

COUNTRY REPORT FOR SWITZERLAND

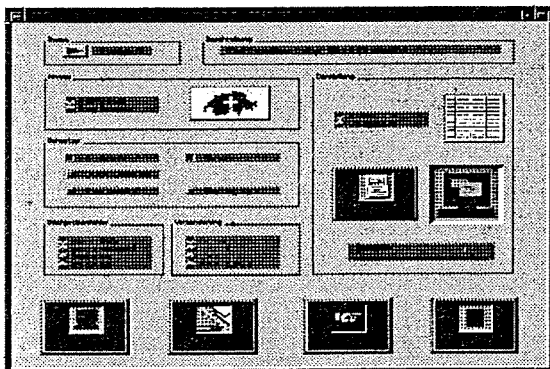
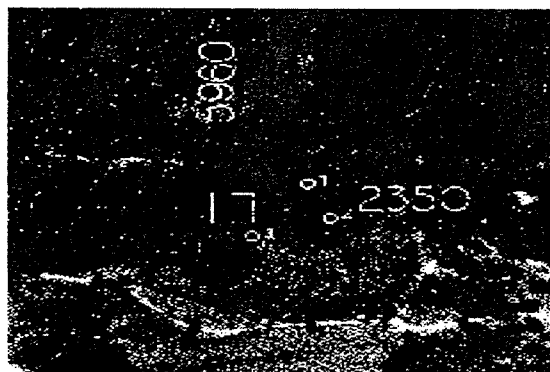
Michael Köhl

with co-operation of

Peter Brassel

Swiss Federal Institute for Forest, Snow and Landscape Research

Switzerland



Summary

1. Overview

The total area of Switzerland comprises 4.13 Mill. ha, of which 1.19 Mill. ha (28.7%) are covered by forests. The main tree species are spruce, fir and beech. The first Swiss NFI started in 1983, the results were published in 1988. The second inventory cycle was started in 1993, the results will be published in 1998.

The political mandate for the Swiss NFI is with the Swiss Federal Office for Environment, Forests and Landscape, Bern.

Since 1984 the condition of Swiss forests is monitored on the national level. Nowadays the assessments are done according to the ICP regulations. In several cantons (federal states) of Switzerland sample based inventories of domains are carried out.

2.1 Nomenclature

In the Swiss NFI more than 170 attributes are directly assessed in field surveys, by aerial photo interpretation, by enquiries or are taken from maps. Roughly 30 attributes are used for the identification of trees, plots, aerial photographs etc., roughly 140 attributes provide information which is used for the analysis or as input for derivations. The list of derived attributes contains at the moment little more than 30 attributes, which are mostly related to timber volume, assortments and growth. During the analyses procedures more attributes will be added, especially those related to NWGS, forest ecosystems and timber harvesting and accessibility.

The definitions and measurement rules of attributes have - with few exceptions - not been changed between the first and second assessment. Additional attributes have been added in the second NFI and relate mostly on non-timber functions of forests. A new set of attributes have been added in the aerial photo interpretation due to the intensified and more efficient use of aerial photography in the second NFI.

The forest area decision is done in aerial photographs and verified in field assessments. Where the forest/non-forest decision cannot be made on aerial photographs, it is done by terrestrial assessments. This is, however, in rare exceptions the case. All changes in forest cover between the first and second NFI, i.e. forested plots becoming non-forested and vice versa, are verified by field groups. The forest area definition was made up of the two attributes width of the forested patch and its crown closure. A functional relationship between these two attributes was set up for the forest/non-forest decision and reflects the specific situations in various eco-regions in Switzerland. The minimum crown closure is between 100 and 20 percent cover, the minimum width is between 25 and 50m. Except for afforestations, young growth, mountain alder and mountain pine the minimum top height of a forested patch has to be more than three meters to be classified as forest

2.2 Data sources

The Swiss NFI utilises the following data sources: aerial photographs (black-and-white, 1:30,000), field assessments, enquiries and maps in both printed and digital format. The aerial photographs are provided by the Swiss Federal Office of Topography free of charge.

2.3 Assessment techniques

The Swiss NFI covers all forests of Switzerland except those forested areas, which are stocked by woody plants with permanent top height of less than three meters. In the second cycle roughly 6,600 concentric field plots and 160,000 aerial photo plots were assessed. In addition maps and questionnaires were used as data sources. On field sample plots the data are captured by hand-held computers. A two-phase sampling design for stratification was used to combine the information originating from the different data sources. The period of data assessment covered three years, no reference date was given

2.4 Data storage and analysis

The data of the Swiss NFI are kept under the responsibility of the Swiss Federal Institute for Forest, Snow and Landscape Research. The data are stored in an ORACLE data base and are analysed with a special SAS application. No updating is applied.

The statistical analysis is done by a two-phase sampling for stratification approach with ratio estimators. Tree and plot data are expanded and results are independently calculated for five regions of Switzerland. The regional results are combined to results on the national level.

The data are available with restrictions. Thematic and geographic sub-units can be formed at pleasure. Links to other geo-referenced data sources are provided.

2.5 Reliability of data

Data quality has always been a major issue of the Swiss NFI. Intensive training and check assessments are key elements to ensure the reliability of data. The results of check assessments, however, are not used to correct data. An error budget was developed for the volume estimation, which combines sampling errors with other non-sampling errors such as measurement errors, grouping errors and prediction errors.

2.6 Models

In the current NFI models for volume, assortments and growth components are included. The input attributes for those models are d.b.h., upper stem diameters, tree height and others. Models related to non-wood goods and services, biomass, carbon cycle and timber supply are currently under investigation.

2.7 Inventory reports

The first inventory report was issued 1988. The second inventory report is planned to be issued in 1998. The data which form the base of the first inventory report were assessed between 1982 and 1986, the aerial photographs originate from 1979 to 1984.

As Switzerland has four official languages the inventory reports have been and will be published in two languages (German and French). The first inventory report contains 11 chapters, the content focuses mainly on the productive function of forests. The information groups forest structure, forest condition and forest sites were ranked highest in an user needs assessment. Most requests for special analyses were submitted from cantonal (=federal) administrations and research institutions.

2.8 Future development and improvements plans

The third cycle of the Swiss NFI will probably start in 2003. The same data sources as in the first and second NFI will be utilised. The photo interpretation, however, might no longer be done by analytical instruments but by means of digital photogrammetry. The data analysis and data storage will be based on commercial software such as SAS or Oracle. The reliability of data will remain a major issue. Intensive training and check assessments will be the backbone of data quality.

A whole set of new attributes and models related to non wood goods and services will be included in the third cycle. GIS-based analyses will gain importance.

1. OVERVIEW

The total area of Switzerland comprises 4.13 Mill. ha, of which 1.19 Mill ha (28.7%) are covered by forests. Switzerland can be divided into five productive regions: Jura, plateau region (*Mittelland*), Pre-Alps (*Voralpen*), Alps (*Alpen*) and southern slopes of the Alps (*Alpensüdseite*), which reflect different site conditions. The largest forest cover can be found on the southern slopes of the Alps (46.4%), the lowest in the Alps (22.7%). 68.5% of the forests are publicly owned, 31.5 % are privately owned. The average size of a stand (smallest management unit) is less than 1 ha. 6.1 Mill. inhabitants are living in Switzerland (BFS, 1995), which results in slightly more than five inhabitants per ha of forested land. The differences between productive regions are pronounced (see Table 1).

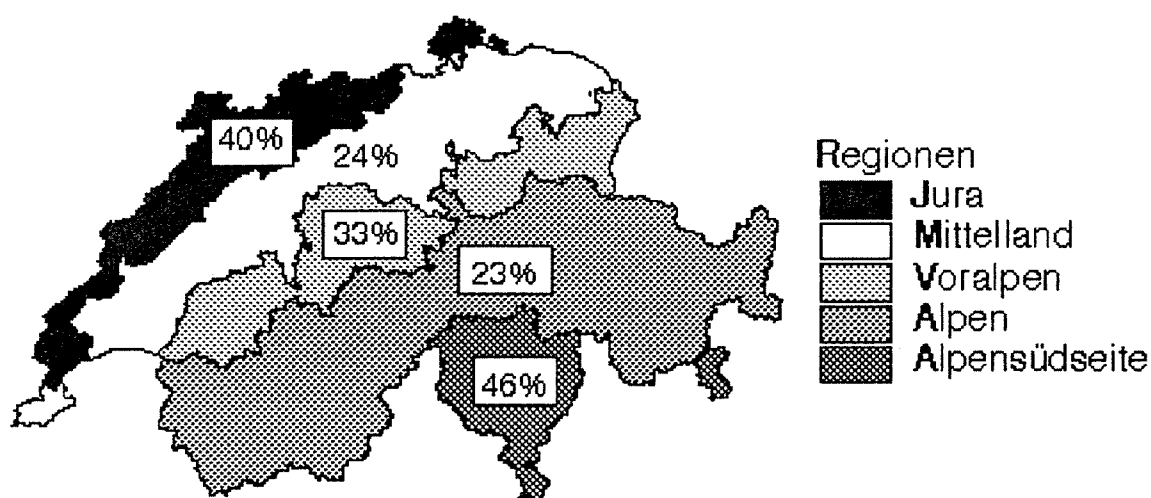


Figure 1. Productive Regions of Switzerland and their forest cover (Jura, plateau region (Mittelland), Pre-Alps (Voralpen), Alps (Alpen) and southern slopes of the Alps (Alpensüdseite)).

Table 1. Statistics of Switzerland.

Region	Forest area [ha]	Total area [ha]	Forest area [%]	Volume [m ³ /ha]	Privately owned forest [%]	Inhabitants per ha forested land ¹
Jura	195000	491100	39.7	328	25.2	4.76
Plateau region	228200	953000	24.2	409	42.6	16.67
Pre-Alps	217000	660700	32.8	417	49.7	3.85
Alps	381600	1679700	22.7	292	22.1	1.59
Southern Slopes of the Alps	164500	354600	46.4	176	21.5	1.61
Switzerland	1186300	4129100	28.7	333	31.5	5.26

¹source: Annuaire suisse de l'économie forestière et de l'industrie du bois 1986, other sources: Swiss NFI

The main tree species are spruce (*Picea abies* [L.] Karst.), fir (*Abies alba* Mill.) and beech (*Fagus sylvatica* L.), which comprise 70 percent of all trees in Switzerland. The exact tree species proportions can be seen in Figure 2 and Figure 3.

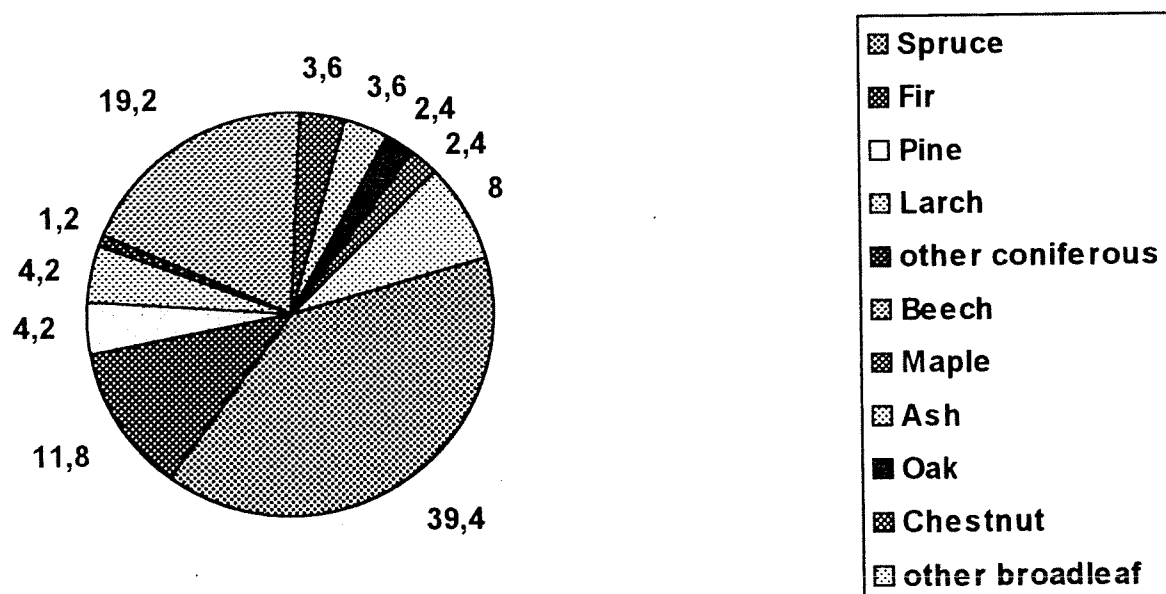


Figure 2. Tree species proportions (percent of number of stems) in Switzerland.

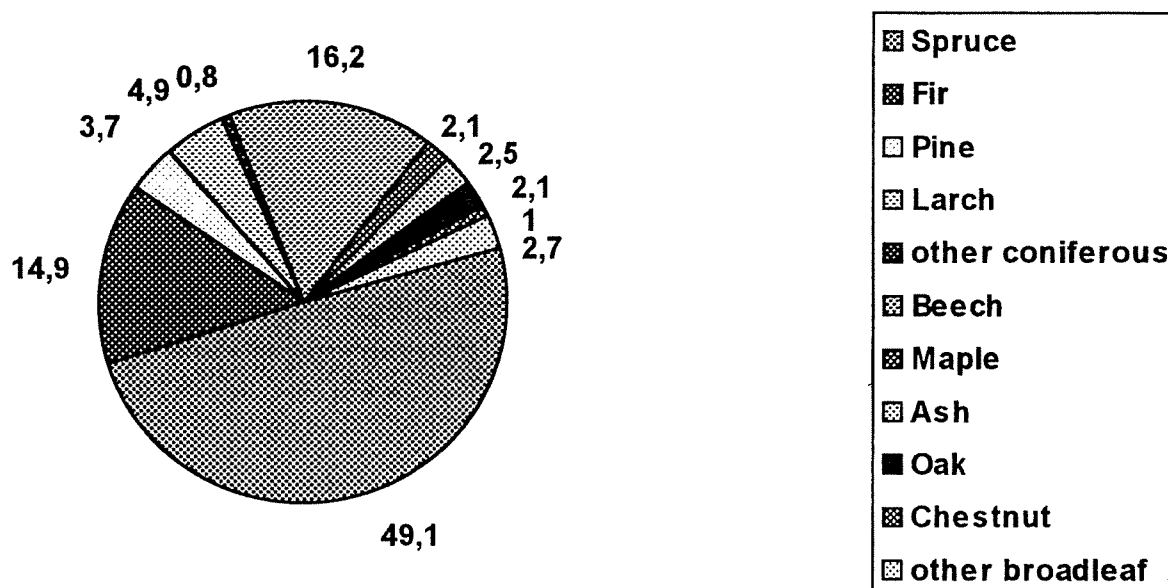


Figure 3. Tree species proportions (percent of standing volume) in Switzerland.

