001, so it can be expected that statistics in this area will improve in the future.

Changes in carbon in wood products is presented as the amount of carbon in products for domestic use (sawn timber, wooden panels, paper and paperboard). Carbon emissions from products burned or decomposed are not taken into account here, but some estimates are available. E.g. it has been estimated (by Seppälä and Siekkinen 1993), that 20% of the carbon in domestic products is released within five years.

Table 4: F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon), Finland, 1990-1999

	Opening	Opening	Changes	Closing
	stock in %	stock	in carbon	stock
	1990	1990	stored	1999
Forest ecosystem				
Woody biomass	18.2	624 000	62 000	687 000
- Stem wood	10.9	373 000	39 000	412 000
 Other woody biomass 	7.3	251 000	24 000	275 000
branches and twigs	2.2	76 000	7 000	83 000
needles and leaves	1.5	50 000	4 000	54 000
roots	3.6	125 000	13 000	138 000
Ground vegetation	0.3	11 000	:	11 000
Forest soils	81.5	2 798 000	-48 000	2 750 000
- in mineral soil	27.3	938 000	:	:
- in peat land	54.2	1 860 000	:	
Total in forest ecosystem	100.0	3 433 000	15 000	3 448 000
Wood products in the economy	(for memory)			
- Wood products 1)		:	8 000	
- Paper products 1)		:	6 000	:

¹⁾ Sum of products for domestic use 1990-1999

3.2.3 France

In the pilot study for France (Peyron et al. 2002), carbon balances for standing timber were calculated by applying conversion factors to the volume data for standing timber by tree species. The conversion factors from volume of wood to tonnes of carbon were:

1 m³ wood = 0.28 tonne carbon for coniferous trees and poplar trees 1 m³ wood = 0.30 tonne carbon for broadleaved trees, excluding poplar

The carbon in other woody biomass was estimated by applying expansion factors to the standing timber data. The carbon in stumps and roots was assumed to be a share of 0.18 of the above-stump carbon for broadleaves and 0.22 for conifers. A small addition was also made for the carbon in dead wood. The expansion factors are based on a study by Dupouey et al. (1999).



Table 5: F1. Carbon balance for woody biomass (1000 tonnes of carbon), France, 1999

	Opening stock	Gross increment	Total removals	Other changes	Changes in use/status	Closing stock
Total woody biomass	953 162	34 022	-19 029	-3 446	0	964 709
- Standing timber	798 833	32 222	-19 029	-3 446	0	808 580
available for wood supply	726 496	31 353	-19 029	-3 446	0	735 373
coniferous	247 410	12 968	-11 004	-271	0	249 104
broadleaved	479 086	18 385	-8 025	-3 175	0	486 270
not available for wood supply	72 337	869	0	0	0	73 206
- Other woody biomass	154 330	1 800	0	0	0	156 129
available for wood supply	140 355	1 639	0	0	0	141 994
not available for wood supply	13 975	160	0	0	0	14 135

The carbon content of foliage, ground vegetation and forest soil are estimated from the forest area, using conversion factors from Dupouey et al. (1999). The factors used are

- 3.4 tonnes of carbon per hectare for foliage of broadleaves and poplars
- 9.6 tonnes of carbon per hectare for foliage of conifers
- 1 tonne of carbon per hectare for ground vegetation
- 70 tonnes of carbon per hectare for forest soils

The estimates of carbon in wood products are based on a study by Lochu (1998). An average lifetime of 18.3 years is assumed for construction materials, wooden furniture and other wood products. For paper products the average lifetime is set to one year.

Table 6: F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon), France, 1999

	Opening stock	Changes in	Closing stock
		carbon stored	
Forest ecosystem			
Standing timber	798 833	9 747	808 580
Other woody biomass	154 330	1 800	156 129
Other biomass in forest	106 403	274	106 677
Forest soils	1 108 149	2 891	1 111 040
Total in forest ecosystem	2 167 715	14 711	2 182 426
Wood products in the eco	onomy (for memor	y)	
- Construction materials	46 792		
- Wooden furniture	10 531		
- Paper	4 801		
- Other wood products	1 587		



3.2.4 Germany

In the pilot study for Germany (Dieter and Elsasser 2002), carbon balances for standing timber were calculated by applying conversion factors to the volume data for standing timber (coarse wood) from the forest inventory. The volume data was stratified by state, nine species groups and 12 age classes. The conversion factors from volume of wood in m³ to tonnes of carbon were:

Oak	Beech	Lrb (1)	Srb (2)	Spruce	Fir	Douglas fir	Pine	Larch
0.33	0.34	0.325	0.205	0.215	0.205	0.235	0.245	0.275

¹⁾ Other long rotation broadleaves

In order to estimate the carbon content of small wood (twigs and branches below 7 cm diameter) and needles, species and age dependent expansion factors were applied to the data for standing timber (coarse wood). The expansion factors were based on results from several studies in Germany and other countries. Using regression analysis, the factor for each species was estimated as a function of the age of the trees. The expansion factors for both small wood and needles were found to decrease with age in a non-linear way, see Figure 1 for an example. The average expansion factor for small wood was 0.18, and for needles the factors were 0.11 for pine and 0.18 for spruce. The carbon in living leaves was not included in the estimates, in order to avoid possible double counting with dead leaves included in soil carbon estimates made during the winter.

1,0 picea pinus 0,9 abies small wood/coarse wood ratic 0,8 larix pseudotsuga 0,7 filled symbols: temperate 0,6 open symbols: boreal 0,5 0,4 0,3 0.2 0,1 0,0 250 50 100 150 200 0 age

Figure 1: Small wood/coarse wood ratios of conifers in relation to age

Source: Dieter and Elsasser (2002)

The biomass of roots was estimated as a function of the above-ground biomass (standing timber and small wood), with an average expansion factor of 0.18. The conversion factors from biomass to carbon were assumed to be the same for roots as for standing timber. See Dieter and Elsasser (2002) for more details on the estimates of the different expansion factors.

The estimates for carbon in forest soil are based on the National Forest Soil Inventory. There has only been one such inventory so far, so there is currently little data available for changes. A second forest soil inventory is in preparation, so the data situation can be expected to improve in the future.

²⁾ Short rotation broadleaves (poplar and birch)



Table 7: F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon), Germany, 1987/1993

	Opening stock 1987/1993 (4)	Changes in carbon stored (annual average 1987/1993-1999)	Closing stock
Forest ecosystem			
Standing timber 1)	724 364	9 610	
Other woody biomass	293 401	4 595	
Small wood 2)	127 345	2 286	
Roots	166 056	2 309	
Other biomass in forest 3)	62 947	690	
Forest soils	1 168 000	0 *	
Humus layer	223 000	0 *	
Mineral soil	945 000	0 *	
Total in forest ecosystem	2 248 712	14 895	
Wood products in the econ	omy (for memo	ry)	
- Construction materials			
- Wooden furniture			
- Paper			
- Other wood products			

^{*)} Data on change in soils is not available, but are assumed to be 0.

3.2.5 Sweden

In the Swedish pilot study (Norman et al. 2001), the carbon balance was estimated based on data from the national forest inventory. The conversion factor from volume of wood to carbon was:

1 m³ wood = 0.19 tonne carbon for all trees

In Sweden 'managed forest' is defined as land suitable for wood production and not primarily used for other purposes, and with a potential yield under ideal management conditions of at least 1 m³ per hectare per year. The estimates of carbon in branches and foliage and in stumps and roots are based on a Swedish study from 2000.

Table 8: F1. Carbon balance for woody biomass (1000 tonnes of carbon), Sweden, 1990-1994

	Opening stock 1990	Natural growth	Fellings	Other changes	Changes in use/status (1)	Closing stock 1994
Total woody biomass	1 016 000	145 000	115 000	0	0	1 046 000
Above-stump biomass:						
- trees on forest areas	550 000	90 000	62 000	0	0	578 000
- managed forests	514 000	86 000	61 000	0	0	540 000
- coniferous	439 000	72 000	52 000	0	0	459 000
- broadleaved	75 000	15 000	8 700	0	0	81 000
- other forest areas	36 000	4 000	1 700	0	0	38 000
- branches and foliage	276 000	31 000	31 000	0	0	276 000
Stumps and roots	190 000	23 000	21 000	0	0	192 000

^{1) 0.2-0.3} million hectares of managed forests were converted to protected forests during this period and thus transferred to other forest areas. This is neglected here.

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¹⁾ Stems and branches above 7 cm diameter

²⁾ Twigs and branches below 7 cm diameter

³⁾ Needles

^{4) 1987} for the former West Germany, 1993 for the former East Germany



Regarding carbon in forest soils, data was not available for the pilot study, but Sweden is currently carrying out a national inventory on forest soils. This will include determination of the carbon content of the various layers.

3.3 Conclusions

The pilot studies show that data availability and quality is quite good for carbon stored in standing timber, estimated by applying conversion factors to volume data based on national forest inventories. Carbon in other woody biomass (small branches, stumps, roots etc.) can also be estimated by applying expansion factors to the data for standing timber, but the accuracy will not be as good.

Carbon stored in forest soils can be estimated by applying coefficients to land use data in hectares (the French pilot study assumed 70 tonnes of carbon per ha), but both the average per hectare and also the changes in land use from year to year will be uncertain. Another problem is that when land is afforested, the carbon stock tends to build up gradually over time. Taking this into account in the estimates will be difficult in practice, however. Leaves are also a potential problem, since they are part of the soil in winter and part of the trees in summer. With independent data sources for woody biomass and soil, this may lead to either double counting or to leaves not being included at all, depending on the time of measurement.

Estimating carbon stocks and changes in stock separately for 'forest available for wood supply' and for 'forest not available for wood supply' proved difficult. There was also little data available on the carbon stored in wood products, in the pilot studies only France reported data on this. The French study showed that the carbon stock in wood products is about 3% of the stock in the forest ecosystem, but the Finnish study suggests that changes in the carbon stored in wood products can be relatively more important.

Despite the potential data problems, the results from the pilot studies are relatively similar, as illustrated by the table below (Sweden provided no data for soil, so it is not included in the table). More than half of the carbon in the forest ecosystem is found in the soil, and around a third in standing timber.

Carbon stock in forest ecosystem, in % of total, 1990s

	Austria	Finland	France	Germany
Standing timber	33	25	37	32
Other woody biomass	8	17	7	13
Other biomass in forest	1	1	5	3
Total biomass in forest	42	43	49	48
Forest soils	58	57*	51	52
Total in forest ecosystem	100	100	100	100

^{*} Not including peat land.