The average volume per hectare is $333 \text{ m}^3\text{ha}^{-1}$ for the entire Swiss forests, but differs between productive regions (see Table 1). At the moment no sample based results on increment are available. All results presented in this section have been taken from EAFV (1989), if not stated otherwise.

The start signal to conduct a national forest inventory, NFI (*Schweizerisches Landesforstinventar, LFI*) in Switzerland was given in 1972 when a new department was founded at the former Swiss Federal Institute for Forestry Research (*Eidgenössische Anstalt für das Forstliche Versuchswesen, EAFV*) which is called nowadays Swiss Federal Institute for Forest, Snow and Landscape Research (*Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft, WSL*¹). After the preparation phase the data assessment of the first NFI started in 1983 and was finished in 1986. The results were published in 1989 (EAFV, 1989) in German and 1990 in French. Between 1993 and 1995 the data for the second NFI were collected. The Swiss NFI gives results for the entire area of Switzerland. In addition the results are broken down to five productive regions (Jura, Plateau region, Pre-Alps, Alps and southern slopes of the Alps, see Fig. 1). The responsibility for the Swiss NFI is shared between the WSL and the Swiss Federal Office for Environment, Forests and Landscape (*Bundesamt für Umwelt, Wald und Landschaft, BUWAL*²). The BUWAL is responsible for the allocation of funds, the political interpretation and transfer of the results and the specification of the information needs. The WSL is responsible for planning, and conducting the survey, the data analysis and the publication of the results. The Swiss Federal Forestry law of 1993 (*Schweizerisches Waldgesetz*) requires the permanent monitoring of Swiss forests by means of a NFI.

¹Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft, WSL, Sektion Landesforstinventar, CH-8903 Birmensdorf, Switzerland

²Bundesamt für Umwelt, Wald und Landschaft, BUWAL, Eidgenössische Forstdirektion, CH-3003 Bern

Since 1984 the condition of Swiss forests is monitored by means of a sample based survey. In 1984 and 1985 the public and accessible forests of Switzerland were inventoried by a tract survey, the key attributes assessed were crown transparency and discoloration. Since 1985 the forest condition is monitored on a sub-sample of the Swiss NFI. In 1993 the grid size of the sub-sample was reduced from 4*4km to 8*8km. Since 1995 the 8*8km grid is remeasured in a three year rota, the annual assessment covers the 16*16km grid as suggested by the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP) regulations. In the beginning the forest health monitoring program was called 'Sanasilva forest health survey' (*Sanasilva Waldschadensinventur*) and later on renamed to 'Swiss survey of forest condition' (*Waldzustandsinventur*). The surveys assess tree and crown attributes according to the ICP regulations. The analysis of the forest health survey does not use a combined, two-phase approach but relates strictly to the field assessments. Simple random sampling estimates are calculated. The forest/non-forest decision and other tree, plot and area related data are taken from the NFI. The plot design is the same as in the NFI. In 1994 at each plot location a second plot was established, that has as well the same design as the NFI-plot. These plots have not been used for the derivation of national results but used for comparative studies and special investigations concerning the structural diversity within stands. As the survey of forest condition is closely linked to the NFI and the ICP-regulations it will not be treated in this report to avoid redundancy.

In several Swiss cantons sample based surveys at the district (*Forstkreis*) or stand level are conducted. These surveys are never extended to a regional level. At the moment several cantons, e.g. Bern, Graubünden and Appenzell, are preparing regional forest surveys, which should substitute the district and stand level inventories in the future. Most of these regional surveys will be based on the sampling methods and the nomenclature of the Swiss NFI. As those surveys are currently in a planning phase and neither field assessments have started nor results are available, they will not be treated in this study.

1.2 OTHER IMPORTANT FOREST STATISTICS

This chapter relates to additional information and data on forests and forestry available in the country, which is not assessed by the forest resource assessment under concern. Important national forest statistics other than forest resource assessments are listed and information is provided to which and how data from the forest resource assessment are submitted to UN and Community institutions.

1.2.1 Other forest data and statistics on the national level

Topic and spatial structure	Period	Responsibility	Data source	Availability
Phytosanitary Observation and Reporting Service (<i>Phytosanitärer Beobachtungs- und Meldedienst</i>)	permanent	WSL	enquiry	available
Forest Statistics (<i>Forststatistik</i>)	annually	BFS	enquiry	available
Timber market analysis (<i>Holzmarktanalyse</i>)	annually	BUWAL	enquiry	available
Statistics on coniferous timber (<i>Nadelrundholzstatistik</i>)	annually	BUWAL	enquiry	available
Statistics on forest area reduction (<i>Waldrodungsstatistik</i>)	annually	BUWAL	assessment	limited
Statistics on forest fires (<i>Waldbrandstatistik</i>)	annually	BUWAL	assessment	limited
Statistics on game and hunting (<i>Wild- und Jagdstatistik</i>)	annually	BUWAL	enquiry	available
Statistics on timber prices (<i>Holzpreisstatistik</i>)	annually	BFS	enquiry	available
Assessment of timber processing (<i>Holzverarbeitungserhebung</i>)	annually	BFS	enquiry	available
Forestry enterprises statistics (<i>Betriebszählung</i>)	10 years	BFS	enquiry	available
Land use statistics (<i>Arealstatistik</i>)	15 years	BFS	assessment	limited, data in digital format available
Geostatistic (<i>Geostat</i>)	permanent	BFS	assessment	limited, data in digital format available

BFS: Bundesamt für Statistik, Bollwerk 27, 3003 Bern,

BUWAL: Bundesamt für Umwelt, Wald und Landschaft, 3003 Bern

L+T: Bundesamt für Landestopographie, Seftigenstr. 264, 3084 Wabern

WSL: Eidgen. Forschungsanstalt für Wald, Schnee und Landschaft, 8903 Birmensdorf

1.2.2 Delivery of the statistics to UN and Community institutions

The statistics and information presented under 1.2.1. are available on the national and international level. Special investigations and analyses are done by various institutions upon request. Thus it is difficult to assess how and in which international institutions information on Swiss forestry is utilised. As Switzerland is not member of the EU the delivery to community institutions is rather limited.

1.2.2.1 Responsibilities for international assessments

- a) FAO/ECE for the 1990 Forest Resource Assessment (FRA 1990)
until 1995:
Dr. Marco Zanetti, Eidgen. Forstdirektion, BUWAL, 3003 Bern, Tel: +41-31-3247784, Fax: +41-31-3247866
since 1996:
Dr. Peter Brassel, WSL, 8903 Birmensdorf, Tel: +41-1-7392238, Fax: +41-1-7392215, email: brassel@wsl.ch
- b) EUROSTAT
None
- c) OECD (Environment Compendium)
Arthur Zesiger, Bundesamt für Statistik, Abteilung Raumwirtschaft, Bollwerk 27, 3003 Bern, Tel: +41-31-3228656, Fax: +41-31-3226981
- d) to any other intergovernmental enquiries
IIASA: Urs-Beat Brändli, WSL, 8903 Birmensdorf, Tel: +41-1-7392343, Fax: +41-1-7392215, email: braendli@wsl.ch

1.2.2.2 Data compilation

The results provided for FRA and other questionnaires were mainly taken from the results publication. In some cases special investigations were conducted. Where the nomenclature of international assessments did not meet the Swiss nomenclature either expert guesses were provided or the results of the NFI without adjustment were given.

2. SWISS NATIONAL FOREST INVENTORY

2.1 NOMENCLATURE

2.1.1 List of attributes directly assessed

A) Geographic region

Attribute	Data source	Object	Measurement unit
Number of topographic map 1:25000 (<i>Landeskartennummer 1:25000</i>)	map	field plot	Number
Number of topographic map 1:50000 (<i>Landeskartennummer 1:50000</i>)	map	field plot	Number
Number of topographic map 1:100000 (<i>Landeskartennummer 1:100000</i>)	map	field plot	Number
Productive Region (<i>Produktionsregion</i>)	map	field plot	Name
Economic region (<i>Wirtschaftsregion</i>)	map	field plot	Number
Canton (federal state) (<i>Kanton</i>)	map	field plot	Name
Forest district (<i>Forstkreis</i>)	map	field plot	Number
Community (<i>Gemeindenummer</i>)	map	field plot	Number
Forest/non-forest decision (<i>Wald/Nichtwald Entscheid</i>)	aerial photograph sample-plot	Code	

B) Ownership

Attribute	Data source	Object	Measurement unit
Ownership (<i>Eigentum</i>)	enquiry	field plot	Code
Superfizes/different owner of land and trees (<i>Superfizes</i>)	enquiry	field plot	Code

C) Wood production

Attribute	Data source	Object	Measurement unit
Diameter at breast height (<i>Brusthoehendurchmesser</i>)	field assessment	tree	cm
Upper stem diameter in 7m height (<i>Durchmesser in 7m Hoehe</i>)	field assessment	tree	cm
Tree height (<i>Baumhoehe</i>)	field assessment	tree	m
Shape of tree crown (<i>Kronenform</i>)	field assessment	tree	Code
Crown class (<i>Kronenklasse</i>)	field assessment	tree	Code
Crown length (<i>Kronenlaenge</i>)	field assessment	tree	Code
Kind of assortment (<i>Trämel/Langholz</i>) (<i>Traemel/Langholz</i>)	enquiry	field plot	Code
Circumference (<i>Umfang</i>)	field assessment	tree	cm
Layer to which sample tree belongs (<i>Schicht</i>)	field assessment	tree	Code
Remarks on special features of sample tree (<i>Bemerkung</i>)	field assessment	tree	Code

D) Site and soil

Attribute	Data source	Object	Measurement unit
Azimuth of aspect (<i>Azimut der Exposition</i>)	field assessment	field plot	gon
Aspect (<i>Exposition</i>)	aerial photography	photo plot	Code
Can aspect be determined? (<i>Exposition bestimmbar?</i>)	field assessment	field plot	Code
Relief (<i>Relief</i>)	field assessment	field plot	Code
Relief (<i>Relief</i>)	aerial photography	photo plot	Code
Special sites and water bodies (<i>Spezialstandorte und Gewaesser</i>)	field assessment	field plot	Code

Soil characteristic depth (<i>Bodeneigenschaft Gruendigkeit</i>)	map	field plot	Code
Soil characteristic nutrient content (<i>Bodeneigenschaft Naehrstoffspeicher</i>)	map	field plot	Code
Soil characteristic skeleton content (<i>Bodeneigenschaft Skelettgehalt</i>)	map	field plot	Code
Soil characteristic soil moisture (<i>Bodeneigenschaft Vernaessung</i>)	map	field plot	Code
Soil characteristic water storage capacity (<i>Bodeneigenschaft Wasserspeicherfaehigkeit</i>)	map	field plot	Code
Soil characteristic risk of rock/soil slides (<i>Rutschungs- /Sackungsgefahr</i>)	map	field plot	Code

E) Forest structure

Attribute	Data source	Object	Measurement unit
Method for age determination (<i>Altersbestimmungsmethode</i>)	field assessment	tree	Code
Number of year rings (<i>Anzahl Jahringer</i>)	field assessment	tree	Number
Age of stand (<i>Bestandesalter</i>)	field assessment	field-plot	Years
Tree species (including shrubs) (<i>Baumart</i>)	field assessment	tree	Code
Tree code (<i>Code fuer Art der Baeume, Baumtyp</i>)	aerial photography	photo-plot	Code
Code for woody plants (<i>Code fuer Art des Gehoelzes</i>)	aerial photography	photo-plot	Code

Stand edge (<i>Bestandesgrenze</i>)	field assessment	field-plot	Code
Stand margin (<i>Bestandesgrenze</i>)	aerial photography	photo-plot	Code
Stage of forest development (<i>Entwicklungsstufe</i>)	field assessment	field-plot	Code
Stage of forest development (<i>Entwicklungsstufe</i>)	aerial photography	photo-plot	Code
Mixture proportion (coniferous/broadleaf) (<i>Mischungsgrad</i>)	field assessment	field-plot	Code
Mixture proportion (<i>Mischungsgrad</i>)	aerial photography	photo-plot	Code
Crown closure (<i>Schlussgrad</i>)	field assessment	field-plot	Code
Closure (<i>Schlussgrad</i>)	aerial photography	photo-plot	Code
Closure (<i>Deckungsgrad</i>)	field assessment	field-plot	Code
Crown closure (<i>Deckungsgrad aufgrund</i> <i>25 Pte.</i>)	aerial photography	photo-plot	Percent
Crown closure (<i>Deckungsgrad aufgrund</i> <i>9 Pte.</i>)	aerial photography	photo-plot	Percent
Social position (<i>Soziale Stellung</i>)	field assessment	tree	Code
Stand structure (vertical layers) (<i>Bestandesstruktur</i>)	field assessment	field-plot	Code
Forest structure (<i>Struktur</i>)	aerial photography	photo-plot	Code
Standards (<i>Ueberhaelter</i>)	aerial photography	photo-plot	Code
Planting in advance (<i>Vorbau</i>)	field assessment	field-plot	Code
Origin and management type of forest (<i>Waldform</i>)	field assessment	field-plot	Code
Forest type (<i>Waldtyp</i>)	field assessment	field-plot	Code