Even though most of the carbon stock is in the forest soil, this changes only slowly, so most of the change in carbon in the forests is in the biomass. The greenhouse gas inventory for the EU (European Environment Agency 2002) show that in 2000, the increase in forest and other woody biomass removed about 221 million tonnes of CO₂ from the atmosphere, about 6.7% of the total CO₂ emissions of around 3 300 million tonnes. In comparison, changes in forest land and grassland caused net emissions of 12 million tonnes of CO₂.

The data situation on carbon storage can be expected to improve over time, since this is an area with high political and scientific interest, partly as a result of the demands of the UNFCCC (Kyoto process). It has been decided to include Tables F1 and F2 in the set of annual timber accounts tables from 2003 onwards, see European Commission (2002).



4 Factors linked to biodiversity

Biodiversity can be defined as the range of organisms present in a given ecological community or system. It can be measured by the numbers and types of different species, or the genetic variations within and between species. Slowing down the rate of species extinction due to human factors is a key objective of the conservation of biodiversity. Forests are important in this respect, since they are the natural habitat for a wide range of plants and animals.

4.1 Proposed tables

Three tables on factors linked to biodiversity are proposed in the forest accounts. In Table F3 the focus is on forest-occurring species at risk or endangered. The number of species that are threatened by extinction is an indicator for (potential) loss of biodiversity, and also for changes in the functioning of the forest ecosystem.

Table F4 covers protection of forest and other wooded land. Areas are often protected in order to conserve biological diversity and maintain the natural ecological processes of an ecosystem.

Table F5 shows the area of forest and other wooded land according to the different types of forest regime, i.e. species, age structure and availability for wood supply. This is an indicator of the variability of the forest. A more varied forest will generally be suitable as a habitat for a wider range of species than a more homogenous forest.

Table F3. Forest-occurring species at risk or endangered 1)

	Total number of known forest-	i forest- IUCN category 2)					
	occurring species	CR	EN	VU	CR+EN+VU	% of total	species in % of all species
Trees (coniferous and broadleaved species)							
Other vascular plants (flowers)							
Total vascular plants							
Mosses							
Lichens							
Macrofungi							
Algae							
Total non-vascular plants							
Mammals							
Birds							
Other vertebrates (fish, amphibians, reptiles, snakes)							
Total vertebrates							
Insects							
Other invertebrates							
Total invertebrates							

¹⁾ The TBFRA-2000 uses the following definition of 'Species occurring on forest/other wooded land': Species of flora and fauna which occurs on forest or other wooded land for at least part of its everyday existence, e.g. for shelter, feeding, nesting or breeding.

CR = critically endangered

EN = endangered

VU = vulnerable

Two tables are to be provided; one for a reasonable post-1950 year and the other for the most recent year. If possible, endemic and exotic species should be distinguished, and estimates of extinct species included in the table.

²⁾ A species is endangered when it is facing a high risk of extinction in the wild in the near future. The IUCN categories are:



Table F4. Protection of forest and other wooded land (1000 ha)

	IUCN cat. I and II	IUCN cat. III and IV	Total IUCN	Other legal protection	Total legally protected area 1)	Other protected areas	% of total	Natio- nal target (%) 2)	Natura 2000 areas 3)
Opening area									
Afforestation									
Deforestation									
Natural colonisation or regression									
Other changes									
Changes in land classification									
Closing area									

¹⁾ Forest not available for wood supply with severe legal restriction on wood production (e.g. national parks, nature reserves and other protected areas such as those of special scientific, historical or cultural interest) as requested by the IEEAF. Care is needed to avoid double counting areas that are included in several sources.

- 2) The political target for the proportion of national forest and other wooded land to be exempted from wood production in order to safeguard and preserve the level of biodiversity and allow species to spread.
- 3) Wooded land included in the Natura 2000 program of the EU, a European network of special areas of conservation. The legal basis is 'Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora'

The IUCN categories are:

- I. Strict nature reserve/wilderness area
- II. National park
- III. Natural monument
- IV. Habitat/species management area

The table is to be provided for a reference period of five years



Table F5. Forest regime (1000 ha)

	Opening area	Changes	Closing area
Total forest and other wooded land			
- Not available for wood supply			
- Available for wood supply			
Uneven-aged high forest 1)			
Broadleaved 2)			
Coniferous 3)			
Mixed 4)			
Even-aged high forest 5)			
Broadleaved			
Coniferous			
Mixed			
Coppice 6)			
Coppice with standards 7)			
Broadleaved			
Coniferous			
Mixed			
Undetermined regime			

Definitions from TBFRA 2000:

- 1) High forest in which there is a mixture of different age classes. Usually, the trees can not be separated into different storeys.
- 2) Land on which broadleaved trees account for more than 75% of the tree crown area.
- 3) Land on which coniferous trees account for more than 75% of the tree crown area.
- 4) Land on which neither coniferous nor broadleaved trees account for more than 75% of the tree crown area.
- 5) High forest in which the predominant proportion of trees falls into the same age class, generally resulting in a single storey forest.
- 6) Forest composed of stool-shoots or root suckers.
- 7) Coppice with scattered trees.

The table is to be provided for a reference period of ten years.



4.2 Results of the pilot studies

4.2.1 Austria

For the proposed table on forest-occurring species at risk or endangered, the data available in Austria is insufficient. Data of the Red List Austria provide an overview concerning the total flora and fauna in Austria, and does not consider the distribution of species among different types of ecosystems. The Red List deals with indigenous species, occurring in Austria at least since 1850. That means that exotic species introduced after 1850 are not taken into consideration. So far, an assessment of forest-occurring species, on the database of the Red List species, has been carried out just once (in 1986) and for the group of vascular plants only.

Data on forest-occurring species endangered or at risk in Austria were provided for the TBFRA 2000. However, there is no established source for such data, the respective figures reflecting expert opinions collected from experts of the zoological and botanical departments of the Museum of Natural History in Vienna.

Table 9: F3. Forest-occurring species at risk or endangered, Austria, 1986

	Total number of	Е	Endangered forest-occurring species IUCN category				Forest- occurring
	known forest- occurring species	CR	EN	VU	CR+EN+VU	% of total	species in % of all species
Total vascular plants	640	36	98	197	331	51.7	21.7

At the time of the pilot study there was little data available for Table F4 on protection of wooded land. The first national study on this topic has been conducted by the FEA, the preliminary results became available in September 2002 only. Driven by the process of the Ministerial Conference of the Protection of Forests in Europe (MCPFE), the study will most likely be updated in the future. However, it is almost certain that it will not be possible to provide detailed data on the change items that are specified in Table F4.

For Table F5 on the forest regime, some data is available in the Austrian Forest Inventory, but not on the detailed classification of forest and other wooded land available for wood supply.

Table 10: F5. Forest regime (1000 ha), Austria, 1990-1996

	Opening area 1990	Changes	Closing area 1996
Total forest and other wooded land	3 878	46	3 924
- Not available for wood supply	547	25	572
- Available for wood supply	3 331	21	3 352
Uneven-aged high forest	:	:	:
Broadleaved	:	:	:
Coniferous	:	:	:
Even-aged high forest	:	:	:
Broadleaved	:	:	:
Coniferous	:	:	:
Coppice	96	2	94
Mixed coppice and high forest	:	:	:
Broadleaved	:	:	:
Coniferous	:	:	:
Undetermined regime	2 946	43	2 989



4.2.2 Finland

Inventories of threatened species have been made in Finland in 1986, 1992 and 1997-2000. For the study covering 1997-2000, the new categories and criteria of the Red List of threatened species of the World Conservation Union (IUCN) were used. According to the latest inventory, 37% of threatened species in Finland were forest-occurring species. The data were provided by the Ministry of the Environment and the Finnish Environmental Institute.

Table 11: F3. Forest-occurring species at risk or endangered, Finland, 1997-2000

	Total number	r Endangered species IUCN category					
	of known	CR	EN	VU	CR+EN+VU	%	
	species					of total	
Trees	:	:	:	:	:	:	
Other vascular plants	:	:	:	:	:	:	
Total vascular plants	3 200*	13	21	34	68	2.1	
Mosses	883	7	12	37	56	6.3	
Lichen	1 452	12	10	22	44	3.0	
Macrofungi	5 454	51	66	109	226	4.1	
Algae	5 000*	0	0	0	0	0.0	
Total non-vascular plants	12 789	70	88	168	326	2.5	
Mammals	65	1	3	1	5	7.7	
Birds	240	3	4	7	14	5.8	
Other vertebrates	78	0	0	0	0	0.0	
Total vertebrates	383	4	7	8	19	5.0	
Insects	19 850*	43	86	136	265	1.3	
Other invertebrates	6738*	1	6	10	17	0.3	
Total invertebrates	26 588*	44	92	146	282	1.1	
Grand total	43 000*	131	208	356	695	1.6	

^{*}Forest is the most important habitat for the species

Statistics on protection of forest and other wooded land is not available by IUCN-categories. A committee co-ordinated by the Ministry of Agriculture and Forestry is currently working on definitions and areas of protected forests and other wooded land, and only preliminary results for year 2001 were available at the time of the pilot study.



Table 12: Protection of forests and other wooded land, Finland, 1997-2001

		Opening	Change	Closing	Change
		area		area	% of
		1997		2001	opening area
Not available for	Strictly protected forests	1 528	133	1 662	8.7
wood supply	Strict nature reserves	79	-11	69	-13.5
	National parks	405	109	514	26.8
	Wilderness areas	454	0	454	0.0
	Others	589	36	625	6.0
Available for	2. Forests under other protection	911	297	1 208	32.6
wood supply	2a. 'Light' fellings allowed	211	0	211	0.2
	2b. Limited use for forestry	700	297	997	42.4
	 of which high altitude areas 	513	0	513	0.0
Total		2 440	430	2 870	17.6

4.2.3 France

In France, there is some data available on forest-occurring species, defined as species strictly or frequently encountered in forests. The category 'Other vertebrates' includes only reptiles and amphibians, and 'Other vascular plants' does not include Mediterranean vascular plants. No data are available for forest-occurring non-vascular plants and invertebrates.

Table 13: F3. Forest-occurring species at risk or endangered, France, 1999

	Total number of known		Endanger	ed specie	es IUCN categ	ory	Forest- occurring species in
	species	CR	EN	VU	CR+EN+VU	% of total	% of all species
Trees (coniferous and broadleaved species)	136						
Other vascular plants (flowers)	651						
Total vascular plants	787	2	4	8	14	1.8	13.1
Mosses							
Lichens							
Macrofungi							
Algae							
Total non-vascular plants							
Mammals	73	4	3	11	18	24.7	59.3
Birds	120	8	1	7	16	13.3%	33.6
Other vertebrates (fish, amphibians, reptiles, snakes)	24	1	0	6	7	29.2	32.9
Total vertebrates	217	13	4	24	41	18.9	22.3
Insects							
Other invertebrates				·			
Total invertebrates							



For protected areas, data are available for national parks, protection forests, biological reserves in public forests, nature reserves, the 'conservatoire du littoral' and national game reserves. Other protection regimes also exist but data on the corresponding areas are not available.

Table 14: F4. Protection of forest and other wooded land (1000 ha), France, 1994-1999

	IUCN cat. I and II	IUCN cat. III and IV	Total IUCN	Other legal protection	Total legally protected area	% of total	National target (%)	Natura 2000 areas
Opening area	112	62	174		174	1.1		
Afforestation								
Deforestation								
Natural colonisation or regression								
Other changes								
Changes in land classification								
Closing area	114	91	205		205	1.3		2 807

Data on the forest regime is available in the national forest inventory. There are two sets of data, based on different methodologies. The first data set is based on field observations at a number of observation points, while the second is based on aerial photographs. The aerial data show about 20% of the area that is available for wood supply as being of undetermined regime and another 6% as mixed stands. In the field observation data, these categories are both 0.

Table 15: F5. Forest regime (1000 ha), France, 1999

A) According to elementary stand structure, based on field observations

	Opening area	Changes	Closing area
Total forest and other wooded land	15 831	41	15 872
- Not available for wood supply	1 434	3	1 437
- Available for wood supply	14 397	38	14 435
Uneven-aged high forest	785	8	793
Broadleaved	416	8	425
Coniferous	369	0	368
Mixed	0	0	0
Even-aged high forest	7 324	66	7 390
Broadleaved	3 394	68	3 463
Coniferous	3 930	-2	3 928
Mixed	0	0	0
Coppice	1 999	-24	1 975
Coppice with standards	4 289	-12	4 277
Broadleaved	3 518	-14	3 504
Coniferous	771	2	773
Mixed	0	0	0
Undetermined regime	0	0	0
Young plantations	0	0	0
Undetermined	0	0	0



B) According to stand types, based on aerial photographs

	Opening area	Changes	Closing area
Total forest and other wooded land	15 831	41	15 872
- Not available for wood supply	1 434	3	1 437
- Available for wood supply	14 397	38	14 435
Uneven-aged high forest	488	5	494
Broadleaved	144	-3	142
Coniferous	264	-1	263
Mixed	80	9	88
Even-aged high forest	4 753	55	4 808
Broadleaved	1 179	-23	1 157
Coniferous	2 818	-5	2 814
Mixed	755	83	838
Coppice	1 458	-1	1 458
Coppice with standards	4 909	36	4 944
Broadleaved	3 896	11	3 907
Coniferous	1 013	24	1 037
Mixed	0	0	0
Undetermined regime	2 789	-58	2 731
Young plantations	411	-10	400
Undetermined	2 378	-48	2 330

4.2.4 Sweden

The Red List of Swedish Species is compiled by the Swedish Species Information Centre at the Swedish Agricultural University. The list was updated in May 2000, and is based upon the criteria and categories suggested by the IUCN. The total number of forest-occurring species is not known in Sweden, but rough estimates are available and have been used for Table F3.

The number of species in the categories defined as endangered are probably under-estimated, since some species in the categories 'data deficient' and 'not evaluated' probably would be classified as endangered if sufficient knowledge existed. The information on mammals, birds and other vertebrates are more accurate than for example data on invertebrates, where even the total number of species is uncertain.



Table 16: F3. Forest-occurring species at risk or endangered, Sweden, 2000

	Total number of		•	ed forest-occurri	ng species	
	known species	CR	EN	VU	CR+EN+VU	% of total
Trees (coniferous and broadleaved species)	78	2	2	0	4	5.13
Other vascular plants (flowers)	2100			:	44	2.10
Total vascular plants	2200			:	48	2.18
Mosses	1060	13	9	23	45	4.25
Lichens	2300	20	47	53	120	5.22
Macrofungi	4000	28	65	128	221	5.53
Algae	34	0	0	0	0	0.00
Total non-vascular plants	7400	61	121	204	386	5.22
Mammals	67	2	4	4	10	14.93
Birds	253	2	1	15	18	7.11
Other vertebrates (fish, amphibians, reptiles, snakes)	183	0	0	4	4	2.19
Total vertebrates	503	4	5	23	32	6.36
Insects	25000	45	122	280	447	1.79
Other invertebrates	5000	1	3	17	21	0.42
Total invertebrates	30000	46	125	297	468	1.56

At the Swedish Environmental Protection Agency (EPA) there is a database on protected forest and other wooded land (the Nature Conservation Register), which is updated continuously. The register is based on information gathered by the county authorities, and includes data on about 5300 different objects. Each year a statistical bulletin is compiled by Statistics Sweden and the EPA based on the information in the register.

The register does not contain data classified according to the detailed IUCN categories, but the EPA has tentatively classified all national parks as category II, all nature reserves as category IV and all nature management areas as category V, and these data are used in Table F4. The national parks and the nature reserves are the categories of land which are legally protected. Forest and other wooded land in each protected object has been estimated. In the future, there are plans to classify each object in the register according to the IUCN categories.

The national target proposed by the Swedish government in 2000 is to increase the protected are of forest and other wooded land (now 865 000 hectares) by 800 000 hectares by the year 2010. This target includes both legally and otherwise protected forest land, and equals about 6% of the productive forest land.



Table 17: F4. Protection of forest and other wooded land (1000 ha), Sweden, 1993-1998

	IUCN categories I and II	IUCN categories III to IV	Legal protection	Other protection	Protected forest in % of total	National target (%)
Opening area, 1993	33	382	415	303	3.1	-
Afforestation						
Deforestation						
Natural colonisation or regression						
Other changes						
Changes in land classification	6	220	226	-183	0.2	
Closing area, 1998	39	602	641	120	3.3	6.3

4.3 Conclusions

In all four participating countries there are so-called 'Red Lists' of endangered species, but there were problems in distinguishing the species that are forest-occurring, since the Red Lists are not generally classified by habitat. In Austria, vascular plants is the only Red List group that has been classified as forest-occurring or not. In France, data for forest-occurring species are available only for vertebrates, trees and other non-Mediterranean vascular plants. In Finland, there is data available for forest-occurring species, and in Sweden there are rough estimates. It should be noted that the number of endangered species is sensitive to the geographical level for which the Red Lists are made. The smaller the geographical area, the more likely is a species endangered. This can make comparisons across countries difficult.

In Austria, there was little data on protected areas available for the pilot study, but this kind of data will be published by the Federal Environment Agency in the near future. In Finland data on protected areas is available, and a classification according to IUCN categories is under development. In France and Sweden, data is available on IUCN categories.

There were little data available on the different types of changes specified in Table F4, but for protected areas, 'Changes in land classification' is likely to be the most important, while there is little or no afforestation and deforestation. It should be noted that when several different sources are used to compile data on protected areas, there is a danger of double counting areas that are covered by more than one protection scheme.

Table F5 on the forest regime was introduced in the pilot studies at a late stage, and only Austria and France attempted to fill it in. In France, this kind of data is provided in the national forest inventory, but in Austria, the classification of forests into even-aged and uneven-aged stands was not available.

A previous version of the proposed set of tables included tables for regeneration and extension of forest and other wooded land, but the Task Force decided to drop them. For the regeneration table, it was a problem to find information on how areas had been regenerated in the past (naturally or by planting), and for the extension table, which focused on afforestation and deforestation, the link to biodiversity was not very clear.



5 Recreational functions

Access to forests enables people to benefit from the recreational value of forests, and a wide variety of recreational activities take place in forests.

5.1 Proposed tables

Two tables are proposed for recreational functions. Table F6 focuses on the forest areas that are available for recreation, as an indicator for the supply of non-marketed recreational services. Table F7 shows the number of visits to forests classified by purpose, which can be seen as an indicator for the demand for the various recreational services. The visits are classified according to the length, which may be useful for valuation purposes, for example.

Table F6. Recreational areas of forest and other wooded land (1000 ha)

	Opening area		Cha	anges	Closing area	
	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant
National parks 1)						
Urban recreation areas 2)						
Other recreation areas with open access 3)						
Total						

¹⁾ Only the parts of national parks that are open to the public should be included here.

The table is to be provided for a reference period of five or ten years

Table F7. Recreation visits to forests by main purpose

Main purpose	Nι	Number of visits/year				% o	% of total			Number of visits/inhabitant			
	Short	Day	Longer	Total	Short	Day	Longer	Total	Short	Day	Longer	Total	
	visits 1)	visits 2)	visits 3)	visits	visits	visits	visits	visits	visits	visits	visits	visits	
Hiking/Skiing													
Dog walking													
Cycling/Horse riding													
Organised sports													
Barbecue/Picnic													
Camping													
Hunting and fishing													
Off-road driving													
Bird-watching													
Picking berries,													
mushrooms													
Other													
Total													

¹⁾ Less than 2 hours.

The table is to be provided every five or ten years.

²⁾ Forests within a certain distance from urban areas according to national definitions. These definitions should be provided in a note to the table.

³⁾ Refers to all forest areas accessible for recreational purposes, except national parks and urban recreation areas.

²⁾ Between 2 hours and a full day.

³⁾ More than one day.



5.2 Results of the pilot studies

5.2.1 Austria

Almost all the forest land in Austria is available to the public for recreational purposes. The category 'Other recreation areas with open access' is therefore estimated as the total forest area from the Austrian Forest Inventory, less the area of national parks and some areas where public access is restricted or forbidden on legal grounds. The latter estimate is based on data from the Austrian Alpine Association for the year 1995 (118 513 ha). These figures refer to areas with restricted access in both forests and mountainous regions, and it is assumed that half of these areas relate to forests. (With the overall share of forest area being about 46% in Austria, this seems to be a valid assumption for rural regions).

There are no separate data available for urban recreation areas, but these areas are included in the category 'Other recreation areas with open access'.

Table 18: F6. Recreational areas of forest and other wooded land (1000 ha), Austria, 1990-1996

	•	ning area 1990	C	Changes	Closing area 1996	
	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant
National parks	20	0.0025	23	0.0030	44	0.0054
Urban recreation areas	:	:	:	:	:	:
Other recreation areas with open access	3 798	0.4713	23	0.0030	3 821	0.4741
Total	3 819	0.4739	46	0.0057	3 865	0.4796

At the moment, no national data exist about visits to forests and their purposes as would be needed for Table F7. A sample survey conducted in 1998 by the Austrian Central Statistical Office gives data on the frequency of recreational visits to forests for Austrian inhabitants older than 15 years of age. Based on this, the total number of recreational forest visits can be estimated to 220 million per year (not including visits by children and foreign tourists). This corresponds to an average of 33.5 visits per inhabitant.

5.2.2 Finland

In Finland practically all forests are freely accessible to the public, and available for recreational purposes. The only exceptions are some relatively small strict nature reserves, some birds nesting areas and military areas.