Class of raster point (<i>Entscheidung</i>)	aerial photography	photo-plot	Code
Crown height (<i>Kronenhoehe des Rasterpunkts</i>)	aerial photography	photo-plot	m
Mean tree height (<i>mittlere Baumhoehe aus 25er-Raster</i>)	aerial photography	photo-plot	m
Mean tree height (<i>mittlere Baumhoehe aus 9er-Raster</i>)	aerial photography	photo-plot	m
Altitude of raster point (<i>Bodenhoehe des Rasterpunkts</i>)	aerial photography	photo-plot	m a.s.l.
Number of points on crowns (<i>Anzahl Punkte auf dem Kronen-dach aus 25er-Raster</i>)	aerial photography	photo-plot	Number
Number of points on crowns (<i>Anzahl Punkte auf dem Kronen-dach aus 9er-Raster</i>)	aerial photography	photo-plot	Number

F) Regeneration

Attribute	Data source	Object	Measurement unit
Class of young growth ($<1.3\text{m}$, $>1.3\text{m}$) (<i>Jungwaldgruppe</i>)	field assessment	regeneration plot	Code
Location of regeneration plot (<i>Jungwalddlage</i>)	field assessment	regeneration plot	Code
Class (height/d.b.h.) of regeneration (<i>Jungwaldklasse</i>)	field assessment	regeneration plot	Code
Tree and bush species on regeneration plot (<i>Pflanzenart</i>)	field assessment	tree/seedling	Code
Species count on regeneration plot (<i>Pflanzenzählung</i>)	field assessment	regeneration plot	Number

Closure of regeneration (>0.1m height, <12 cm d.b.h.) (<i>Verjuengungs- Deckungsgrad</i>)	field assessment	field-plot	Percent
Closure of regeneration on regeneration plot (<i>Gesamtdeckungsgrad</i>)	field assessment	regeneration plot	Percent
Protection of regeneration (<i>Schutz</i>)	field assessment	regeneration plot	Code
Type of regeneration (<i>Verjungungsart</i>)	field assessment	regeneration plot	Code
Condition of regeneration (<i>Gesundheitszustand</i>)	field assessment	regeneration plot	Code

G) Forest condition

Attribute	Data source	Object	Measurement unit
Stand stability (<i>Bestandesstabilitaet</i>)	field assessment	field-plot	Code
Fire (<i>Brandspuren</i>)	field assessment	field-plot	Code
Erosion caused by water (<i>Erosion durch Wasser</i>)	field assessment	field-plot	Code
Slides (<i>Rutschungen</i>)	field assessment	field-plot	Code
Tree damages (<i>Schaeden</i>)	field assessment	tree	Code
Location of damage (<i>Schadenort</i>)	field assessment	tree	Code
Size and type of damage (<i>Schadenbild-Groesse</i>)	field assessment	tree	Code
Cause of damage (<i>Schadenursache</i>)	field assessment	tree	Code
Damage caused by snow (<i>Schneespuren</i>)	field assessment	field-plot	Code
Damage caused by rockfall (<i>Steinschlag</i>)	field assessment	field-plot	Code
Pasture (<i>Beweidung</i>)	field assessment	field-plot	Code
Intensity of grazing (<i>Beweidungsintensitaet</i>)	field assessment	field-plot	Code

Heavy utilisation and disturbances (<i>Ueberbelastung und Stoerungen</i>)	field assessment	field-plot	Code
--	------------------	------------	------

H) Accessibility, harvesting and management

Attribute	Data source	Object	Measurement unit
Distance for timber extraction (<i>Rueckedistanz</i>)	enquiry	field-plot	m
Management operation (<i>Nutzungsart</i>)	enquiry	field-plot	Code
Utilisation class (<i>Nutzungskategorie</i>)	field assessment	field-plot	Code
Utilisation class (<i>Nutzungskategorie</i>)	aerial photography	photo-plot	Code
Kind of next silvicultural treatment (<i>Eingriffsart</i>)	enquiry	field-plot	Code
Need for management operation (<i>Eingriffsdringlichkeit</i>)	field assessment	field-plot	Code
Tools for timber harvest (<i>Art der Baumernte</i>)	enquiry	field-plot	Code
Carrying out of timber harvest (<i>Ausfuehrung der Holzernte</i>)	enquiry	field-plot	Code
Constraints for timber harvest (<i>Einschraenkungen fuer die Holzhauerei</i>)	field assessment	field-plot	Code
Number of years since last cut (<i>Anzahl Jahre seit letzter Nutzung</i>)	enquiry	field-plot	Years
Timber extraction method (<i>Rueckemittel</i>)	enquiry	field-plot	Code
Kind of management plan (<i>Planungsgrundlage</i>)	enquiry	field-plot	Code

Year when last management plan was created (<i>Jahrzahl der aktuellen Planungsgrundlagen</i>)	enquiry	field-plot	Year
Direction of timber transport (<i>Rueckerichtung</i>)	enquiry	field-plot	Code
Constraints for extraction method (<i>Einschraenkung fuer die Rueckemittelwahl</i>)	field assessment	field-plot	Code
Length of cable line (<i>Laenge der Seillinie</i>)	field assessment	field-plot	m
Place to which timber is skidded after cut (<i>Rueckeziel</i>)	enquiry	field-plot	Code
Accessibility (<i>Zugaenglichkeit</i>)	field assessment	field-plot	Code
Proportion of unregulated fellings (<i>Anteil Zwangsnutzung</i>)	enquiry	field-plot	Percent
Cause of unregulated fellings (<i>Ursache der Zwangsnutzung</i>)	enquiry	field-plot	Code

I) Attributes describing forest ecosystems

Attribute	Data source	Object	Measurement unit
Heaps of branches (<i>Asthaufen</i>)	field assessment	field-plot	Code
Stumps (<i>Stoecke</i>)	field assessment	field-plot	Code
Berry species (<i>Beerenstraeucher Hauptart</i>)	field assessment	plants	Code
Dead trees (<i>Duerrstaender</i>)	field assessment	field-plot	Code
Closure of ground vegetation (<i>Bodenvegetations-Deckungsgrad</i>)	field assessment	field-plot	Code

Closure of berries (<i>Beerenstraeucher- Deckungsgrad</i>)	field assessment	field-plot	Code
Closure of shrub species (<i>Strauchschicht- Deckungsgrad</i>)	field assessment	field-plot	Code
Geomorphologic objects (<i>Geomorphologische Objekte</i>)	field assessment	field-plot	Code
Forest edge present (<i>Waldrand</i>)	field assessment	field-plot	Code
Forest edge (<i>Waldrand</i>)	aerial photography	photo-plot	Code
Width of forest (<i>Waldbreite</i>)	aerial photography	photo-plot	m
Type of forest edge (horizontal) (<i>Verlauf</i>)	field assessment	field-plot	Code
Type of forest edge (vertical) (<i>Waldrandaufbau</i>)	field assessment	field-plot	Code
Density of forest edge (<i>Waldranddichte</i>)	field assessment	field-plot	Code
Species at forest edge (<i>Artenaufnahme Waldrand</i>)	field assessment	plant species	Code
Species proportion at forest edge (<i>Art-Anteil</i>)	field assessment	field-plot	Code
Width of forest edge (<i>Waldmantel-Breite</i>)	field assessment	field-plot	m
Width of shrub belt at forest edge (<i>Strauchguertel-Breite</i>)	field assessment	field-plot	m
Width of herbals belt at forest edge (<i>Waldrand- Krautsam</i>)	field assessment	field-plot	Code
Border at forest edge (<i>Waldrandbegrenzung</i>)	field assessment	field-plot	Code
Surrounding of forest edge (<i>Waldrand- Umgebung</i>)	field assessment	field-plot	Code

Condition of forest edge (<i>Waldrand-Zustand</i>)	field assessment	field-plot	Code
Dry walls and heaps of stones (<i>Trockenmauer</i>)	field assessment	field-plot	Code
Patches without vegetation (<i>Vegetationslose Stellen</i>)	field assessment	field-plot	Code
Number of trees outside forested area (<i>Anzahl Baeume</i>)	aerial photography	photo-plot	Number
Size of stand (<i>Bestandesgroesse</i>)	aerial photography	aerial photography	ha
Length of wooded area (<i>Laenge des Gehoelzes in m</i>)	aerial photography	aerial photography	m
Kind of shrub forest (<i>Gebueschwaldart</i>)	aerial photography	aerial photography	Code
Type of shrub forest (<i>Gebueschwaldtyp</i>)	aerial photography	photo-plot	Code

J) Non-wood goods and services (NWGS), forest functions other than production

Attribute	Data source	Object	Measurement unit
Type of gaps (<i>Luecken</i>)	field assessment	field-plot	Code
Special situation (national park etc.) (<i>Besondere Verhaeltnisse</i>)	field assessment	map	Code
Infrastructure for recreation (<i>Erholungseinrichtung</i>)	field assessment	field-plot	Code
Woody plants outside forests (<i>Gehoelz ausserhalb des Waldes</i>)	aerial photography	photo-plot	Code

K) Miscellaneous

Attribute	Data source	Object	Measurement unit
Reason for verification (<i>Abklaerungsgrund</i>)	aerial photography	photo-plot	Code
Azimuth of single tree (<i>Azimut</i>)	field assessment	tree	gon

Date and time of assessment (<i>Aufnahmedatum und Zeit der Messung</i>)	field assessment		Date
Tree identification number (<i>Baumnummer</i>)	field assessment	tree	Number
Single tree status (<i>Baumstatus</i>)	field assessment	tree	Code
Reason for trees present in 1st assessment not found in 2nd assessment (<i>Grund fuer Baumstatus: nicht gefunden</i>)	field assessment	tree	Code
Date of enquiry (<i>Datum der Umfrage</i>)	enquiry		Date
Date of field assessment (<i>Feldaufnahmedatum</i>)	field assessment		Date
Declination of compass (<i>Deklination</i>)	field assessment		gon
Distance of tree from plot centre (<i>Distanz</i>)	field assessment	tree	m
Date when data are stored in database (<i>Einfuehlldatum</i>)			Date
Identification of field group (<i>Aufnahmegruppennummer</i>)	field assessment	field-plot	Number
Inventory identification (<i>Inventurnummer</i>)	field assessment	tree	Number
Radius of large regeneration plot (horizontal: 2.12m) (<i>Jungwaldradius gross</i>)	field assessment	regeneration plot	m
Radius of small regeneration plot (horizontal: 1m) (<i>Jungwaldradius klein</i>)	field assessment	regeneration plot	m
Identification number of regeneration plot (<i>Jungwaldsatellitennummer</i>)	field assessment	regeneration plot	Number
Plot radius of 500 m ² field plot (horizontal: 12.62m) (<i>Probeflaechenradius gross</i>)	field assessment	field-plot	m

Plot radius of 200 m ² field plot (horizontal: 7.98m) (<i>Probeflaechenradius klein</i>)	field assessment	field-plot	m
Status of field plot (<i>Probeflaechenstatus</i>)	field assessment	field-plot	Code
Reactions to marking of bark in 1st assessment (<i>Reisserstrich</i>)	field assessment	tree	Code
Weather condition, when plot was assessed (<i>Wetter bei der Baumaufnahme</i>)	field assessment		Code
Number of stereo pair (<i>Nummer des Luftbildes (Landestop.)</i>)	list	photo-plot	Number
Year of flight (<i>Flugjahr</i>)	list	photo-plot	Year
Number of flight line (<i>Nummer der Fluglinie</i>)	list	photo-plot	Number
Date of interpretation (<i>Datum der Erstinterpretation</i>)	aerial photography	photo-plot	Date
Conditions for interpretation (<i>Interpretationsbedingungen</i>)	aerial photography	photo-plot	Code
Manual forest/non-forest decision (<i>manueller Wald-/Nichtwald-Entscheid</i>)	aerial photography	photo-plot	Code
Location of plot centre (<i>Lage des Probeflaechenzentrums</i>)	aerial photography	photo-plot	Code
Verification (<i>Terrestrisch abklaeren ja/nein</i>)	aerial photography	photo-plot	Code
Distance plot centre-forest edge (<i>Distanz Zentrum - Waldrand</i>)	aerial photography	photo-plot	m
Central x-coordinate of model (<i>Zentrumskoordinate X des Modells</i>)	aerial photography	photo-plot	Number
Central y-coordinate of model (<i>Zentrumskoordinate Y des Modells</i>)	aerial photography	photo-plot	Number

2.1.2 List of derived attributes

Many attributes are not directly assessed but are derived using directly assessed attributes as input variables. This list contains all attributes, which are used for the presentation of the inventory results. Excluded are those attributes, which are used only in the analysis process and are not referred later on, e.g. dummy variables, weights, index values in databases, etc.