Data on urban recreation areas are only partially available from the recreation supply survey (see the description of forest visits below), and at present the coverage of this data is not adequate to be presented at national level.

Table 19: F6. Recreational areas of forest and other wooded land (1000 ha), Finland

	Opening area 1986-1994		C	Changes	Closing area 1992-2000		
	1000 ha	ha per inhabitant				ha per inhabitant	
National parks	675	0.13	46	0.01	721	0.14	
Urban recreation areas							
Other recreation areas with open access							
Total 1)	26 276	5.08	-12	-0.00	26 264	5.08	

¹⁾ Forests, scrub land and waste land

Data on recreation visits to forests are based on the 'National outdoor recreation demand and supply assessment', a survey conducted by the Finnish Forest Research Institute, the University of Helsinki and Statistics Finland in 1997-2000. The sampling frame of the outdoor recreation demand study was the

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Finnish population from age 15 to age 74, and the total sample was about 12 000 people. For the outdoor recreation supply, survey forms were sent to recreation area associations, state land holders and to all municipalities.

Table 20: F7. Recreation visits to forests by main purpose, Finland, 1997-2000

	Number of visits/year (million)		% of total			Number of visits/inhabitant			
Main purpose	Short visits	Day visits	Longer visits	Short visits	Day visits	Longer visits	Short visits	Day visits	Longer visits
Hiking/Skiing/Orienteering	19.6	18.0	15.7	19.0	14.9	26.9	5.0	4.6	4.0
Hiking (and backpacking)	5.3	10.0	7.2	5.2	8.3	12.3	1.4	2.6	1.8
Cross-country skiing	13.8	7.1	8.3	13.4	5.9	14.1	3.6	1.8	2.1
Orienteering	0.4	0.9	0.3	4.0	0.7	0.5	0.1	0.2	0.1
Cross-country horseback riding	1.7	1.1	0.3	1.7	0.9	0.5	0.4	0.3	0.1
Camping in back-country	:	0.4	0.8	:	0.3	1.3	:	0.1	0.2
Hunting and leisure time-game management	0.7	7.0	0.9	0.7	5.8	1.6	0.2	1.8	0.2
Hunting	0.7	4.6	0.9	0.7	3.8	1.6	0.2	1.2	0.2
Game management in leisure time	:	2.3	:	•	1.9	:	:	0.6	:
Off-road driving	4.1	6.3	1.4	3.9	5.2	2.4	1.0	1.6	0.4
Snowmobiling	1.1	2.2	0.6	1.0	1.8	1.1	0.3	0.6	0.2
Driving off-road vehicles	:	2.9	0.6	:	2.4	1.0	:	0.8	0.1
Cross-country bicycling	3.0	1.1	0.2	2.9	0.9	0.3	8.0	0.3	0.0
Picking berries/mushrooms	4.8	16.3	4.9	4.7	13.6	8.4	1.2	4.2	1.3
Picking berries	2.9	10.5	2.9	2.8	8.8	4.9	0.7	2.7	0.7
Picking mushrooms	1.9	5.8	2.1	1.9	4.8	3.5	0.5	1.5	0.5
Collecting smallwood, forest management in leisure time	2.6	12.1	1.6	2.5	10.1	2.8	0.7	3.1	0.4
Bird watching and other nature studying	69.3	59.2	32.8	67.5	49.2	56.1	18.5	15.7	8.8
Bird watching	12.3	14.8	1.5	11.9	12.3	2.5	3.2	3.8	0.4
Nature studying 1)	57.1	44.4	31.3	55.6	36.9	53.6	15.3	11.9	8.4
Total	102.7	120.3	58.5	100.0	100.0	100.0	27.1	31.4	15.4

¹⁾ Nature studying: Picking herbs, flowers etc., nature painting and photography, studying or collecting plants, collecting stones, sightseeing in nature and enjoying nature

Supplementary data: Other activities related to forests

	Number of visits/year (million)			% of total			Number of visits/inhabitant		
Main purpose	Short visits	Day visits	Longer visits	Short visits	Day visits	Longer visits	Short visits	Day visits	Longer visits
Spending time at summer cottage	6.6	36.8	25.4	1.3	19.7	55.8	1.7	9.5	6.5
Walking, running, jogging, etc.	442.2	80.6	:	87.4	43.1	:	113.7	20.7	:
Camping in campground	:	0.4	0.4	:	0.2	0.9	:	0.1	0.1
Recreation vehicle, caravan	0.3	1.4	1.5	0.1	0.7	3.2	0.1	0.3	0.4
Picnicking	1.8	6.0	0.7	0.4	3.2	1.4	0.5	1.6	0.2
Bicycling	48.7	21.7	1.8	9.6	11.6	3.8	12.9	5.8	0.5
Participation in camps, events and excursions	0.1	0.6	0.5	0.0	0.3	1.0	0.0	0.2	0.1
Fishing	5.4	36.3	12.3	1.1	19.4	27.0	1.4	9.3	3.2
Other 2)	0.6	3.4	3.1	0.1	1.8	6.8	0.2	0.9	0.8
Total	505.7	187.1	45.5	100.0	100.0	100.0	130.4	48.3	11.7

¹⁾ Walking, running, jogging, outdoor activities with children, playing games outdoors, walking dog

²⁾ Dog sledding, skiing with wheel skis, downhill skiing, telemark skiing, snowshoeing, rock/mountain climbing



For national purposes the results of the recreation demand survey (outdoor recreation) clearly connected to forests were grouped under eight main purposes:

- 1. Hiking/Skiing/Orienteering
- 2. Cross-country horseback riding
- 3. Camping in back-country
- 4. Hunting/Leisure time-game management
- 5. Off-road driving (driving off-road vehicles, snowmobiling, cross-country bicycling)
- 6. Picking berries/mushrooms
- 7. Collecting smallwood and forest management in leisure time
- 8. Bird watching/Other nature studying

The results were directly used to fill the table 'F7. Recreation visits to forests by main purposes'. Aggregation can be made on the level of main purpose or on a more detailed level, since significant overlapping between categories is excluded in the survey.

Outdoor recreation by the eight main purposes shown above was not separated for forests and other areas. This is because 75% of the total land area in Finland is covered by forests and other wooded land, mostly with free access to all citizens for recreational purposes (except off-road driving), and the survey shows that even for the category 'walking, running, jogging, outdoor activities with children etc.' forest was present in more than 80% of both day visits and longer visits.

Recreation with less clear connections to forests, such as spending time at the summer cottage, walking, running, jogging, outdoor activities with children etc., camping in campgrounds, recreation vehicles, caravans, picnicking, bicycling, participation in camps, events and excursions, and fishing, are presented as additional information. These recreation uses are presented as a supplementary table.

The survey on recreation will probably be repeated in the next ten years, and updating the recreation table would be possible even based on smaller surveys than the one performed in 1997-2000. General data on time use of Finnish citizens are available annually from time use surveys, but on the basis of those surveys no detailed conclusions can be made on changes and development of forest-related recreation.

5.2.3 France

In France, data on recreational areas are available in the context of the National Forest Inventory, see French Ministry of Agriculture (2000).

Urban recreational areas refer to forests within a 100-km radius for Paris and a 50-km radius for the other urban areas with more than 200 000 inhabitants. The resulting 4.7 million ha corresponds to 0.08 ha per person for the whole French population, and 0.13 ha per person in the cities and towns with more than 200 000 inhabitants. Data for 1994 also exist, but they are not directly comparable to 1999 data.

The same areas can be included in more than one category, so the total recreational area of wooded land can not be calculated because of double counting.

Table 21: F6. Recreational areas of forest and other wooded land (1000 ha), France, 1994-1999

	Opening area		Changes		Closing area	
		1994			1999	
	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant
National parks	99	0.00	0	0.00	99	0.00
Urban recreational areas					4 695	0.08
Other recreation areas with open access	3 110	0.05	20	0.00	3 130	0.05
Total						

The data on recreation visits to forests are based on a survey carried out by ENGREF in 2001, on a random sample of the French population.



Table 22: F7. Recreation visits to forests by main purpose, France, 2001

	Num	nber of vis	its/year (m	nillion)	% of total			Number of visits/inhabitant				
Main purpose	Short visits	Day visits	Longer visits	Total visits	Short visits	Day visits	Longer visits	Total visits	Short visits	Day visits	Longer visits	Total visits
Hiking/Skiing	0	4.7	0	4.7	0	0.4	0	0.4	0.0	0.1	0.0	0.1
Dog walking	92.9	29.9	0	122.7	7.8	2.5	0	10.3	1.6	0.5	0.0	2.1
Cycling/Horse riding	0.3	4.5	0	4.8	0	0.4	0	0.4	0.0	0.1	0.0	0.1
Organised sports	47.0	69.5	0.3	116.8	3.9	5.8	0	9.8	0.8	1.2	0.0	2.0
Barbecue/picnic	0	0.3	0	0.3	0	0	0	0.0	0.0	0.0	0.0	0.0
Camping	0	0.5	0	0.5	0	0	0	0.0	0.0	0.0	0.0	0.0
Hunting and fishing	3.2	21.1	0	24.3	0.3	1.8	0	2.0	0.1	0.4	0.0	0.4
Off-road driving	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Bird-watching	2.1	16.0	0	18.0	0.2	1.3	0	1.5	0.0	0.3	0.0	0.3
Picking berries, mushrooms	9.8	50.1	0	59.9	0.8	4.2	0	5.0	0.2	0.8	0.0	1.0
Other	260.5	578.3	1.0	839.7	21.9	48.5	0.1	70.4	4.4	9.7	0.0	14.1
Total	415.8	774.8	1.3	1191.9	34.9	65.0	0.1	100	7.0	13.0	0.0	20.0

5.2.4 Sweden

All Swedish forest areas including national parks and nature reserves are accessible for the public ('the right of common access') and hence have to be regarded as recreational areas. Information on these two area-classes is given annually in the report 'Protected Nature', published by the Swedish EPA and Statistics Sweden. Forest and other wooded land are also specified. The first report was published in 1991. For earlier years, it is difficult to obtain accurate information. In the tables the reference period is 1990 to 1998. It is possible to divide the protected (recreational) areas by NUTS-2 region and attempts to distribute the areas by municipality have also been made.

Studies by Statistics Sweden have been made on land surrounding urban agglomerations. The surrounding land was divided in kilometre zones from the border of the agglomeration. The land of common access, i.e. the recreational areas were measured. Land of common access is mostly forest and other wooded land, while agricultural land is excluded. These studies have been carried out for the years 1980 and 1990. The latter comprised urban recreation areas around the 10 largest urban agglomerations and was surveyed by Statistics Sweden in 1994. No regular statistical production using this methodology is planned.

One way of getting regular information on the area surrounding urban agglomerations is to define buffers within a certain distance from the agglomerations, for example 3 kilometres, and process the information using geographical information systems. To determine the share of forest land within these zones it is possible to use the information from the above mentioned studies which estimate this area to 42 % of the total surrounding area. Since demarcation of urban areas is carried out every 5 years it is possible to get a fairly accurate estimate of forests within a certain distance from urban areas.

Table 23: F6. Recreational areas of forest and other wooded land (1000 ha), Sweden, 1990 - 1998

	Opening area 1990		C	Changes	Closing area 1998	
	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant
National parks	33	0.0038	6	0.0007	39	0.0044
Urban recreation areas (1)	2 953	0.3437	153	0.0173	3 106	0.3508
Other publicly owned recreation areas (2)	661	0.0769	61	0.0069	722	0.0815
Total	3 647	0.4245	220	0.0248	3 867	0.4368

⁽¹⁾ Forests within 3 km from urban areas (1995)

⁽²⁾ Sweden used an earlier version of the table, which had the category 'Other publicly owned recreation areas' rather than 'Other recreation areas with open access'



Three studies on recreation have been carried out during the last decades; one by the National Institute of Economic Research (NIER) in co-operation with Statistics Sweden ('Recreation value of the Swedish forests', in 1997) and the other two by Statistics Sweden ('Leisure time 1976-1991', and 'Leisure time 1999').

The NIER survey registered the frequencies of eight specified activities by visitors to the forest during leisure time for a period of twelve months. Persons between 18 and 74 years old were surveyed. The activities measured do not correspond fully to the proposed table. Camping was not included in the survey, and bird watching was not specified but included in the activity 'flora and fauna studies'. On the other hand, camping was part of the surveys by Statistics Sweden, which reported 12 million visits. The total number of visits in the two surveys was very similar, 373 and 371 million visits. It could be possible to redistribute the forest visits in the NIER-study in order to separate the camping activity. The easiest way is to reduce 'Hiking/Skiing' with the same number of visits (12 million).

The studies by Statistics Sweden are part of the Swedish National Survey of Living Conditions, which regularly updates the information on 11 different welfare components, including 'leisure time'. The activities registered in the survey correspond less well to the proposed Table F7 than the NIER study, so the NIER study was chosen for the completion of the table.

Table 24: F7. Recreation visits to forests by main purpose, Sweden, 1996

	Number of visits/year (million)	% of total	Number of visits/inhabitant
Main purpose	Total visits	Total visits	Total visits
Hiking/Skiing 1)	184	49	31
Dog walking			
Cycling/Horse riding			
Organised sports			
Barbecue/picnic			
Camping			
Hunting and fishing 2)	11	3	2
Off-road driving			
Bird-watching 3)	46	12	8
Picking berries, mushrooms	45	12	8
Other 4)	87	23	15
Total	373	100	62

¹⁾ Including 'outdoor life' (29 million visits)

5.3 Conclusions

In all four countries there is data on the area of national parks. In France and Sweden there is data for urban recreation areas, but with different definitions. In Austria, Finland and Sweden, practically the whole forest area is available to the public for recreational purposes, but this is not the case in France.

In Austria, there is little data available on forest recreation visits, but in the other three countries there are surveys of forest or outdoor recreation that have been used to fill in the table. A problem was that the categories used differ among the surveys, and do not necessarily match the categories in Table F7. This means that the data is not fully comparable across countries. In some countries foreign tourists may be an important user group, which is often not covered by the recreation surveys.

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²⁾ Fishing excluded

³⁾ Including all studying of flora and fauna

⁴⁾ Including sports activities (54 million) and collecting firewood (21 million)



6 Protective functions

Forests have several important protective functions. These can be related to other natural resources, such as protection of soil against erosion or protection of the quantity and quality of water. Forests also protect infrastructure (roads, buildings etc.) against avalanches and mud slides. All forests fulfil these functions to some degree, but for some forests protection is the primary management objective.

6.1 Proposed table

Table F8 focuses on the forests with protective functions as the primary management objective.

Table F8. Forest and other wooded land with protective functions (1000 ha)

	Opening area	Changes	Closing area
Soil protection			
Protection of water resources			
Avalanche protection			
Coastline protection			
Other or multiple objectives 1)			
Total			
% of total forest and other wooded land			

¹⁾ E.g. when soil, avalanche and water protection are overlapping

The table refers to areas where protection is the primary management objective. In the TBFRA-2000, protection is defined as follows:

'The function of forest/other wooded land in providing protection of soil against erosion by water or wind, prevention of desertification, the reduction of risk of avalanches and rock or mud slides; and in conserving, protecting and regulating the quantity and quality of water supply, including the prevention of flooding. Includes: Protection against air and noise pollution.'

The table is to be provided for a reference period of ten years.

6.2 Results of the pilot studies

6.2.1 Austria

Austria has a long tradition of managing forests for protective purposes, but the data situation is relatively weak. According to the Austrian Forestry Act from 1975, there are two different kinds of protective forest in Austria, 'Schutzwald', forest in areas endangered by soil erosion, and 'Bannwald', forest area dedicated to protect objects (e.g. protection against avalanches or air emissions). Data on these areas are published in the context of the Austrian Forest Inventory.

In Table F8, the data for 'Schutzwald' is used for the category 'soil protection', but it will also include other management objectives, such as the protection of water resources and avalanche protection. The data for 'Bannwald' is used for 'other or multiple objectives'. Most of the areas classified as 'Bannwald' will also be part of the 'Schutzwald', so the data should not be added together.

An alternative data source could be the Austrian Forest Development Plan, which classifies forest areas according to the main function. The problem is that these plans are elaborated by local forest authorities, and aggregated data for the whole of Austria are not yet available.



Table 25: F8. Forest and other wooded land with protective functions (1000 ha), Austria, 1990-1999

	Opening area 1990	Changes	Closing area 1999
Soil protection	741	14	755
Protection of water resources	:	:	:
Avalanche protection	:	:	:
Coastline protection	:	:	:
Other or multiple objectives	21	-10	11
Total	762	4	766
% of total forest and other wooded land	19.6	8.7	19.5

6.2.2 Finland

In Finland, the only data available on forests with protective functions relate to high-altitude forests. The protective function is to prevent extinction of forests in areas where natural or artificial regeneration of tree cover is uncertain because of soil type and climate conditions. In 2001, this area was 513 000 ha, about 2.3% of forest and other wooded land. There has been no significant change in this area over the last five years.

6.2.3 France

In France, the estimates of forest areas with protective functions were mainly based on the location of the forest. For the categories in the suggested table, the following definitions were used:

- Soil protection: forest area with a slope higher than 30%.
- Protection of water resources: forests located in a protection area for catchment area of drinking water and sources of marketed mineral water.
- Avalanche protection: forests located at an altitude higher than 1500 metres above sea level.
- Other and multiple objectives: forests with protection as primary objective and forests with protection as secondary objective (soil, water, avalanche, landslide...) and forests of the RTM zone (Restauration des Terrains en Montagne).

The total could not be calculated because of double counting between categories.

Table 26: F8. Forest and other wooded land with protective functions (1000 ha), France, 1990-1999

	Opening area 1990	Changes	Closing area 1999
Soil protection	3 272	131	3 403
Protection of water resources	800	0	800
Avalanche protection	191	141	332
Coastline protection	95	6	102
Other or multiple objectives	1 338	104	1 442
Total			
% of total forest and other wooded land			

6.2.4 Sweden

In Sweden, the only data available on forests with protective functions relate to coastline protection. The data are from National Board of Forestry, and refer to 33 000 ha of pine plantations along some stretches of the coast, which protect against sand and soil erosion.

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6.3 Conclusions

The pilot studies showed that the data situation for areas with protective functions is relatively difficult at the moment. In Austria, data is available at regional level, but there are some aggregation problems in order to get data for the whole country. In Sweden, the only data are for coastline protection, and in Finland only for high altitude forests. In France, there is little data available now, but some possible methods have been developed, mainly based on the location of the forests.



7 Health of trees

Defoliation is a reaction to several environmental factors that influence trees, and is an important indicator of the health of the forests. Surveys on defoliation are conducted annually within the framework of the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP-Forests) and the European Union Scheme on the Protection of Forests Against Atmospheric Pollution. See www.icp-forests.org for more details.

7.1 Proposed table

The proposed Table F9 shows the percentage of trees with different degrees of defoliation, according to the UNECE and EU defoliation classification. In addition to the main species groups (conifers and broadleaves), data on species that are of particular importance in each country should be included.

Table F9. Defoliation of trees by classes and species (%)

	None 1)	Slight 2)	Moderate 3)	Severe and dead 4)
Conifers				
Broadleaves				
Total				

¹⁾ Up to and including 10 %

The table is to be provided annually. Under the main groupings, detailed species should be included. These will vary between countries, according to forestry conditions and data availability.

7.2 Results of the pilot studies

7.2.1 Austria

The defoliation data available in Austria are (more than) sufficient for the proposed table. The data are collected in the context of the Forest Damage Monitoring System (ICP – Forest Grid Level 1), provided by the Austrian Federal Forestry Research Centre, and published annually by the Programme Coordinating Centre (PCC). The survey and the presentation of the results are in accordance with the 'Manual on Methods and Criteria for Harmonized Sampling, Assessment, Monitoring and Analysis of the Effects of Air Pollution on Forests' from the UNECE (edited by Programme Coordinating Centre West, Hamburg, 4th edition 1998). During the last decade more than 7 000 trees of different species, spread all over Austria, have been observed on a regular basis.

^{2) &}gt;10 to 25 %

^{3) &}gt;25 to 60 %

^{4) &}gt;60 %



Table 27: F9: Defoliation of trees by classes and species (%), Austria, 2000

	None	Slight Moderate		Severe and dead	
Conifers	63.3	27.6	7.9	1.2	
Spruce	65.3	25.7	7.7	1.3	
Fir	48.7	34.6	13.5	3.2	
Larch	75.0	22.1	2.3	0.6	
White pine	52.9	37.4	8.9	0.8	
Broadleaves	62.8	29.6	5.8	1.8	
Beech	68.3	28.5	2.4	0.8	
Oak	35.6	35.6	22.1	6.7	
Total	63.2	27.9	7.6	1.3	

7.2.2 Finland

Annual data on defoliation by main tree species (pine, spruce, broadleaves) are available in Finland since 1987. The data are provided by the Finnish Forest Research Institute, using the same estimation methods as in about 30 other European countries. The results are presented as 'defoliation frequency of sample trees on mineral soil sites'. Mineral soil sites represent 66 percent of total forestry land in Finland. The total number of sample trees was more than doubled in 1995, to around 8700.