A) Geographic region

does not apply

B) Ownership

Attribute	Measurement unit	Input attributes
Ownership public/private <i>Eigentumskategorien</i> <i>oeffentlich/ privat</i>	Code	ownership

C) Wood production

Attribute	Measurement unit	Input attributes
Proportion of basal area <i>Basalflaechenanteil der Baeume mit BHD > 50</i>	percent	d.b.h., plot expansion factor
Single tree volume <i>(Einzelbaumvolumen)</i>	m ³	d.b.h., diameter in 7m height, total tree height, tree species
Estimated tree height (<i>bohd</i>)	m	d.b.h., site index, h _{dom} , altitude, bifurcation
Estimated d7 (<i>D7D</i>)	cm	d.b.h., site index, h _{dom} , altitude, bifurcation
Estimated mean diameter of an assortment (<i>MITDMD</i>)	cm	d.h.b., estimated d7, estimated tree height
Type of assortment <i>(SORTART)</i>	Code	
Class of Assortment <i>(SORTKLD)</i>	Code	
Estimated volume of assortments without bark <i>(SORTVD)</i>	m ³	d.b.h., estimated d7, estimated tree height
Tariff volume of bole over bark (<i>TV</i>)	m ³	d.b.h., h _{dom} , site index, altitude
Estimated bole volume without bark (<i>VoRD</i>)	m ³	d.h.b., estimated d7, estimated tree height

Basal area increment (<i>BAI</i>)	cm ²	d.b.h., site index, estimated age of stand
Volume increment (<i>VI</i>)	m ³	d.b.h., site index, estimated age of stand
Estimated volume of branches (diameter ≥ 7 cm) (<i>VAST</i>)	dm ³	d.b.h., estimated d7, estimated tree height, altitude, crown length
Estimated volume of twigs (diameter < 7 cm) (<i>VZWEIG</i>)	dm ³	d.b.h., estimated d7, estimated tree height, altitude, crown length
Estimated dry weight of foliar biomass (<i>VBIOMASS</i>)	kg	d.b.h., estimated d7, estimated tree height, altitude, crown length

D) Site and soil

Attribute	Measurement unit	Input attributes
Acidity according to classification by Keller (<i>Aciditaet nach Keller</i>)	Code	4 geographic regions defined according to forest plant societies by Keller, geo-technical units on geo-technical map
Derived aspect (<i>Abgeleitete Exposition</i>)	Code	aspect
Site Index according to Keller (<i>GWL nach Keller</i>)	Code	4 geographic regions according to forest plant societies by Keller, soil acidity, geology (Trias, Lias, Limestone), aspect, relief, altitude
Site index for beech according to Keller (<i>Oberhoehebonitaet fuer Buche nach Keller</i>)	m	site index, tree species
Site index for spruce according to Keller (<i>Oberhoehebonitaet fuer Fichte nach Keller</i>)	m	site index, tree species
Site index for pine according to Keller (<i>Oberhoehebonitaet fuer Kiefer nach Keller</i>)	m	site index, tree species

Site index for larch according to Keller (<i>Oberhoeohenbonitaet fuer Laerche nach Keller</i>)	m	site index, tree species
Site index for fir according to Keller (<i>Oberhoeohenbonitaet fuer Tanne nach Keller</i>)	m	site index, tree species

E) Forest structure

Attribute	Measurement unit	Input attributes
Forest type with respect to winter <i>Winterwaldtyp</i>	Code	basal area of larch and mixture proportion

F) Regeneration

Does not apply

G) Forest condition

Does not apply

H) Accessibility, harvesting and management

Attribute	measurement unit	input attributes
Accessibility for transport vehicles (<i>Bodeneigenschaft Befahrbarkeit</i>)	Code	soil type taken from geo-technical map
Period of utilisation (<i>Abgeleiteter Nutzungszeitraum</i>)	Code	if no utilisation assessed in 2nd NFI, period between assessments + period of utilisation as assessed in first NFI

I) Attributes describing forest ecosystem

Attribute	Measurement unit	Input attributes
Naturalness of stock (<i>Naturnaehe der aktuellen Bestockung</i>)	Code	potential natural vegetation as derived by Kienast (map product), basal area per tree species of current stocking

J) Non-wood goods and services (NWGS)

Attribute	Measurement unit	Input attributes
Number of inhabitants per ha (<i>Einwohnerzahl pro ha</i>)	Code	taken from land-use statistics (<i>Areal-statistik</i>), given per ha per community

K) Miscellaneous

Attribute	Measurement unit	Input attributes
Bifurcation (<i>Zwiesel</i>)	Code	remarks
Tree expansion factor for trees with d.b.h. ≥ 16 cm (<i>Repraesentierte Stammzahl mit BHD ≥ 16</i>)	number	d.b.h., plot expansion factor
Tree expansion factor for trees with d.b.h. ≥ 40 cm (<i>Repraesentierte Stammzahl mit BHD ≥ 40</i>)	number	d.b.h., plot expansion factor
Plot expansion factor (<i>repraesentierte Stammzahl</i>)		d.b.h., horizontal area of plot, slope, forest edge coordinates

2.1.3 Measurement rules for measurable attributes

For each of the measurable attributes the following information is given:

- a) measurement rule
- b) threshold values
- c) measurement scale
- d) rounding rules
- e) instrument used for measurement
- f) data source

Derived attributes such as volume or assortments are listed in chapter 2.6 'Models'.

A) Geographic region

Does not apply

- d) rounded downwards to lower class limit
- e) calliper
- f) field assessment

B) Ownership

Does not apply

*Upper stem diameter in 7m height
(Durchmesser in 7m Hoehe)*

C) Wood production

Diameter at breast height (Brusthoehen-durchmesser)

- a) Stem diameter measured in 1.3m height of the tree above ground, on slopes measured from uphill side. Measured with calliper, calliper pointing to plot centre. One reading
- b) Minimum d.b.h.: 12 cm, maximum d.b.h.: 60cm (above 60cm d.b.h. measurement with girth tape)
- c) cm, recorded in 1cm classes

- a) Upper stem diameter measured in 7m height above ground, on slopes measured from uphill side.
- b) none
- c) cm, recorded in 1cm classes
- d) rounded lower class limit
- e) Finnish calliper
- f) field assessment

Tree height (Baumhoehe)

- a) Tree height as distance between ground and top of tree (end of highest branch)
- b) Minimum height: 1.3 m.
- c) m, recorded in 1 m classes
- d) rounded to lower class limit
- e) Christen altimeter (geometric principle)
- f) field assessment

Circumference (Umfang)

- a) Stem diameter measured in 1.3m height of the tree above ground, on slopes measured from uphill side.
- b) Minimum d.b.h.: 12 cm
- c) cm, recorded in 1cm classes
- d) rounded to lower class limit
- e) girth tape
- f) field assessment

D) Site and soil*Azimuth of aspect (Azimut der Exposition)*

- a) Direction with the steepest slope measured downhill.
- b) none
- c) gon
- d) 1-gon classes
- e) Suunto-compass
- f) field measurement

E) Forest structure*Number of year rings (Anzahl Jahrringe)*

- a) Number of year rings counted on stumps of trees, which have been cut between 1st and 2nd NFI. Counted at three stumps, from mark to cambium.
- b) none
- c) number
- d) does not apply
- e) does not apply
- f) field assessment

Crown closure (Deckungsgrad aufgrund 25 Pte.)

- a) Crown closure calculated from assessment of 25 raster points (*Entscheid*)
- b) none
- c) percent
- d) does not apply
- e) Leica DSR1/DSR15 analytical plotter
- f) aerial photography

Crown closure (Deckungsgrad aufgrund 9 Pte.)

- a) Crown closure calculated from assessment of nine raster points (*Entscheid*)
- b) none
- c) percent
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Crown height (Kronenhoehe des Rasterpunkts)

- a) Crown height measured as difference between tree top and bottom of tree or ground altitude given by digital terrain model, if ground not visible.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Mean tree height (mittlere Baumhoehe aus 25er-Raster)

- a) Mean tree height calculated from measurement of tree height {Crown height, (*Kronenhoehe des Rasterpunkts*)} of 25 raster points.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Mean tree height (mittlere Baumhoehe aus 9er-Raster)

- a) Mean tree height calculated from measurement of tree height {Crown height, (*Kronenhoehe des Rasterpunkts*)} of nine raster points.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Number of points on crowns (Anzahl Punkte auf dem Kronendach aus 25er-Raster)

- a) Number of 25 raster point located on tree crowns.
- b) none
- c) number
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Number of points on crowns (Anzahl Punkte auf dem Kronendach aus 9er-Raster)

- a) Number of nine raster point located on tree crowns.
- b) none
- c) number
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

F) Regeneration

Number of plants per species (Pflanzenzählung)

- a) Number of plants counted and recorded per species on regeneration plot.
- b) none
- c) number
- d) does not apply
- e) does not apply
- f) field assessment

G) Forest condition

Does not apply

H) Accessibility, harvesting and management

Does not apply

I) Attributes describing forest ecosystems

Width of forest edge (Waldmantel-Breite)

- a) Width of trees at forest edge given as distance between forest edge (= line of trees at forest edge having minimum d.b.h. of 12 cm) and crown projection of trees.
- b) 1 to 50 m
- c) m
- d) none
- e) estimated
- f) field assessment

Width of forest (Waldbreite)

- a) Width of forest stand measured as shortest distance between forest edges.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR15 analytical plotter
- f) aerial photography

Width of shrub belt at forest edge (Strauchguertel-Breite)

- a) Width of shrubs at forest edge given as distance between forest edge (= line of trees at forest edge having minimum d.b.h. of 12 cm) and outer tips of twigs of shrubs..
- b) 1 to 99 m
- c) m
- d) none
- e) tape
- f) field assessment

Number of trees outside forest area (Anzahl Baeume)

- a) Number of trees on photo plot.
- b) none
- c) number
- d) does not apply
- e) Leica DSR1/DSR15 analytical plotter
- f) aerial photography

Size of stand (Bestandesgroesse)

- a) Size of stand measured by digitising forest edge.
- b) none
- c) ha
- d) does not apply
- e) Leica DSR1/DSR15 analytical plotter
- f) aerial photography

Length of wooded area (Laenge des Gehoelzes in m)

- a) Length of wood strips outside forests.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR15 analytical plotter
- f) aerial photography

J) NWGS, forest functions other than production

Does not apply

K) Miscellaneous*Azimuth of single tree (Azimut)*

- a) Azimuth of sample tree measured from plot centre.
- b) none
- c) gon
- d) 1-gon classes
- e) compass
- f) field assessment

Distance of tree from plot centre (Distanz)

- a) Distance of sample tree measured from plot centre.
- b) none
- c) cm
- d) 1cm classes
- e) tape
- f) field assessment

Radius of large regeneration plot (horizontal: 2.12m) (Jungwaldradius gross)

- a) Radius of large regeneration plot corrected for slope.
- b) none
- c) cm
- d) 1cm classes
- e) tape
- f) field assessment

Radius of small regeneration plot (horizontal: 1m) (Jungwaldradius klein)

- a) Radius of smaller regeneration corrected for slope.
- b) none
- c) cm
- d) 1cm classes
- e) tape
- f) field assessment

Plot radius of 500 m² field plot (horizontal: 12.62m) (Probeflaechenradius gross)

- a) Radius of 500m² plot corrected for slope.
- b) none
- c) cm
- d) 1cm classes
- e) tape
- f) field assessment

Plot radius of 200 m² field plot (horizontal: 7.98m) (Probeflaechenradius klein)

- a) Radius of 200m² plot corrected for slope.
- b) none
- c) cm
- d) 1cm classes
- e) tape
- f) field assessment

Crown coverage

- a) Ratio of area covered by tree crowns and total forested area.
- b) no threshold
- c) in 5% classes (0-4.9%, 5% to 9.9%,...)
- d) rounded to closest class limit
- e) ocular estimate
- f) aerial photography

Initials of interpreter (Initialen des Operators)

- a) Initials of interpreter have to enable comparisons in check assessments
- b) none
- c) initials
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

*Code for interpretation instrument
(Bezeichnung des Interpretationsgeraets)*

- a) Specification which of the two available analytical was used for photo-interpretation.
- b) none
- c) Leica DSR1/DSR 15 analytical plotter
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) interpreter

Number of aerial photograph (Nummer des Luftbildes laut Landestopographie)

- a) number of aerial photograph taken from list/map provided by federal office of topography (*Bundesamt fuer Landestopographie*), Bern
- b) none
- c) number-code
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list

Year of flight (Flugjahr)

- a) Year of flight for each aerial photograph taken from list/map provided by federal office of topography (*Bundesamt fuer Landestopographie*), Bern,
- b) none
- c) year
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list

Number of flight line (Nummer der Fluglinie)

- a) number of flight line of aerial photograph taken from list/map provided by federal office of topography (*Bundesamt fuer Landestopographie*), Bern,
- b) none
- c) number-code
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list

Altitude of raster point (Bodenhoehe des Rasterpunktes)

- a) Altitude of raster point, obtained by direct measurement or taken from digital terrain model.
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list

Date of interpretation (Datum der Erstinterpretation)

- a) Date when photo-plot was interpreted.
- b) none
- c) date
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list

Distance plot centre-forest edge (Distanz Zentrum - Waldrand)

- a) Distance from photo-plot centre to nearest forest edge
- b) none
- c) m
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) aerial photography

Central x-coordinate of model (Zentrums-kordinate X des Modells)

- a) Central x-coordinate of model
- b) none
- c) co-ordinate
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list, map

Central y-coordinate of model (Zentrums-kordinate Y des Modells)

- a) Central y-coordinate of model
- b) none
- c) co-ordinate
- d) does not apply
- e) Leica DSR1/DSR 15 analytical plotter
- f) list, map

2.1.4 Definitions for attributes on nominal or ordinal scale

In this section all attributes are listed that are assessed according to definitions. The following information is provided for each attribute:

- a) the definition
- b) the categories (classes) and
- c) the data sources
- d) remarks

A) Geographic region

Does not apply

B) Ownership

Ownership (Eigentum)

- a) Owner of the forest area under concern.
- b) 1) state (*Bund*)
- 2) federal state (*Kanton*)
- 3) political community (*polit. Gemeinde*)
- 4) community of citizens (*Bürgergemeinde*)
- 5) corporation (*Korporation*)
- 6) private ownership (*Einzeleigentum*)
- 7) associations, unions, church etc. (*Gesellschaften*)
- 8) verify (*abklaeren*)

c) enquiry

Superfizes/different owner of land and trees (Superfizes)

- a) Special form of ownership: Owner of trees and owner of land are different.
- b) 1) Superfizes (*Waldsuperfizes*)
- c) enquiry

C) Wood production

Shape of tree crown (Kronenform)

- a) Shape of the crown of sample trees.
- b) 1) round, symmetric (*rund*)
- 2) slightly one-sided (*leicht einseitig*)
- 3) one-sided, asymmetric (*stark einseitig*)
- c) field assessment

Crown class (Kronenklasse)

- a) Shape of the crown of sample trees.
- b) 1) good (*gut*)
- 2) medium (*mittel*)
- 3) poor (*schlecht*)
- c) field assessment

Crown length (Kronenlaenge)

- a) length of the crown of sample trees.
- b) 1) long crown, more than $\frac{1}{2}$ of tree length (*langkronig*)
- 2) medium crown-length, crown $\frac{1}{4}$ to $\frac{1}{2}$ of tree length (*mittekronig*)
- 3) short crown, less than $\frac{1}{4}$ of tree length (*kurzkronig*)
- c) field assessment

Kind of assortment (Trämel/Langholz) (Traemel/Langholz)

- a) Kind of assortment. Trämel = assortment according to length of bole (2m, 4m, 6m, 8m and multiples) and mean diameter/ Langholz = assortment according to length of bole
- b) 1) Traemel
- 2) Langholz
- c) enquiry

Layer to which sample tree belongs (Schicht)

- a) Stand layer to which sample tree belongs. Location of tree crown in stand with respect to mean height of the 100 tallest trees per ha.
- b) 1) upper layer (*Oberschicht*)
- 2) medium layer (*Mittelschicht*)
- 3) lower layer (*Unterschicht*)
- 4) no layer = standards, single trees (*keine Schicht*)
- c) field assessment

*Remarks on special features of sample tree
(Bemerkung1)*

- a) Remarks on special features of sample tree, code with three digits
- b) 1) normal sample tree (*normal*)
- 2) bifurcation (*Zwiesel*)
- 3) dead tree (*Duerrstaender*)
- 4) lying, dead (*liegend, duerr*)
- 5) lying, green (*liegend, gruen*)
- 6) crown of tree bended down (*gebogener Baum*)
- 7) bended tree, diverges more then 20% from vertical axis (*schiefer Baum*)
- 8) coppice (*Stockausschlag*)
- 9) standard (*Ueberhaelter*)
- 10) pronounced difference,, between d.b.h. and d₇, >15cm or d₇.d.b.h. (*extrem*)
- 11) proportion of dead branches more than 20% of total branch volume (*Duerast*)
- 12) sample trees, with more than one stem axis below 7m (*Capitozzi*)
- c) field assessment

D) Site and soil

Can aspect be determined? (Exposition bestimmbar)

- a) Information about possibility to determine azimuth of aspect
- b) 1) azimuth can be determined (*bestimmbar*)
- 2) azimuth cannot be determined, slope <10%, or plot centre on ridge (*unbestimmt*)
- c) field assessment

Aspect (Exposition)

- a) Aspect determined by measuring a vector, which starts at distance of 15 m above the photo plot centre and which ends 15m below the photo plot centre and is located on the steepest slope.
- b) 0) not assigned (*keine Angaben*)
- 1) N
- 2) NE
- 3) E
- 4) SE
- 5) S

- 6) SW
- 7) W
- 8) NW
- 9) not decided, slope <10% (*unbestimmt, d.h. < 10% Neigung*)

c) aerial photography

Relief (Relief)

- a) form or terrain
- b) 1) plain (*Ebene*)
- 2) rounded hilltop (*Kuppe, Oberhang*)
- 3) medium slope (*Mittelhang*)
- 4) gully (*Hangfuss, Mulde*)
- 5) not determined (*unbestimmt*)
- c) field assessment

Relief (Relief)

- a) Relief according to the following classes:
- b) -1) not assigned (*Keine Angabe*)
- 1) plain (*Ebene*)
- 2) hill top (*Kuppe/Oberhang/Rippe*)
- 3) medium slope (*Mittelhang*)
- 4) bottom of slope (*Hangfuss/Mulde/Grabe*)
- 5) steep slope, slope >70% (*Steilhang (> 70% Neigung)*)
- 6) not determined (*unbestimmt*)
- c) aerial photography

*Special sites and water bodies
(Spezialstandorte und Gewaesser)*

- a) special sites (dry, humid, wet, occasionally flooded) and water bodies
- b) 1) none (*keine*)
- 2) dry (*trocken*)
- 3) forest on mineral soils near water, regularly flooded, > 100m² (*Auenwald*)
- 4) forest on permanently wet soils, temporarily flooded, > 100m² (*Bruchwald*)
- 5) peatland, > 100m² (*Hochmoor*)
- 6) wet sites, wet due to fountains, wells > 100m² (*quellige Stellen*)
- 7) pool, 1 to 200m² (*Tuempel*)
- 8) pond, > 200m² (*Weiher*)
- 9) brook, up to 2m wide (*Bach*)
- 10) river, more than 2m wide, or river (*Fluss*)
- c) field assessment

Soil characteristic depth (Bodeneigenschaft Gruendigkeit)

- a) Depth of soil
- b) 0) not assigned (*keine Angabe*)
 - 1) extremely flat (*extrem flach*)
 - 2) very flat (*sehr flach*)
 - 3) flat (*flach*)
 - 4) medium (*mittel*)
 - 5) deep (*tief*)
 - 6) very deep (*sehr tief*)
 - 7) extremely deep (*extrem tief*)
- c) geotechnical map

Soil characteristic nutrient content (Bodeneigenschaft Naehrstoesspeicher)

- a) nutrient content of soil
- b) 0) not assigned (*keine Angabe*)
 - 1) extremely low (*extrem gering*)
 - 2) very low (*sehr gering*)
 - 3) low (*gering*)
 - 4) medium (*mittel*)
 - 5) good (*gut*)
 - 6) very good (*sehr gut*)
- c) geotechnical map

Soil characteristic skeleton content (Bodeneigenschaft Skelettgehalt)

- a) Skeleton content of soil
- b) 0) not assigned (*keine Angaben*)
 - 1) free of skeleton (*skelettfrei*)
 - 2) minor content of skeleton (*skelettarm*)
 - 3) skeleton (*skeletthaltig*)
 - 4) rich of skeleton (*skelettreich*)
 - 5) extremely rich of skeleton (*extrem skelettreich*)
- c) geotechnical map

Soil characteristic soil moisture (Bodeneigenschaft Vernaessung)

- a) Soil characteristic soil moisture
- b) 0) not assigned (*keine Angaben*)
 - 1) none (*keine*)
 - 2) soil moisture (*grundfeucht*)
 - 3) weak soil moisture (*schwach grundfeucht*)
 - 4) wet soil (*grundnass*)
 - 5) very wet soil (*stark grundnass*)
- c) geotechnical map

Soil characteristic water storage capacity (Bodeneigenschaft Wasserspeicherfaehigkeit)

- a) Soil characteristic water storage capacity
- b) 0) not assigned (*keine Angaben*)
 - 1) extremely low (*extrem gering*)
 - 2) very low (*sehr gering*)
 - 3) low (*gering*)
 - 4) medium (*maessig*)
 - 5) good (*gut*)
 - 6) very good (*sehr gut*)
- c) geotechnical map

Soil characteristic risk of rock/soil slides (Rutschungs-/Sackungsgefahr)

- a) Soil characteristic risk of rock/soil slides
- b) 1) risk of rock slides (*rutschgefaehrdet*)
 - 2) small risk of rock slides (*bedingt rutschgefaehrdet*)
 - 3) risk of soil slides (*sackungsgefaehrdet*)
 - 4) small risk of soil slides (*bedingt sackungsgefaehrdet*)
 - 5) stable (*stabil*)
- c) geotechnical map

E) Forest structure

Method for age determination (Altersbestimmungsmethode)

- a) Method for determination of stand age
- b) 1) no age determined (*keine Altersbestimmung*)
 - 2) visual estimation in uniform, evenaged stands (*Schaetzung*)
 - 3) counting of year rings on stumps (*Jahrringzaehlung*)
 - 4) counting of branch whorls (*Astquirlzaehlung*)
- c) field assessment

Tree species (including shrubs) (Baumart)

- a) Code for woody plant species by German and scientific (Latin) name
- b) 20 coniferous species, 40 broadleaf species, one class other coniferous, one class other broadleaf, 25 shrub species, one class other shrubs
- c) field assessment

Tree code (Code fuer Art der Baeume, Baumtyp)

- a) Tree code to describe tree type of single trees or tree groups outside of forested area.
- b) -1) not assigned (*Keine Angabe*)
 - 1) forest tree species (*Waldbaeume*)
 - 2) park tree species (*Parkbaeume*)
 - 3) fruit trees with high stem (*Obstbaeume (Hochstamm)*)
 - 4) fruit trees with short stem (*Obstbaeume (Niederstamm)*)
 - 5) trees along roads, avenues (*Alleebaeume*)
 - 6) single bushes (*Einzelbuesche*)
 - 7) mixed (*gemischt*)
- c) aerial photography

Code for woody plants (Code fuer Art des Gehoelzes)

- a) Code for woody plants (shrub and tree species) outside forested area.
- b) -1) not assigned (*Keine Angabe*)
 - 1) hedges/agricultural shrubs (*Hecken/landwirtschaftliche Gebuesch*)
 - 2) hedges/agricultural woody plants (*Hecken/landwirtschaftliche Gehoelze*)
 - 3) river side shrubs (*Bach/Ufer Gebuesche*)
 - 4) river side woody plants (*Bach/Ufer Gehoelze*)
 - 5) wind protection strips (*Windschutzstreifen*)
 - 6) shrubs in high altitudes (*Hochlagenbuesche*)
 - 7) tree groups in high altitudes (*Hochlagenrotten*)
 - 8) park trees and shrubs (*Parkgehoelze*)
 - 9) forest corners (*Waldecken*)
- c) aerial photography

Stand edge (Bestandesgrenze)

- a) Presence of stand edge. The stand edge can be the between two stands or a stand and an other land use class. It has to be stated if the sample plot lies on a stand edge.
- b) 1) present (*vorhanden*)
 - 2) not present (*nicht vorhanden*)
- c) field assessment

Stand margin (Bestandesgrenze)

- a) Stand margin found on photo sample-plot
- b) -1) not assigned (*Keine Angabe*)
 - 1) present (*vorhanden*)
 - 2) not present (*nicht vorhanden*)
- c) aerial photography

Stage of forest development (Entwicklungsstufe)

- a) Stage of forest development of stand according to dominant d.b.h. (= d.b.h. of 100 largest trees)
- b) 1) young growth/thicket (*Jungwuchs/Dickung*)
 - 2) polewood (*Stangenholz*)
 - 3) young timber (*Schwaches Baumholz*)
 - 4) medium timber (*mittleres Baumholz*)
 - 5) mature timber (*starkes Baumholz*)
 - 6) mixed, trees with different d.b.h. classes, no dominant stage of forest development or groups of trees (smaller than 0.05 ha) with different stages of forest development (*gemischt*)
- c) field assessment

Stage of forest development (Entwicklungsstufe)

- a) stage of forest development
- b) -1) not assigned (*Keine Angabe*)
 - 1) young growth/ thicket (*Jungwuchs/Dickung*)
 - 2) polewood (*Stangenholz*)
 - 3) mature timber I, stand height between 20 and 30m, normally 120 to 160 trees per photo-plot (*Baumholz I*)
 - 4) mature timber II, stand higher than 25m, normally less than 120 trees per photo-plot (*Baumholz II*)
 - 5) mixed, no dominant stage of forest development (*gemischt*)
 - 6) cannot be determined, no regeneration or young stand can be seen (*unbestimmbar*)
- c) aerial photography

Mixture proportion (coniferous/broadleaf), (Mischungsgrad)

- a) Mixture proportion (coniferous/broadleaf) given as proportion of basal area.
- b) 1) 91-100% coniferous
2) 51-90% coniferous
3) 11-50% coniferous
4) 0-10 % coniferous
- c) field assessment

Mixture proportion (Mischungsgrad)

- a) Mixture proportion (coniferous/broadleaf) given as proportion of crown area.
- b) -1) not assigned (*Keine Angabe*)
1) > 90% coniferous trees (> 90% *Nadelholz*)
2) 51 - 90% coniferous trees (51 - 90% *Nadelholz*)
3) 11 - 50% coniferous trees (11 - 50% *Nadelholz*)
4) 0 - 10% coniferous trees (0 - 10% *Nadelholz*)
- c) aerial photography

Crown closure (Schlussgrad)

- a) Crown closure given as competition of tree crowns in a stand
- b) 1) dense, crowns touch each other, asymmetric crowns, crowns short and one-sided (*gedraengt*)
2) normal, development of crowns 'normal', crowns do not or slightly touch each other (*normal*)
3) small gaps, gaps not large enough that trees from lower layers can grow into gaps (*locker*)
4) spatial distribution of crowns regular, smaller and larger gaps, crowns from lower layers can grow into gaps of upper crown layer (*raeumig*)
5) single trees, area not regularly covered by crowns (*aufgeloest*)
6) groups of trees with dense crowns (*gruppiert, gedraengt*)
7) groups of trees with 'normal' crowns (*gruppiert, normal*)

8) layered crown structure, concurrence more in the vertical than in the horizontal direction (*Stufenschluss*)

- c) field assessment

Closure (Schlussgrad)

- a) Crown closure is assessed according to the nomenclature and classification used in the field assessment.
- b) -1) not assigned (*Keine Angabe*)
1) dense, crowns touch each other, asymmetric crowns, crowns short and one-sided (*gedraengt*)
2) normal, development of crowns 'normal', crowns do not or slightly touch each other (*normal*)
3) small gaps, gaps not large enough that trees from lower layers can grow into gaps (*locker*)
4) spatial distribution of crowns regular, smaller and larger gaps, crowns from lower layers can grow into gaps of upper crown layer (*raeumig*)
5) single trees, area not regularly covered by crowns (*aufgeloest*)
6) groups of trees with dense crowns (*gruppiert, gedraengt*)
7) groups of trees with 'normal' crowns (*gruppiert, normal*)
8) layered crown structure, concurrence more in the vertical than in the horizontal direction (*Stufenschluss*)
10) cannot be assigned (*unbestimmbar*)
- c) aerial photography

Social position (Soziale Stellung)

- a) Social position of sample trees in stand.
- b) 1) predominant (*vorherrschend*)
2) dominant (*herrschend*)
3) co-dominant (*mitherrschend*)
4) dominated (*beherrscht*)
5) suppressed (*unterdrueckt*)
- c) field assessment

Stand structure (vertical layers)
(Bestandesstruktur)

- a) Stand structure related to vertical structure of stand, defined by proportion of different vertical layers
- b) 1) not assigned (*Keine Angabe*)
 - 1) single layer (*einschichtig*)
 - 2) several, regular layers (*mehrschichtig, regelmaessig*)
 - 3) several, spatially separated layers (*stufig*)
 - 4) several groups of trees with dense crowns, belonging to one layer, groups belong to different layers (*Rottenstruktur*)
- c) field assessment

Standards (Ueberhaelter)

- a) Standards found on the photo-plot
- b) -1) not assigned (*Keine Angabe*)
 - 1) standards (*Ueberhaelter vorhanden*)
 - 2) no standards found (*Ueberhaelter nicht vorhanden*)
- c) field assessment