Table 28: F9. Defoliation of trees by classes and species (%), Finland, 1998

	None	Slight	Moderate	Severe and dead
Pine	72.8	23.8	3.1	0.3
Spruce	36.5	37.4	24.4	1.7
Broadleaves	64.9	29.5	4.6	1.0
Total	59.8	28.6	10.7	0.9



7.2.3 France

Annual data for defoliation are available for many different species in France.

Table 29: F9. Defoliation of trees by classes and species (%), France, 1999

	None	Slight	Moderate	Severe and dead
Conifers	57.6	28.3	13.2	0.9
Norway spruce	84.4	11.9	3.3	0.5
Silver fir	64.6	23.6	11.3	0.6
Scots pine	41.5	40.5	16.5	1.5
Maritime pine	59.7	30.3	9.3	0.7
Black pines	56.5	32.4	11.2	0.0
Aleppo pine	10.6	49.1	38.1	0.0
Douglas fir	64.9	15.7	17.6	0.0
Larch	43.3	29.1	27.7	0.0
Other conifers	68.9	19.3	10.9	0.0
Broadleaves	36.2	41.0	21.7	1.1
Sessile oak	26.8	50.4	22.4	0.3
Pedunculate oak	15.5	47.7	35.2	1.6
Evergreen oak	22.3	51.3	25.6	0.0
Pubescent oak	22.5	47.5	28.7	0.0
Beech	39.0	41.8	19.0	0.0
Maples	57.2	33.6	9.2	0.0
Birch	46.0	33.0	20.5	0.0
Hornbeam	70.6	23.3	5.7	0.0
Chestnut	69.2	19.4	8.4	2.9
Ash	59.9	29.3	10.1	0.0
Poplars	45.6	29.8	22.2	2.3
Wild cherry	29.0	40.5	26.0	0.0
Other hardwoods	58.7	28.4	10.5	2.4
Total	43.8	36.4	18.7	1.1



7.2.4 Sweden

In Sweden there are two regular surveys measuring defoliation of pine and spruce, but broadleaves are not regularly surveyed. The Swedish National Forest Inventory started data collection on defoliation in 1984 and reports the results annually. The National Board of Forestry gathers information on defoliation from 223 permanent observation areas. These areas were surveyed for the first time in 1997.

Both surveys are carried out according to international standards. They are co-financed by the European Union and are reported in the Forest Statistical Yearbook. In northern Sweden there are considerable variations in the reported defoliation from year to year, probably because of the relatively small sample size. Differences between single years must therefore be interpreted with caution. In the table below, data from the National Forest Inventory is used.

Table 30: F9. Defoliation of trees by classes and species (%), Sweden, 1999

	None 1)	Slight 2)	Moderate 3)	Severe and dead 4)
Pine	89.0	9.8	0.7	0.5
Spruce	71.1	21.0	4.8	3.1
Broadleaves	:	:	:	:
Total	:	:	:	:

The defoliation classes None, Slight and Moderate used are different from the proposed table:

In the ICP-Forests 2001 report (see UNECE and European Commission 2001), the following defoliation data is given for Sweden in 2000, using the standard classifications:

Table 31: F9. Defoliation of trees by classes and species (%), Sweden, 2000

	None	Slight	Moderate	Severe and dead
Conifers	55.3	30.2	12.3	2.2
Broadleaves 1)	61.2	31.3	5.4	2.1
Total	56.3	30.0	11.6	2.1

¹⁾ From a special study on birch

7.3 Conclusions

Because of the EU and UNECE co-operation, the data situation on defoliation is good. The EU countries (and most other European countries) estimate defoliation according to a harmonised method, in the framework of ICP-Forests.

¹⁾ Up to and including 20 %

^{2) &}gt;20 to 40 %

^{3) &}gt;40 to 60 %

^{4) &}gt;60 %



8 Valuation of environmental and recreational functions

8.1 Introduction

There is substantial interest in estimates of the monetary value of the environmental and recreational functions provided 'free' by the forests. This information can be useful for many policy issues, e.g. decisions on subsidies and the allocation of public budgets which require a macro valuation of the benefits that can be expected, cost/benefit analysis of legislative initiatives and negotiation of international agreements such as the Kyoto protocol on greenhouse gas emissions. A large number of academic studies have been published on these topics, particularly on the valuation of carbon binding and recreational functions of forests.

Because of the interest in valuation of the environmental and recreational functions, it would seem useful to include them in the forest accounts framework. However, there are many theoretical and practical problems involved in integrating these values into a system that is based on national accounting principles, in particular:

- Availability of monetary estimates. The monetary estimates for non-ESA forest functions are not part
 of official statistical programmes, and the availability of such data varies greatly across the different
 functions and across countries.
- Comparability of monetary estimates. The methods and assumptions used in the valuation studies are not standardised, and many theoretical and practical problems are still being debated. A related problem is known as 'benefits transfer'. The studies often focus on certain forest areas, and it is not straightforward to transfer the results obtained to areas not covered by the studies. As shown in the previous sections, there are also weaknesses in the physical data which are often the basis for the value estimates.
- Comparability with national accounts data. When results from valuation studies are combined with national accounts data, there are substantial risks of overlapping and double counting with values already included in the national accounts. Also, the national accounts data are mainly based on market prices, while studies of the value of for example forest recreation functions usually include the consumer surplus.

For these reasons, it is not proposed to include valuation of non-ESA functions in the IEEAF for the time being. However, for illustrative purposes it may be useful to present some value estimates and compare them to the market values of forest-related goods and services as recorded in the national accounts, and this approach was used in several of the pilot studies. The pilot studies mainly focused on valuing flows of services, rather than the corresponding asset values, but asset values can in general be derived from (forecasts of future) flows using the net present value method.

The possibilities and problems of valuing the various forest functions are discussed below, together with results presented in the pilot studies. The categories of forest services used here are the same as those used in the physical description above. For completeness, there is also a brief discussion of the valuation of forest goods. The possibility of providing data for government expenditure related to maintaining and improving forest functions is also mentioned.

The methods for environmental valuation were originally developed in the context of cost-benefit analysis, and they are based on the economic theory of consumer and producer behaviour. Environmental valuation is a complex topic, with a large amount of literature. For a general discussion of valuation methods for environmental services, with a focus on environmental degradation, see Chapter 9 of the new SEEA.

8.2 Forest goods

All goods provided by forests are, at least theoretically, included in the framework of national accounts, either when they are produced (e.g. the growth of cultivated timber) or when they are harvested (for non-produced goods such as berries, mushrooms, game meat and non-cultivated timber).



A distinction is made between marketed goods and goods produced for own final use. Estimating marketed forestry goods poses few problems, but the data situation can be more difficult for own final use. The valuation of goods is generally based on market prices, and for own final use on prices of similar marketed goods.

The value of output of the various forest goods is included in the timber accounts part of the IEEAF.

8.3 Carbon binding

The valuation of the carbon binding function of forests is relatively simple in principle, by applying a price per tonne of carbon to the quantity data for stocks and changes in stocks of carbon bound in the forest. The main issue is how the price per tonne of carbon is to be determined. There are several possibilities:

- Market prices on emission permits. The use of market prices is a method that fits well with the national accounting framework, but the market for carbon binding is only just developing and the regulatory framework is still under construction. The EU is planning to introduce tradable CO₂ emission permits from 2005 onwards. The aim is to reduce emissions of greenhouse gases in a cost-effective manner, in order to allow the EU to meet its obligations under the UNFCCC and the Kyoto Protocol. A limited amount of trading has already taken place in a few countries, such as Denmark and the UK. Future trading prices can also be estimated using economic models.
- Emission taxes. Several countries have introduced taxes on the use of energy that are linked to the
 amount of CO₂ emitted. In practice however, it may be difficult to distinguish a tax that is called a CO₂tax from other energy taxes.
- Damage valuation. The monetary value of the damage by a (marginal) increase in CO₂ in the atmosphere can be interpreted as equivalent to the marginal value of carbon sequestration. The value of the damage can be estimated with economic models.
- Damage avoidance cost. These measure the costs of lowering emissions e.g. by using more energy
 efficient technologies, or the costs of increasing carbon sequestration, in forests, soil, geological
 formations, oceans etc.

For integration with national accounts data, it should be noted that a simple addition of the value of carbon binding and the value of wood production is not possible. According to ESA95, the value of the net growth of standing timber is included in the output of the forestry and logging industry. Under the assumption that emissions trading would be in place, forest management would strive for an optimal mix of carbon sequestration and timber production and the national accounts would properly capture these values.

8.3.1 Germany and Austria

In the German pilot study, the preferred approach to valuing carbon are the prices realised in some early markets for CO_2 emission permits. These are in the range of 1 to 10 euro per tonne of CO_2 . 5 euro per tonne CO_2 (or 18 euro per tonne carbon⁴) was used as an average, which gives a value of the net increase in carbon stored in German forests of about 270 million euro per year. The same average was used in the Austrian pilot study, resulting in a value of around 64 million euro per year.

The German study also summarised several model-based estimates of avoidance costs. These vary greatly, depending on the assumptions used. An average of 8 euro per tonne CO₂ was reported in a situation were global trading of emission permits is permitted. With trade restricted to the EU only, the costs could be four times as high. Results of damage valuation estimates also vary widely, but are of the same order of magnitude as the realised prices and the avoidance cost estimates.

 $^{^4}$ The price per tonne of CO₂ can be converted to the price per tonne of carbon by multiplying by the conversion factor from carbon to CO₂, which is 3.67.



8.3.2 Finland

The Finnish pilot study used CO₂-taxes to value carbon. The Finnish CO₂-tax varies a lot across the different energy products, from 0.1 euro per tonne of CO₂ for peat to 17 euro for petrol (in 1999). The average tax on all energy products was about 4 euro per tonne CO₂ (15 euro per tonne carbon). According to the greenhouse gas inventory, the net change of carbon stored in Finnish forests in 1998 was around 2.6 million tonnes. Using the average CO₂ tax, the value of carbon binding was about 45 million euro.

The pilot study also quotes the results of a Finnish analysis of possible future emission trade prices in the EU, which vary from 3.5 to 20 euro per tonne CO₂, depending on the assumptions used.

8.3.3 Sweden

The Swedish pilot study also used the CO_2 -tax as the main method for valuing carbon binding. In 1999, the tax was 42 euro per tonne CO_2 , or 155 euro per tonne carbon, i.e. significantly higher than in Finland. The amount of carbon sequestered by forests in 1999 was estimated to be 5.2 million tonnes. Using the carbon tax to price the service, the value was 810 million euro.

The pilot study also mentions the results of several studies of future emission trade prices and of damage costs. The problem with using these studies for valuing carbon storage is that the values are highly dependent on the assumptions used in the analysis. There is a factor of 50 between the highest and lowest estimates mentioned, see Table 32.