Planting in advance (Vorbau)

- a) Planting in advance
- b) 1) yes (*ja*)
 - 2) no (*nein*)
- c) field assessment

Forest type defined by origin (Waldform)

- a) Forest type defined by origin of trees
- b)



1) high forest, generative origin (seeds) and selection forests (*Hochwald*)



2) coppice forest (*Niederwald*)



3) coppice with standards (*Mittelwald*)



4) chestnut and walnut stands, besides wood production utilisation of fruits and grass (*Selve*)

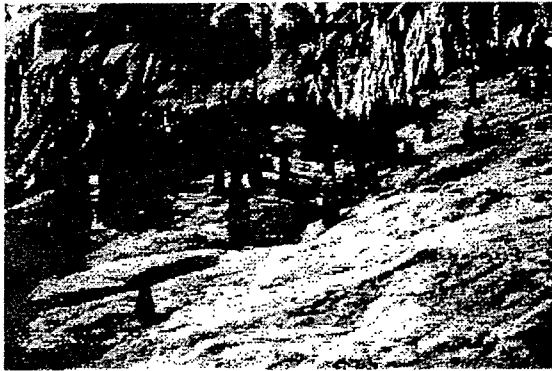


5) poplar or willow plantation (*Plantage*)

c) field assessment

Forest type (Waldtyp)

- a) Forest type defined by density
- b) 1) normal forest, all forest types (defined by origin) except open forests (*Normalwald*)



- 2) open forest, permanently open forests, crown coverage 20-60% (*aufgeloeste Bestockung*)

- c) field assessment

Class of raster point, (Entscheid)

- a) decision to which class raster point belongs
- b) -1) not assigned (*Keine Angabe*)
 - 1) non-forest (*Nichtwald*)
 - 2) deciduous tree crown (*Laubbaumkrone*)
 - 3) coniferous tree crown (*Nadelbaumkrone*)
 - 4) larch (*Laerchenkrone*)
 - 5) forest ground, could be stocked (*Waldboden bestockbar*)
 - 6) forest ground, cannot be stocked, e.g. rock (*Waldboden nicht bestockbar*)
 - 7) shrub species crown (*Gebueschkrone*)
 - 8) forest ground, street (*Waldboden Strasse*)

- c) aerial photography

F) Regeneration*Class of young growth (<1.3m, >1.3m) (Jungwaldgruppe)*

- a) Class of young growth
- b) 1) height < 1.3m (*Hoehe < 1,3m*)
 - 2) height > 1.3m (*Hoehe > 1,3m*)
- c) field assessment

Location of regeneration plot (Jungwaldlage)

- a) Location of the centre of the regeneration plot (RPC) with regard to sample plot centre (SPC).
 - b) 1) RPC in same stand as SPC (*massgebender Bestand*)
 - 2) RPC in other stand than SPC (*anderer Bestand*)
 - 3) not accessible (*nicht begehbar*)
 - 1) non-forest (*Nichtwald*)
- c) field assessment
- d) IF RPC is not in the same class as SPC (class 2) the stage of forest development of the stand, in which the RPC is located has to be given.

Class (height/d.b.h.) of regeneration (Jungwaldklasse)

- a) Classification of young growth according to height and/or d.b.h.
 - b) 1) height 10-39cm (*10cm - 39cm*)
 - 2) height 40-69cm (*40cm - 69cm*)
 - 3) height 70-99cm (*70cm - 99cm*)
 - 4) height 100-129 cm (*100cm - 129cm*)
 - 5) d.b.h. <3.9cm (*BHD <0,9cm*)
 - 6) d.b.h. 4-7.9cm (*BHD 4cm - 7,9cm*)
 - 7) d.b.h. 8-11.9cm (*BHD 8cm - 11,9cm*)
 - 8) 30-130 cm (*30cm - 130cm*)
- c) field assessment
- d) for the measurement of d.b.h. a diameter fork is used.

Tree and bush species on regeneration plot (Pflanzenart)

- a) Tree and bush species on regeneration plot have to be recorded according to the NFI tree species code for woody plant species by German and scientific (Latin) name
- b) 20 coniferous species, 40 broadleaf species, one class other coniferous, one class other broadleaf, 25 shrub species, one class other shrubs
- c) field assessment

Closure of regeneration (>0.1m height, <12 cm d.b.h.) (Verjuengungs-Deckungsgrad)

- a) Closure of regeneration on regeneration plot in two classes (>0.1m height and <12 cm d.b.h) given separately for the three most frequent species on the plot
- b) in 5% classes
- c) field assessment

Closure of regeneration on regeneration plot (Gesamtdeckungsgrad)

- a) Closure of regeneration on regeneration plot given for all species together.
- b) in 5% classes
- c) field assessment

Protection of regeneration (Schutz)

- a) Information concerning protection of plants against damages caused by game.
- b) 1) not protected (*ungeschuetzt*)
- 2) fence (*Zaun*)
- 3) protection of single plants by chemical means, wire baskets etc. (*Einzelschutz*)
- c) field assessment

Type of regeneration (Verjungungsart)

- a) Information on origin of regeneration
- b) 1) natural reproduction (*Naturverjuengung*)
- 2) planting (*Pflanzung*)
- 3) mixed (*gemischt*)
- 4) none (*keine*)
- c) field assessment

Condition of regeneration (Gesundheitszustand)

- a) Condition of regeneration. Information on proportion of damaged plants and proportion of damage causes, kind of damage.
- b) 1) other damages (*andere*)
- 2) dead (*tot*)
- 3) dry top (*Gipfelduerre*)
- 4) frayed by antlers (*gefegt*)
- 5) bitten (*verbissen*)
- 6) ill (*krank*)
- 7) timber harvest (*Holzernte*)

8) damaged by snow or slides (*beschadigt*)

9) bitten on side (*Seitenverbiss*)

9) healthy (*gesund*)

c) field assessment

G) Forest condition

Stand stability (Bestandesstabilitaet)

- a) Stability of stand given as the expected consistency of stand with respect to disturbances for the next 10 years (Plateau region, Jura, Pre-Alps) or 20 years (Alps, Southern slopes of the Alps). Only the present condition but not the possible development of the stand should be regarded.
- b) given in a 10 point score, 1= not stable, 10=stable
- c) field assessment

Fire (Brandspuren)

- a) Fire marks found on the sample plot.
- b) 1) present (*vorhanden*)
- 2) not present (*nicht vorhanden*)
- c) field assessment

Erosion caused by water (Erosion durch Wasser)

- a) Removal of soil or ruts caused by water.
- b) 1) drain (*Gerinne*)
- 2) flat areas (*Flaeche*)
- 3) erosion on slopes (*Boeschung*)
- 4) not present (*nicht vorhanden*)
- c) field assessment

Slides (Rutschungen)

- a)
- b) 1) drain (*Gerinne*)
- 2) others (*andere*)
- 3) not present (*keine*)
- c) field assessment

Tree damages (Schaden)

- a) Single tree damage is given as a three digit code that is made up by size, kind and location of the damage. Two 3-digit codes can be given per tree. See attributes 'size and kind of damage' and 'location of damage'
- c) field assessment

Size and kind of damage (Schadenbild-Groesse)

- a) the two first digits of 3-digit tree damage code defining the size and kind of damage.
- b) 0) no damage (*kein Schaden*)
 - 11) wood visible, <1 palm (*Holzkoerper < Hand*)
 - 12) wood visible, 1-4 palms (*Holzkoerper 1-4 Haende*)
 - 13) wood visible, <4 palms (*Holzkoerper > 4 Haende*)
 - 21) fissure up to 1m (*Riss bis 1 m*)
 - 22) fissure > 1m (*Riss > 1 m*)
 - 31) breakage < 1/2 of crown (*Schaftbruch < 1/2 Krone*)
 - 32) breakage > 1/2 of crown (*Schaftbruch > 1/2 Krone*)
 - 32) breakage of stem (*Stammbruch*)
 - 41) loss of < 1/2 of crown (*Verlust. < 1/2 Krone*)
 - 42) loss of > 1/2 of crown (*Verlust > 1/2 Krone*)
 - 43) dry top (*Gipfelduerre*)
 - 45) loss of < 1/3 crown (*Verl. < 1/3 Krone*)
 - 51) cancer < 1/2 stem (*Krebs < 1/2 Stamm*)
 - 52) cancer > 1/2 stem (*Krebs > 1/2 Stamm*)
 - 61) mechanic damage (*gestossen*)
 - 71) necrosis on bark (*Rindennekrosen*)
 - 72) mistletoe (*Misteln*)
 - 73) fungi on stem (*Stammpilz*)
 - 74) stem torsion (*Drehwuchs*)
 - 75) fusion (*Verwachsungen*)
 - 76) inclusions (*Einwuechse*)
 - 77) resin (*Harzfluss*)
 - 78) insects (*Insekten*)
 - 79) grazing (*Weidgang*)
 - 81) fungi, wood pecker (*Pilz, Specht*)
 - 82) main branch lost (*Hauptast weg*)
- c) field assessment

Location of damage (Schadenort)

- a) Location of damage
- b) 1) stump, root (*Stammanlauf*)
- 2) stem (*Stamm*)
- 3) stem inside crown (*Schaft*)
- 4) crown (*Krone*)
- c) field assessment

Cause of damage (Schadenursache)

- a) Cause of damage
- b) 1) timber harvesting (*Holzernte*)
- 2) fire (*Feuer*)
- 3) rockfall (*Steinschlag*)
- 4) wind, snow (*Wind, Schnee*)
- 5) slides (*Rutschungen*)
- 6) bark beetles (*Borkenkaefer*)
- 7) other insects (*andere Insekten*)
- 8) game (*Wild*)
- 9) others (*andere*)
- 10) wood extraction (*Ruecken*)
- 11) cutting (*Faellen*)
- 12) others caused by human beings (*andere, vom Menschen verursachte Schaeden*)
- 13) cattle (*Vieh, Nutztiere*)
- 14) fungi (*Pilze*)
- 15) wind (*Wind, Raureif*)
- 16) avalanches (*Lawinen*)
- 17) frost, sun (*Frost, Sonne*)
- 18) mistletoe, birds (*Mistel, Voegel*)
- 19) snow breakage (*Schneelast, Bewegung*)
- c) field assessment

Damage caused by snow (Schneespueren)

- a) Damage caused by movement of snow.
- b) 1) present (*vorhanden*)
- 2) not present (*nicht vorhanden*)
- c) field assessment

Rockfall (Steinschlag)

- a) Rockfall (stones and rocks)
- b) 1) present (*vorhanden*)
- 2) not present (*nicht vorhanden*)
- c) field assessment

Pasture (Beweidung)

- a) Signs of pasture.
- b) 1) not present (*keine Beweidung*)
- 2) horned cattle, cows (*Rinder und Kuehe*)
- 3) horses (*Pferde*)
- 4) goats (*Ziegen*)
- 5) sheep (*Schafe*)
- 6) can not be determined (*unbestimmt*)
- c) field assessment

Intensity of grazing (Beweidungsintensitaet)

- a) Intensity of grazing
- b) 1) extensive, not current (*extensiv, nicht aktuell*)
- 2) extensive, current (*extensiv, aktuell*)
- 3) intensive, not current (*intensiv, nicht aktuell*)
- 4) intensive, current (*intensiv, aktuell*)
- c) field assessment

Heavy utilisation and disturbances (Ueberbelastung und Stoerungen)

- a) The presence of the major anthropogenic impacts is assessed with some attributes. Here the major influences caused by man, not employed by forest management are assessed.
- b) 1) none (*keine*)
- 2) recreation (*Erholung*)
- 3) others (*andere*)
- 4) waste (*Deponie*)
- 5) old, no longer used drainage (*alte Entwaesserung*)
- 6) new, used drainage (*neue Entwaesserung*)
- 7) buildings (*Bauten*)
- c) field assessment

H) Accessibility, harvesting and management*Management operation (Nutzungsart)*

- a) Last management operation since past 10 years.
- b) 1) improvement felling (*Pflege*)
- 2) thinning (*Durchforstung*)
- 3) overhead release felling (*Lichtung*)
- 4) final cutting (*Raeumung*)
- 5) selection cutting (*Plenterung*)
- 6) thinning of mountain forests (*Gebirgsdurchforstung*)
- 7) cutting of coppice or coppice with standards (*Nieder- oder Mischwaldschlag*)
- 8) thinning for conversion (*Ueberfuehrungsdurchforstung*)
- 9) transformation (*Umwandlung*)
- 10) sanitary cuts (*Sanitaerhieb*)
- 11) no management operation (*kein Eingriff*) enquiry

Utilisation class (Nutzungskategorie)

- a) The major utilisation class of the stand
- b) 1) forest roads (*Strasse*)
- 2) timber storage (*Lagerplatz*)
- 3) recreation facilities (*Erholungsanlage*)
- 4) nursery (*Pflanzgarten*)
- 5) brook (*Bach*)
- 6) erosion, traces from avalanches etc. (*Zug*)
- 7) meadow (*Wiese*)
- 8) other gaps such as wet patches, rocks, stone hedges (*uebrige*)
- 9) temporarily unstocked area, cut, burned or windblown areas (*Schlagflaeche*)
- 10) stand with limited production, powerlines, cable lines, safety bands near railroads or roads and under power lines (*Schneisen*)
- 11) stand with limited production, road embankment not wider than 4 m (*Boeschungen*)
- 12) normal stand, none of the under 1 to 11 listed classes (*Bestand, normal*)
- c) field assessment
- d) class 1 to 8: permanently unstocked area

Utilisation class (Nutzungskategorie)

- a) Utilisation class to be given for photo plot.
- b) -1) not assigned (*Keine Angabe*)
- 1) road (*Strasse*)
- 2) wood storage (*Lagerplatz*)
- 3) recreation facility (*Erholungsanlage*)
- 4) nursery (*Pflanzgarten*)
- 5) brook (*Bach*)
- 6) tracks from avalanches etc. (*Zug*)
- 7) meadow (*Wiese*)
- 8) others (*Uebrige*)
- 9) cut, burned or windfall areas (*Schlag/Brand/Sturmflaeche*)
- 10) gap (*Schneise*)
- 11) embankment (*Boeschung*)
- 12) stand/ normal production (*Bestand/ Normalproduktion*)
- c) aerial photography

*Kind of next silvicultural treatment
(Eingriffsart)*

- a) The next silvicultural treatment (improvement, cuts). Sanitary cuts are not included. The silvicultural treatment has to be decided upon without regarding the economic and legal situation.
- b) 1) improvement felling (*Pflege*)
2) thinning (*Durchforstung*)
3) overhead release felling (*Lichtung*)
4) final cutting (*Räumung*)
5) selection cutting (*Plenterung*)
6) thinning of mountain forests (*Gebirgsdurchforstung*)
7) no management operation (*kein Eingriff*)
- c) enquiry

*Need for management operation
(Eingriffsdringlichkeit)*

- a) Time period for next management operation.
- b) 1) immediately (*sofort*)
2) in 2-5 years (*in 2-5 Jahren*)
3) in 6-10 years (*in 6-10 Jahren*)
4) in 11-20 years (*in 11-20 Jahren*)
5) in >20 years (*in > 20 Jahren*)
- c) field assessment

Tools for timber harvest (Art der Baumernte)

- a) Tools for timber harvest
- b) 1) axe (*Axt*)
2) chain saw (*Motorsäge*)
3) processor (*Prozessor*)
4) chip harvester (*Hacker*)
5) harvester (*Vollernter*)
- c) enquiry

*Carrying out of timber harvest
(Ausführung der Holzernte)*

- a) Timber harvest done by own staff or enterprises. Given for timber harvesting during last 10 years or, if no timber harvesting has taken place, give the most likely for the moment.