Table 32: Value of carbon binding, Sweden, 1999

Valuation method	Euro per tonne CO ₂	Euro per tonne carbon	Million euro
Carbon tax	42	155	810
Damage cost 1)	2	8	42
Emission permit price, low 2)	6	21	110
Emission permit price, high 3)	110	400	2 080

¹⁾ Based on a study by W. Nordhaus from 1992.

8.4 Biodiversity

Biodiversity is a complex concept, which refers to the existence of several species but also to the genetic diversity between them. Whereas the existence of one (or several) species relate to direct use values (e.g. recreation), option and existence values of the genetic diversity are more linked with stability and resilience of ecosystems as a whole. It is an area where both physical descriptions and experience with valuation are limited at present. The pilot studies of Austria and Sweden presented a few examples of monetary valuation.

8.4.1 Austria

In Austria, a few studies have been made on the value of nature in selected national parks and nature conservation areas. These are based on contingent valuation methods (CVM), where respondents are asked about their willingness to pay to preserve the areas. There are many methodological problems with this kind of valuation, and the studies refer to special, regional conditions, so it is not possible to provide an estimate for Austria as a whole.

8.4.2 Sweden

Several studies exist on the willingness to pay to save individual species, but aggregation problems make it complicated to present figures for all species in a forest account. A Swedish CVM study (Johansson 1990) asked a sample of respondents how much they were willing to pay to protect the 300 species being threatened at that time. The answer was 65 million euro a year.

²⁾ Assuming no restrictions on international trade of emission permits.

³⁾ Assuming major restrictions on international trade of emission permits.



Recently, the costs of reaching the new environmental targets concerning biodiversity set up by the government was analysed in a government report (Swedish Governmental Commission 2000). Increasing the protected forest land from 3.3% to 7% of forest land would cost the government 90 million euro annually. The forest companies would lose 70 million euro annually in revenue, since their harvesting volumes would decrease.

8.5 Recreational services

Some of the recreational services provided by forests are included in the national accounts as the value of market and other non-market services. These include:

- entrance fees (e.g. for natural parks, recreational areas or camping sites),
- payments for hunting licenses or hunting rights,
- expenditure (and corresponding output) for forest management supported by general government and non-profit institutions serving households (NPISH) for providing recreational services (infrastructures for the reception of the public, etc.). Expenditure could also take the form of afforestation subsidies paid for the purpose of tourism development or of accepting higher deficits for publicly managed forests due to the maintenance of recreation functions.

These services are included in the national accounts, but they may not always be separately identified. Market services are valued at market prices, while the other non-market services are valued at production cost.

In addition, there are the free forest recreation services which are not included in the national accounts, but have to be taken into account in a welfare approach. The value of these services are often estimated using contingent valuation methods (CVM), where a sample of consumers is asked how much they would be willing to pay for access to particular forest.

For integration with national accounts data, it is important to determine to what extent the values from the CVM studies include services that are already included in the national accounts. In order to avoid double counting, the CVM results used should capture only the value given by consumers to a free access to forests. Government non-market production related to forest recreation should also be excluded. Another problem when using CVM estimates in a national accounts context is that the willingness to pay figure includes the consumer surplus, while it is not included in the national accounts figures, which are based on market prices.

For a service with a zero price, the consumer surplus represents the area under a stated demand curve, and often the valuation studies allow deriving the shape of this demand curve. This can then be used to determine a 'quasi-market' value of the service. If the demand curves are linear, it can be shown that the maximum hypothetical 'quasi-market' value of output would be 50% of the consumer surplus. Analyses of the forms of demand curves derived from CVM studies show that they tend to be convex rather than linear, which implies that the 'quasi-market' value will be less than 50% of the consumer surplus.

Estimates of the value of forest recreation were provided in the pilot studies of Finland, Germany and Sweden.

8.5.1 Sweden

The Swedish pilot study includes an estimate of the recreational value of forest visits. A study from the National Institute of Economic Research (Jämttjärn 1996) summarises several Swedish valuation studies from the 1980s and early 1990s, mainly of the CVM type. The average value of a forest visit was found to be 6 euro. All activities have more or less the same valuation, except hunting, which was valued at about 15 euro per visit (not including the value of the game meat). Using these average values and the visiting frequencies from Table F7, the annual forest recreation value in Sweden can be estimated at 2 370 million euro, see Table 33, or 270 euro per inhabitant. This is about the same as the market value of the annual timber harvest. This illustrates the importance of forest recreation in Sweden, even though, as mentioned above, the recreation value includes the consumer surplus and is therefore not directly comparable to the market value of timber.



Table 33: Value of recreation visits to forests, Sweden, 1996

Main purpose	Number of visits	Average value	Total value	
	Million	Euro	Million euro	
Hunting	11	15	170	
Other activities	362	6	2 200	
Total	373	6	2 370	

8.5.2 Germany

A recent study (Elsasser 2001) estimated the value (consumer surplus) of day visits to forests at around 2 500 million euro per year for Germany as a whole. The study combined results from several German CVM studies, which gave an average value of about 50 euro per forest visitor per year. This was multiplied by an estimate of around 45 million people who visit forests at least once per year (64% of the population above 13 years of age). In comparison, the value of the timber harvest in Germany was around 2 050 million euro in 1999.

8.5.3 Finland

Monetary values related to outdoor recreation were estimated in the 'National outdoor recreation demand and supply assessment 1997-2000', which was also the source of the physical data presented in section 5. The estimates include money spent on recreation (which are included in the national accounts) and the willingness to pay for the use of forests for recreation purposes.

Table 34: Value of forest-related outdoor recreation, million euro, Finland, average of 1997-2000

Main purpose	Total value
WTP for use of government owned recreation areas	74
WTP for use of privately owned recreation areas	173
Money spent on recreation	1 598

In comparison, the annual value of the timber harvest was around 1 800 million euro in the years from 1997 to 1999. It is interesting to note that the willingness to pay for the use of government owned recreation areas, which usually are protected areas, is quite close to the actual government expenditure on nature protection, which averaged 77 million euro in the same period.

8.6 Protection services

The protection services provided by forests have positive consequences for many productive activities, such as agriculture, housing, water supply etc. The protective functions serve as inputs to production processes, and the values of these services may already be included in the output and gross value added (as a producer's surplus, i.e. net operating surplus) in the national accounts.

Alternatively, the effect may be that the prices of the products produced by these industries are lower than they would have been the case without the protective services of forests (e.g. lower market prices of drinking water or agricultural products, lower premiums for insurance against flooding, lower rents or costs of constructing houses etc.). In this case, the result in an increase in consumer surplus on these products.

In practice, the links between forests and production activities are often complex to describe in physical terms, and few valuation studies are available.

The Austrian pilot study mentions some studies, in particular a study on the value of Austrian forests in protecting against avalanches (Pruckner et al. 1991). One approach used is the replacement cost method, which is an estimate of the cost of replacing the protective function of forests by technical measures. Depending on the assumptions used, the replacement cost varies between 37 and 330 million euro. An



alternative valuation method is opportunity cost, which measures the reduction in income and increase in costs that is the result of the forest being managed primarily for protection purposes rather than for optimal wood production.

8.7 Health of trees

The health of trees underlies all functions of the forest, but it can not be regarded as a forest service in itself. Consequently, it is not easy to determine a specific monetary value that is exclusively related to the health of trees, rather than to recreation, biodiversity, protection etc.

One possibility is to measure the value of the change in other forest functions that follow from a certain change in forest health. The Austrian pilot study mentions some examples, but it is not possible to estimate a total value for Austria based on the available data.

8.8 Government expenditure on forests

An area where data should generally be available is government expenditure on the protection and improvement of the environmental and recreational functions of forests. Expenditure data can give an indication of the value that society puts on such services. Examples of such expenditures can be management of national parks, payments to forest owners to compensate for reduced revenue from logging in protected areas, funding of afforestation measures and funding of forest research.

The government expenditure on forests is already covered in the normal national and government accounts, as government final consumption, gross fixed capital formation, subsidies, transfers etc., but it can be useful to present the forest-related expenditure in more detail in the forest account. Identifying the relevant expenditure will require a detailed functional analysis of the government accounts, and to ensure comparability across countries, definitions have to be agreed upon. A potential problem is that some kinds of expenditure promote several goals at the same time, e.g. both environmental services and timber production, and it can be difficult to identify the part that is related to environmental services.

The Austrian pilot study looked at government expenditure related to forest services. The main conclusion was that little data of this type is easily available at the moment.

8.9 Summary and conclusions

The results of the pilot studies show that there are many problems, both conceptual and practical, involved in integrating values of environmental and recreational services into a forest accounting system. The most promising areas for monetary valuation are carbon binding and recreation. In both cases, the physical data are relatively well defined (tonnes of carbon stored and number of forest visits, respectively), and there are studies available which can be used to derive average values per physical unit. However, the pilot studies also show that the monetary estimates are highly dependent on the assumptions used and therefore require careful explanation when presented. For the other environmental functions covered by the pilot studies (protection, biodiversity and the heath of trees) valuation is generally very difficult, and only a few partial valuation examples could be provided.

The results from the Swedish study illustrate the relative importance of the carbon binding and recreational services. In Table 35, estimates of the monetary value of the carbon binding and recreational functions of forests are presented together with the market value of the harvested timber. The recreational services have the highest value, but as mentioned above, this is a measure of consumer surplus which is not directly comparable to market values. The value of carbon binding, based on the Swedish CO₂-tax, is almost 40% of the value of the harvested timber. If the average price from the early trades of CO₂ emission permits is used instead, as suggested in the German and Austrian studies, the value would be much lower, about 100 million euro per year or only 5% of the value of the timber harvest.



Table 35: Value of forest-related functions, million euro, Sweden, 1999

	Value
Harvested timber	2 147
Carbon binding (based on CO ₂ -tax)	810
Recreational services	2 370

In addition to carbon binding and recreational functions, an area where monetary data is generally available is government expenditure on the protection and improvement of forests. These are already covered in the standard national accounts, but it can be useful to present the forest-related expenditures in more detail in the forest accounts.



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Annex 1: Links to MCPFE indicators

The proposed tables for recreational and environmental functions of forests have links to several of the indicators for Sustainable Forest Management (SFM) which is currently being finalised by the Ministerial Conference on the Protection of Forests in Europe (MCPFE), see www.mcpfe.org. The table below shows the relationship between the non-wood tables and the MCPFE indicators.