- b) 1) own staff (*Eigenregie*)
2) contractor (*Unternehmer*)
3) only cutting done by contractor (*Fällen*)
4) only cutting done by contractor (*Aufräumen*)
5) cutting and limbing done by contractor (*Fällen, Aufräumen*)
6) extraction done by contractor (*Rücken*)
7) sold on stumpage (*Stehendverkauf*)
- c) enquiry

*Constraints for timber harvest
(Einschränkungen für die Holzhauerei)*

- a) Constraints for timber harvest in the neighbourhood of the sample plot. Only major constraints have to be mentioned.
- b) 1) none (*keine*)
2) railway line (*Bahnlinie*)
3) main road (*Hauptstrasse*)
4) power and telephone lines (*Leitungen*)
5) settlement (*Siedlungen*)
- c) field assessment

Timber extraction method (Rückemittel)

- a) Method for timber extraction, all methods used for transport of timber during timber harvest.
- b) 1) downhill slides (*Reisten*)
2) horse (*Pferd*)
3) rafting (*Floessen*)
4) skidding on ground line by cable winch, single (*Seilwinde einzeln*)
5) skidding on ground line by cable winch, mounted on tractor eg. (*Seilwinde angeb.*)
6) tractor (*Traktor*)
7) skidder with articulated frame steering (*Knickschlepper*)
8) forwarder (*Forwarder*)
9) clam bunk skidder (*Klemmbankschlepp*)
10) mobile cable crane (*Seilkran mobil*)

- 11) conventional cable crane (*Seilkran konvent*)
- 12) Jeep (*Jeep*)
- 13) truck (*Lastwagen*)
- 14) sledge (*Schlitten*)
- 15) helicopter (*Helikopter*)
- 16) cable railway, normally used to passenger and/ or goods transport (*Seilbahn*)
- 17) ship (*Schiff*)
- 18) railway (*Eisenbahn*)
- 19) others (*andere*)
- 20) tractor inside stand without cable winch (*Traktor in Bestand ohne Seilwinde*)
- 21) tractor inside stand with cable winch (*Traktor in Bestand mit Seilwinde*)
- 22) tractor on road without cable winch (*Traktor am Weg ohne Seilwinde*)
- 23) tractor on road without cable winch (*Traktor am Weg mit Seilwinde*)

c) enquiry

*Kind of management plan
(Planungsgrundlage)*

- a) Management plan available at present.
- b) 1) forest management plan (*Wirtschaftsplan*)
- 2) silvicultural project description (*Waldbauprojekt*)
- 3) without management plan (*ohne Planung*)
- 4) others, e.g. protection area (*Uebrige*)

c) enquiry

*Direction of timber transport
(Rueckerichtung)*

- a) Direction, in which wood is extracted.
- b) 1) uphill (*aufwaerts*)
- 2) downhill (*abwaerts*)
- 3) flat terrain (*eben*)
- c) enquiry

*Constraints for extraction method
(Einschraenkung fuer die
Rueckemittelwahl)*

- a) Constraints for tools for extraction.
Reason, why most suitable extraction method cannot be applied. Poor accessibility is not considered to be a constraint.
- b) 1) none (*keine*)
- 2) railroad line (*Bahnlinie*)
- 3) main road (*Hauptstrasse*)
- 4) power and telephone lines (*Leitung*)
- 5) others (*andere*)
- c) field assessment

*Place to which timber is skidded after cut
(Rueckeziel)*

- a) Place to which timber is skidded after cut.
- b) 1) extraction road, in slopes <26% (*Rueckegasse*)
- 2) machine track, road built by machines, in slopes >25% (*Maschinenweg*)
- 3) cable line (*Seillinie*)
- 4) helicopter landing (*Helikopter Landeplatz*)
- 5) river, lake (*Fluss, See*)
- 6) truck-able road (*LKW-Strasse*)
- 7) harbour (*Schifflande*)
- 8) cable railway (*Seilbahn*)
- 9) train station (*Eisenbahnstation*)
- 10) intermediate storage place (*Zwischenlager*)
- 11) place, at which timber is sold (*Polter Verkaufsort*)
- 12) wood processing facility (*Holzhof*)
- c) enquiry

Accessibility (Zugaenglichkeit)

- a) Accessibility of a sample plot by field crews.
- b) 1) accessible (*zugaenglich*)
- 2) partially accessible (*teilw. begehbar*)
- 3) not accessible, rock or gully (*unzug. Fels*)
- 4) not accessible, water body (*unzug. Wasser*)
- 5) not accessible, military area with restricted accessibility (*unzug. Militaer*)

- 6) not accessible, access too dangerous (*unzug. Gefahr*)
- 7) not accessible, other causes (*unzug. andere*)
- c) field assessment

Proportion of unregulated felling (Anteil Zwangsnutzung)

- a) Proportion of unregulated fellings within last 10 years, percent of total volume of timber harvested.
- b) 5% classes
- c) enquiry

Cause of unregulated fellings (Ursache der Zwangsnutzung)

- a) Cause of unregulated felling within last 10 years.
- b) 1) insects (*Insekten*)
- 2) fungi (*Pilze*)
- 3) windfall (*Windwurf*)
- 4) snow (*Schneelast*)
- 5) avalanches (*Lawinen*)
- 6) slides (*Ruefe, Rutsch*)
- 7) floods (*Hochwasser*)
- 8) fire (*Waldbrand*)
- 9) poor vitality, dying or dead (*Vitalitaet*)
- 10) others (*uebrige*)
- c) enquiry

I) Attributes describing forest ecosystems

Heaps of branches (Asthaufen)

- a) Heaps of branches and other wood, at least 30 cm height on at least 3m², found on sample plot.
- b) 1) present (*vorhanden*)
- 2) not present (*nicht vorhanden*)
- c) field assessment

Stumps (Stoecke)

- a) Stumps and/or lying trees with diameter of 30 cm and more.
- b) 1) more than 5 stumps (minimum height 20cm) with diameter >30cm or at least on lying tree with d.b.h. >29cm (*Stoecke ja*)
- 2) not present (*nicht vorhanden*)
- c) field assessment

Berry species (Beerenstraeucher Hauptart)

- a) Rubus and Vaccinium species.
- b) 120) *rubus fruticosus*, blackberry (*Brombeere*)
- 121) *rubus idaeus*, raspberry (*Himbeere*)
- 125) *vaccinium myrtillus*, bilberry (*Heidelbeere*)
- 126) *vaccinium vitis-idaea*, cranberry (*Preiselbeere*)
- 127) *vaccinium uliginosum* (*Moorbeere*)
- 128) *vaccinium oxycoccus* (*Moosbeere*)
- c) field assessment

Dead trees (Duerrstaender)

- a) Dead trees, tallied, if d.b.h. > 20cm, total volume of dead trees on sample plot has to be >1m³. Volume of single dead trees is estimated as follows:
d.b.h. 20cm ->0.25m³, d.b.h. 25cm ->0.55m³, d.b.h. 30cm ->0.75m³, d.b.h. 35cm ->1.1m³,
- b) 1) present (*Duerrstaender ja*)
- 2) not present (*Duerrstaender nein*)
- c) field assessment

Closure of ground vegetation, (Bodenvegetations-Deckungsgrad)

- a) Closure of ground vegetation. Considered are all ferns, grasses, herbs (no mosses), rubus sp., small shrubs such as vaccinium sp. The time of assessment is relevant for this attribute.
- b) 1) snow (*Schnee*)
- 2) < 1%
- 3) 1% - 9%
- 4) 10% - 25%
- 5) 26% - 50%
- 6) 51% - 75%
- 7) 76% - 100%
- c) field assessment

Closure of shrub species (Strauchschicht-Deckungsgrad)

- a) Closure of shrub species.
- b) 1) snow (*Schnee*)
 - 2) < 1%
 - 3) 1% - 9%
 - 4) 10% - 25%
 - 5) 26% - 50%
 - 6) 51% - 75%
 - 7) 76% - 100%
- c) field assessment

Closure of berries (Beerenstraeucher-Deckungsgrad)

- a) Closure of berries.
- b) 1) snow (*Schnee*)
 - 2) < 1%
 - 3) 1% - 9%
 - 4) 10% - 25%
 - 5) 26% - 50%
 - 6) 51% - 75%
 - 7) 76% - 100%
- c) field assessment

Geomorphologic objects (Geomorphologische Objekte)

- a) Geomorphologic objects and small landscape elements are open, rocky patches, gullies with a minimum area.
- b) 1) none (*keine*)
 - 2) rocks (*Geroell*)
 - 3) rock debris (*Blockschutt*)
 - 4) rock soil (*Felsbrocken*)
 - 5) band of rocks (*Felsband*)
 - 6) karst ridge (*Karren*)
 - 7) karst hollow (*Doline*)
 - 8) tuff (*Tuff*)
 - 9) pits (*Gruben*)
 - 10) gorge (*Schlucht*)
 - 11) groove (*Rinne*)
- c) field assessment

Forest edge present (Waldrand)

- a) Presence of forest edge on sample-plot.
- b) 1) forest edge present, runs through 25m circle around plot centre and forest touches non-forested area (*WR vorhanden*)
 - 2) forest edge not present (*kein Waldrand*)
- c) field assessment

Forest edge (Waldrand)

- a) Forest edge in photo-plot found. This attribute is given to the field crews to render the location of the field-plot centre more easy and to cross-check the measurements undertaken to locate the field plot centre.
- b)-1) not assigned (*Keine Angabe*)
 - 1) no forest edge (*Kein Waldrand*)
 - 2) normal forest edge, forest edge at least 25 m away from photo-plot centre (*Normaler Waldrand*)
 - 3) inner forest edge, between forest and non forest area a strip of open forest is located, which is not wider than 100m. (*Innerer Waldrand*)
- c) aerial photography

Type of forest edge (horizontal) (Waldrand-Verlauf)

- a) Assessed on a line of 50m length. The horizontal type of the forest edge is classified in the lower section (at breast height).
- b) 1) straight (*gerade*)
 - 2) curved (*geschwungen*)
 - 3) undulant (*gebuchtet*)
 - 4) with large bights (*stark gebuchtet*)
 - 5) open (*aufgeloest*)
- c) field assessment

Type of forest edge (vertical) (Waldrandaufbau)

- a) Vertical structure of the transition of forests and non-forested areas. Includes outer trees of forest and shrub belt.
- b) 1) no forest mantle, no shrub belt (*kein Waldmantel/kein Strauchguertel*)
 - 2) no forest mantle, but shrub belt (*kein Waldmantel/mit Strauchguertel*)
 - 3) steep forest mantle, no shrub belt (*Waldmantel steil/kein Strauchguertel*)
 - 4) wide forest mantle, no shrub belt (*Waldmantel ausladend/kein Strauchguertel*)
 - 5) forest mantle with shrub belt (*Waldmantel mit Strauchguertel*)
 - 6) shrub belt in front of forest mantle (*Strauchguertel vor Waldmantel*)
 - 7) layered structure of forest mantle (*Waldmantel gestuft*)
- c) field assessment

Density of forest edge (Waldranddichte)

- a) Density of forest mantle (shrub belt and tree belt) along the entire assessment line in the lowest 2m section. Explanation: Proportion of view seen from outside into the forest which is covered by trees and shrubs. Young stands and thickets, which touch open land, have to be classified as 'open'.
- b) 1) open, closed 0-25% (*offen*)
2) gaps, closed 26-50% (*lueckig*)
3) small gaps, closed 51-75% (*locker*)
4) dense, closed 76-100% (*dicht*)
- c) field assessment

Species at forest edge (Artenaufnahme Waldrand)

- a) Assessment of species (trees and shrubs) at the forest edge.
- b) 20 coniferous species, 40 broadleaf species, one class other coniferous, one class other broadleaf, 25 shrub species, one class other shrubs
- c) field assessment

Species proportion at forest edge (Art-Anteil)

- a) For each species assessed under 'species at forest edge (Artaufnahme Waldrand)' the abundance is given in seven classes.
- b) 1) very rare (*sehr selten*)
2) rare (*spaeerlich*)
3) 1-5%
4) 6-25%
5) 26-50%
6) 51-75%
7) 76-100%
- c) field assessment

Border at forest edge (Waldrandbegrenzung)

- a) Kind of border at forest edge which separates forest area from non-forest area. This border influences the migration of animals and man into or out of the forest and limits the extension of the shrub belt.