IEEAF recreational and environmental functions table	MCPFE SFM Indicator (Version of 7 October 2002)
F1. Carbon balance for woody biomass (1000 tonnes of carbon)	1.4 Carbon stock
F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon)	1.4 Carbon stock
F3. Forest-occurring species at risk or endangered	4.8 Threatened forest species
F4. Protection of forest and other wooded land (1000 ha)	4.9 Protected forests
F5. Forest regime (1000 ha)	No direct link to any indicator
F6. Recreational areas of forest and other wooded land (1000 ha)	6.11 Accessibility for recreation
F7. Recreation visits to forests by main purpose	6.11 Accessibility for recreation
F8. Forest and other wooded land with protective functions	5.1 Protective forests – soil, water and other ecosystem functions
	5.2 Protective forests – infrastructure and managed natural resources
F9. Defoliation of trees by classes and species (%)	2.3 Defoliation



Annex 2: The proposed set of tables for recreational and environmental functions of forests

Table F1. Carbon balance for woody biomass (1000 tonnes of carbon)

	Opening stock	Gross increment	Total removals	Other changes	Changes in use/status	Closing stock
Total woody biomass 1)						
- Standing timber 2)						
Available for wood supply						
Coniferous						
Broadleaved						
Not available for wood supply						
Coniferous						
Broadleaved						
- Other woody biomass 3)						

- 1) The mass of the woody parts (wood, bark, branches, twigs, stumps and roots) of trees, alive and dead, shrubs and bushes, measured to a minimum diameter of 0 mm (d.b.h.). Includes above-stump woody biomass, and stumps and roots. Excludes foliage (TBFRA 2000).
- 2) Volume of standing trees, living or dead, above-stump measured overbark to top (0 cm). Includes all trees with diameter over 0 cm (d.b.h.) Includes tops of stems, large branches; dead trees lying on the ground which can still be used for fibre or fuel. Excludes small branches, twigs and foliage (TBFRA 2000).
- 3) The woody biomass not included in standing timber, i.e. small branches and twigs, shrubs and bushes, stumps and roots.

The definitions of the different types of changes are the same is in the asset account for standing timber (Table 2a) in the IEEAF set of annual tables:

Gross increment is the volume of natural growth during the period. It is generally calculated by modelling, based on opening stocks by age and species, biological parameters etc. Annual variations of natural growth may be high due to climatic variations – therefore averages over several years (e.g. 5 years) should be used.

Removals refer to those fellings that are removed from the wooded land and other felling sites during the period. Included are removals of trees felled during an earlier period, and removal of trees killed or damaged by natural causes.

Other changes: they cover all reductions in the volume of standing timber, which are not accounted for in removals. They include thinnings and cleanings left in the forest, and trees killed by natural causes (fire, insect attack, disease, wind-throw, landslide, flooding etc.) that are not removed. Other changes may also include a residual item, reflecting inconsistencies among the other data in the asset account.

Changes in use/status refer to changes in the standing volume due to 'changes in use/status' of the corresponding land area. They are recorded twice: as a decrease in the column corresponding to the initial category and as an increase in the column corresponding to the final category. An example is the timber on land that is reclassified from available for wood supply to not available for wood supply. Changes in use/status may also refer to the occasional removals of standing timber located on land 'not available for wood supply'. In this case a positive flow is recorded on the row 'changes in use/status', which is the counterpart of the negative flow recorded under removals.



Table F1 is to be provided for a reference period of five to ten years by using standard conversion factors. The conversion factors from volume of woody biomass to tonnes of carbon should be reported in a note to the table.

Table F2. Carbon balance for the forest ecosystem (1000 tonnes of carbon)

	Opening stock	Changes in carbon stored	Closing stock
Forest ecosystem			
Standing timber			
Other woody biomass			
Other biomass in forest 1)			
Forest soils			
Total in forest ecosystem			
Wood products in the econ	omy (for memo	ry)	
- Construction materials 2)			
- Wooden furniture 3)			
- Paper 4)			
- Other wood products 5)			

¹⁾ Includes needles and leaves and ground vegetation.

2) Mainly products in CPA 20 - Wood and products of wood and cork (except furniture):

CPA 2002 code	Description
20.1	Wood, sawn, planed or impregnated
20.2	Veneer sheets; plywood, laminboard; particle board, fibre board and other panels and boards
20.3	Builders joinery and carpentry, of wood

3) This group consists mainly of products in CPA 36.1 – Furniture:

CPA 2002 code	Description
36.11.12	Seats, primarily with wooden frames
36.12.12	Wooden furniture of a kind used in offices
36.12.13	Wooden furniture for shops
36.13.10 (part)	Kitchen furniture
36.14.12	Wooden furniture of a kind used in the bedroom, in the dining room and in the living room
36.14.13	Wooden furniture, n.e.c.

4) This group consists mainly of products in:

٠,	, the group consists manny or products in						
	CPA 2002 code	Description					
	21.2	Articles of paper and paperboard					
	22.1	Books, newspapers and other printed matter and recorded media					

5) For example:

CPA 2002 code	Description
20.4	Wooden containers
20.51	Other products of wood

Depending on national definitions, additional rows may have to be added to the table. The table is to be provided for a reference period of five to ten years. The data for standing timber and other woody biomass should be taken from Table F1.



Table F3. Forest-occurring species at risk or endangered 1)

	Total number of known forest-	Endangered forest-occurring species IUCN category 2)					Forest- occurring
	occurring species	CR	EN	VU	CR+EN+VU	% of total	species in % of all species
Trees (coniferous and broadleaved species)							
Other vascular plants (flowers)							
Total vascular plants							
Mosses							
Lichens							
Macrofungi							
Algae							
Total non-vascular plants							
Mammals							
Birds							
Other vertebrates (fish,							
amphibians, reptiles, snakes)							
Total vertebrates							
Insects							
Other invertebrates							
Total invertebrates							

- 1) The TBFRA-2000 uses the following definition of 'Species occurring on forest/other wooded land': Species of flora and fauna which occurs on forest or other wooded land for at least part of its everyday existence, e.g. for shelter, feeding, nesting or breeding.
- 2) A species is endangered when it is facing a high risk of extinction in the wild in the near future. The IUCN-categories are:

CR = critically endangered

EN = endangered

VU = vulnerable

Two tables are to be provided; one for a reasonable post-1950 year and the other for the most recent year.

If possible, endemic and exotic species should be distinguished, and estimates of extinct species included in the table.



Table F4. Protection of forest and other wooded land (1000 ha)

	IUCN cat. I and II	IUCN cat. III and IV	Total IUCN	Other legal protection	Total legally protected area 1)	Other protected areas	% of total	National target (%) 2)	Natura 2000 areas 3)
Opening area									
Afforestation									
Deforestation									
Natural colonisation or regression									
Other changes									
Changes in land classification									
Closing area									

- 1) Forest not available for wood supply with severe legal restriction on wood production (e.g. national parks, nature reserves and other protected areas such as those of special scientific, historical or cultural interest) as requested by the IEEAF. Care is needed to avoid double counting areas that are included in several sources.
- 2) The political target for the proportion of national forest and other wooded land to be exempted from wood production in order to safeguard and preserve the level of biodiversity and allow species to spread.
- 3) Wooded land included in the Natura 2000 program of the EU, a European network of special areas of conservation. The legal basis is 'Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora'

The IUCN categories are:

- I. Strict nature reserve/wilderness area
- II. National park
- III. Natural monument
- IV. Habitat/species management area

The table is to be provided for a reference period of five years



Table F5. Forest regime (1000 ha)

	Opening area	Changes	Closing area
Total forest and other wooded land			
- Not available for wood supply			
- Available for wood supply			
Uneven-aged high forest 1)			
Broadleaved 2)			
Coniferous 3)			
Mixed 4)			
Even-aged high forest 5)			
Broadleaved			
Coniferous			
Mixed			
Coppice 6)			
Coppice with standards 7)			
Broadleaved			
Coniferous			
Mixed			
Undetermined regime			

Definitions from TBFRA 2000:

- 1) High forest in which there is a mixture of different age classes. Usually, the trees can not be separated into different storeys.
- 2) Land on which broadleaved trees account for more than 75% of the tree crown area.
- 3) Land on which coniferous trees account for more than 75% of the tree crown area.
- 4) Land on which neither coniferous nor broadleaved trees account for more than 75% of the tree crown area.
- 5) High forest in which the predominant proportion of trees falls into the same age class, generally resulting in a single storey forest.
- 6) Forest composed of stool-shoots or root suckers.
- 7) Coppice with scattered trees.

The table is to be provided for a reference period of ten years.



Table F6. Recreational areas of forest and other wooded land (1000 ha)

	Open	Opening area		anges	Closing area	
	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant	1000 ha	ha per inhabitant
National parks 1)						
Urban recreation areas 2)						
Other recreation areas with open access 3)						
Total						

- 1) Only the parts of national parks that are open to the public should be included here.
- 2) Forests within a certain distance from urban areas according to national definitions. These definitions should be provided in a note to the table.
- 3) Refers to all forest areas accessible for recreational purposes, except national parks and urban recreation areas.

The table is to be provided for a reference period of five or ten years

Table F7. Recreation visits to forests by main purpose

Main purpose	Number of visits/year		% of total			Number of visits/inhabitant						
	Short	Day	Longer	Total	Short	Day	Longer	Total	Short	Day	Longer	Total
	visits 1)	visits 2)	visits 3)	visits	visits	visits	visits	visits	visits	visits	visits	visits
Hiking/Skiing												
Dog walking												
Cycling/Horse riding												
Organised sports												
Barbecue/Picnic												
Camping												
Hunting and fishing												
Off-road driving												
Bird-watching												
Picking berries,												
mushrooms												
Other												
Total												

- 1) Less than 2 hours.
- 2) Between 2 hours and a full day.
- 3) More than one day.

The table is to be provided every five or ten years.



Table F8. Forest and other wooded land with protective functions (1000 ha)

	Opening area	Changes	Closing area
Soil protection			
Protection of water resources			
Avalanche protection			
Coastline protection			
Other or multiple objectives 1)			
Total			
% of total forest and other			
wooded land			

1) E.g. when soil, avalanche and water protection are overlapping

The table refers to areas where protection is the primary management objective. In the TBFRA-2000, protection is defined as follows:

'The function of forest/other wooded land in providing protection of soil against erosion by water or wind, prevention of desertification, the reduction of risk of avalanches and rock or mud slides; and in conserving, protecting and regulating the quantity and quality of water supply, including the prevention of flooding. Includes: Protection against air and noise pollution.

The table is to be provided for a reference period of ten years.

Table F9. Defoliation of trees by classes and species (%)

	None 1)	Slight 2)	Moderate 3)	Severe and dead 4)
Conifers				
Broadleaves				
Total				

- 1) Up to and including 10 %
- 2) >10 to 25 %
- 3) >25 to 60 %
- 4) >60 %

The table is to be provided annually. Under the main groupings, detailed species should be included. These will vary between countries, according to forestry conditions and data availability.