- b) 1) no limit (*keine Begrenzung*)
2) road with asphalt or concrete cover (*Strasse*)
3) gravel road (*Fahrweg*)
4) road or path with natural cover, only useable by tractors etc. (*Feldweg*)
5) fences (*Zaeune*)
6) fence for game (*Wildzaun*)
7) fence of pasture land (*Weidezaun*)
8) wall (*Mauer*)
9) ditch (*Graben*)
10) water (*Gewaesser*)
- c) field assessment

Surroundings of forest edge (Waldrand-Umgebung)

- a) Surroundings of forest edge in 100m circle, the land-use type with the largest cover is recorded.
- b) 1) settlement (*Siedlung*)
2) field (*Acker*)
3) meadow (*Fettwiese*)
4) meadow with trees (*Fettwiese/Baeume*)
5) pasture (*Weide*)
6) pasture with trees (open tree cover) (*Wytweide*)
7) perennial plants (*Hochstauden*)
8) lean meadows (*Magerwiese*)
9) wetland, i.e. mire (*Feuchtgebiet*)
10) water (*Gewaesser*)
- c) field assessment

Condition of forest edge (Waldrand-Zustand)

- a) Kind and intensity of human influence. Cattle is included as 'indirect human influence'. If more than one actions have taken place, the most recent is given priority.
- b) 1) mown, no influence on trees and shrubs (*gemaecht*)
2) cattle, shrubs and lower parts of trees affected (*unterweidet*)
3) branches and shrubs cut back (*geschnitten*)
4) shrubs cut, trees limbed (*ausgeholzt*)
5) parts of tree belt cut, shrubs partially removed (*gerodet*)

- 6) thinned (*durchforstet*)
- 7) manipulated to improve structure of forest edge (*gepflegt*)
- 8) no influence (*kein Einfluss*)
- c) field assessment

*Dry walls and heaps of stones
(Trockenmauer)*

- a) Dry walls and heaps of stones larger than 1m² on plot area.
- b) 1) present (*Trockenmauer ja*)
2) not present (*nicht vorhanden*)
- c) field assessment

Patches without vegetation (Vegetationslose Stellen)

- a) Patches without vegetation are open sandy areas, embankments larger than 3m² or heaps of soil larger than 1m³. Patches without vegetation are recorded, if they are facing sunlight.
- b) 1) present (*vorhanden*)
2) not present (*nicht vorhanden*)
- c) field assessment

Plants outside forest (Baeume ausserhalb Wald)

- a) Woody plants outside forests, given for each photo sample plot.
- b) -1) not assigned (*Keine Angabe*)
1) groups of trees outside forested area (*Gehoelz ausserhalb Waldareal*)
2) single trees outside forested area (*Baeume ausserhalb Waldareal*)
3) groups of trees and single trees outside forested area (*Gehoelz und Baeume ausserhalb*)
4) no groups of trees and single trees outside forested area (*Keine Gehoelze und Baeume ausserhalb*)
- c) aerial photography

Kind of shrub forest (Gebueschwaldart)

- a) Assessment of shrub species
- b) -1) not assigned (*Keine Angabe*)
1) *Alnus viridis* (Chaix) DC., (*Alpenerlen*)
2) *Pinus mugo* Turra var. *arborea*, *Pinus cembra* L., (*Legfoehren*)
3) can not be identified (*nicht identifizierbar*)
- c) aerial photography

Type of shrub forest (Gebueschwaldtyp)

- a) Type of shrub forest
- b) -1) not assigned (*Keine Angabe*)
1) pure shrub forest (*reiner Gebueschwald*)
2) shrub forest with trees (*Gebueschwald mit Waldbaeumen*)
- c) aerial photography

J) NWGS, forest functions other than production

Type of gaps (Lueckentyp)

- a) A gap covers at least an area of 10*10m and has a maximum closure of 20%. Recorded is the major class of the largest gap or opening on the sample plot. Roads, buildings or water bodies are no openings/gaps.
- b) 1) none (*keine*)
2) temporarily not stocked (windfall etc.) (*nicht bestockt*)
3) forest meadow (*Waldwiese*)
4) trees growing in (*einwachsend*)
5) blocks (*Blockschutt*)
6) areas of erosion or slides (*Rutsch*)
7) rock (*Fels*)
8) forest aisle (*Schneise*)
- c) field assessment

*Special situation (national park etc.)
(Besondere Verhaeltnisse)*

- a) Special situation concerning land use.
- b) 1) national park (*Nationalpark*)
2) reservation (*Reservat*)
3) natural protection area (*Naturschutzgebiet*)
4) river side forests (*Auenwald*)
5) park (*Parkwald*)
6) camp ground (*Campingplatz*)
7) limiting value (*Grenzertrag*)
8) not useable (*nicht nutzbar*)
9) others (*andere*)
- c) topographic map, field assessment

*Infrastructure for recreation
(Erholungseinrichtung)*

- a) Infrastructure for regeneration found on sample plot. Priority is increasing from two to six.
- b) 1) none (*keine*)
2) traces, such as trash, fire places, bark carvings (*Spuren*)
3) hiking trail, foot path, bike lanes, unpaved roads (*Wege*)
4) fitness parcouer (*Parcour*)
5) downhill ski slopes, ski lift, chair lift, cross country ski paths (*Skilift*)
6) bench (*Bank*)
- c) field assessment

K) Miscellaneous

*Reason for verification
(Abklaerungsgrund)*

- a) reason for verification of forest/ non-forest decision by field groups
- b) 0) no reason given (*keine Angabe*)
1) plot centre close to forest edge (*Waldrandnaehe*)
2) width of forest critical (*Waldbreite kritisch*)
3) distinction between forest and shrub forest can not be made clearly on an aerial photograph (*Wald- oder Gebueschwald*)
4) clouds or shadows on aerial photo (*Schatten/Wolken im Luftbild*)
5) NFI 1: forest, NFI2: non-forest (*LFI 1 Wald/LFI 2 Nichtwald*)
- c) aerial photography

Single tree status (Baumstatus)

- a) Information on presence of sample trees. The location of sample trees (azimuth and distance from plot centre) as recorded in the first NFI and an internal tree identification number is given.
- b) 1) identified, sample tree assessed in NFI 1 and NFI 2 (*identifiziert*)
2) new tree, ingrowth since last NFI assessment, either >12 cm on 200m² plot or >36cm on 500m² plot, or trees on new plots (*neuer Baum*)

3) tree present, but not assessed, e.g., distance from plot centre larger than plot radius, tree standing not vertical and d.b.h. outside plot area, trees with d.b.h. <12cm or <36cm (and distance > radius of 200m² plot) (*keine Aufnahme*)

4) tree or stump not found (*nicht gefunden*)

5) delete, sample tree data are marked for deletion (*geloescht*)

- c) field assessment

Reason for trees present in 1st assessment not found in 2nd assessment (Grund fuer Baumstatus: nicht gefunden)

- a) Reason for trees present in 1st assessment not found in 2nd assessment. Has to be given is class 4 (=tree or stump not found) has been recorded for the attribute 'single tree status' (*Baumstatus*)
- b) 1) cut, stump found (*abgesaegt*)
2) used in some other way, e.g. no stump found but utilised due to road construction (*sonst genutzt*)
3) natural loss due to windfall, erosion, slides, avalanches, rockfall, mortality (*Abgang*)
4) history of sample plot not known (*unbekannt*)
- c) field assessment

Status of field plot (Probeflaechenstatus)

- a) Information on location of plot and plot centre. The status of the field plot is determined according to reference point taken from aerial photography and the possibility to locate the plot centre. Plot centres on permanent plots have to be relocated by means of polar coordinates of sample trees or colour patches made to mark the plot centre.
- b) 1) aluminium pipe on old plot centre found (*gefunden*)
2) reconstructed (*rekonstruiert*)
3) found by measuring from same reference point as in NFI 1 to plot centre, aluminium stick on old plot centre found (*gefunden einmessen*)

- 4) reconstructed by measuring from same reference point as in NFI 1 to plot centre (*rekonstruiert durch Einmessung*)
- 5) measuring from other reference point as in NFI 1 to plot centre, aluminium pipe on old plot centre found (*gefunden m. FP*)
- 6) reconstructed by measuring from other reference point as in NFI 1 to plot centre (*rekonstruiert mit Fixpunkt*)
- 7) not found, or distance between correct location of plot centre and plot centre located in first NFI > 50m (*nicht gefunden*)
- 8) new plot in NFI 2, plot centre marked (*Erstaufnahme*)
- c) field assessment

Reactions to marking of bark in 1st assessment (Reisserstrich)

- a) In the first NFI sample trees were marked by carving small horizontal line on the bark. Reactions to these carvings are recorded.
- b) 1) no reaction, (*keine Reaktion*)
- 2) small reaction, bark reaction < 1cm thick, raisin (*kleine Reaktion*)
- 3) strong reaction, bark reaction > 1cm thick, bark necrosis (*grosse Reaktion*)
- 4) no mark (*kein Reisser*)
- c) field assessment

Weather condition, when plot was assessed (Wetter bei der Baumaufnahme)

- a) Weather condition when field plot was assessed.
- b) 1) cloud free (*heiter*)
- 2) shadow caused by mountain (*Bergschatten*)
- 3) cloudy (*leicht bewoelt*)
- 4) cloudy - overcast (*stark bewoelt*)
- 5) overcast (*bedeckt*)
- 6) fog (*Nebel*)
- 7) rain (*Niederschlag*)
- c) field assessment

Conditions for interpretation (Interpretationsbedingungen)

- a) condition for aerial photointerpretation.
- b) 1) good (*gut*)
- 2) moderate (*mittel*)
- 3) poor (*schlecht*)
- 4) interpreter drunken or doped (*Interpret sturzbesoffen oder zugekifft*)
- c) aerial photography

Interpreters confirmation of forest/non-forest decision (manueller Wald-/Nichtwald-Entscheid)

- a) According to the measurements and interpretation done, a forest/non-forest decision is provided by the measurement program. The interpreter has to accept or to reject the suggestion.
- b) -9) photo-plot outside area that can be interpreted on the stereo model. The photo-plot will be interpreted on an other stereo pair (*Ausserhalb Luftbildinterpretation*)
- 1) reject suggestion (*Verwerfung des Vorschlages*)
- 2) accept suggestion (*Annahme des Vorschlages*)
- c) aerial photography

Location of plot centre (Lage des Probeflaechenzentrums)

- a) The forest limit (line limiting the forest area) follows the largest possible line which connects all trees at the forest edge having a minimum height of 3 m and which are not further apart from each other than 25m. A photo-plot centre situated outside the actual forest area is still considered if the shortest possible connection line from forest limit to forest limit comprising the plot centre measures less than 25 m.
- b) -1) not assigned (*Keine Angabe*)
- 0) outside limiting line (*aussen*)
- 1) inside limiting line (*innen*)
- c) aerial photography

Verification, (Terrestrisch abklaeren ja / nein)

- a) If a forest/non-forest decision cannot be made (see attribute 'Reason for verification (*Abklaerungsgrund*)', field crews have to visit the plot and have to verify the forest/non-forest decision.
- b) 1) verify on ground (*terrestrisch abklaeren ja*)
2) no verification on ground necessary (*terrestrisch abklaeren nein*)
- c) aerial photography

2.1.5. Forest area definition and definition of "other wooded land"

The forest area definition, which is given by the Swiss forestry law, is not applicable for the assessment in the National Forest Survey. Some of the criteria used for the legal definition of forest land cannot be assessed in sample surveys. Due to practical and financial restrictions only a limited set of easy to assess attributes can be utilised to define forest area in a survey. In the Swiss NFI the forest/non-forest decision results for each sample plot from the interpretation of aerial photographs. This approach was chosen in order to reduce the assessment cost in the field phase.

The NFI-definition focuses on the growing stock and applies to measurable criteria (e.g. width of the forest area, crown closure and top height.). These criteria have been defined (Zingg, 1988)³ as follows:

Width (*Breite*) of the growing stock with canopy closure = 100% is at least 25 m and with crown closure = 20% at least 50m. The functional relation between width and canopy closure can be seen in Figure 4.

Canopy closure (*Deckungsgrad*) between 20% and 100% depending on width of the growing stock (see Fig. 4).

Minimum top height (*minimale Oberhöhe*) 3m (exception: afforestations, young growth, mountain alder, mountain pine).

If a sample plot is not visible in the aerial photography due to clouds, shadow etc., the forest/non-forest decision has to be made on the ground. The field crews apply the same criteria as the interpreter of aerial photographs.

³Zing, A., 1988. Schweizerisches Landesforstinventar: Anleitung für die Erstaufnahme 1982-1986, Eidgen. Anstalt Forstl. Versuchswes., Birmensdorf, Bericht Nr. 304, 134 S.

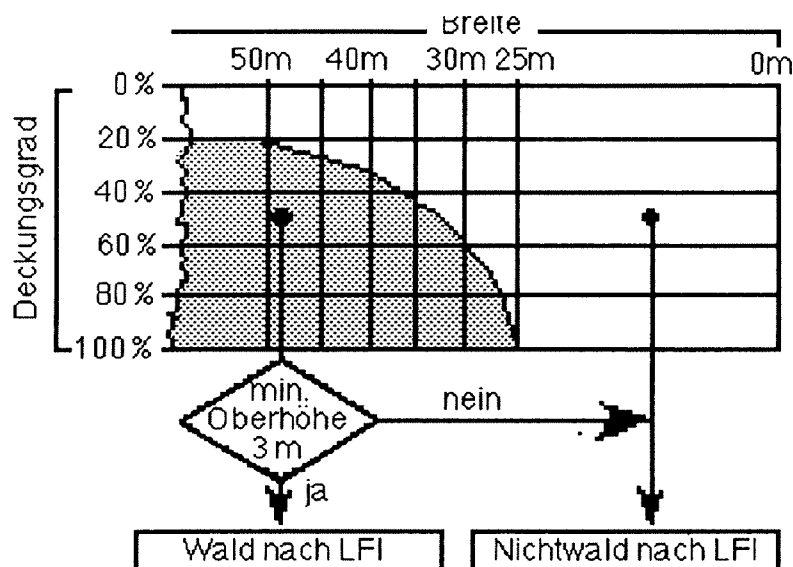


Figure 4. Forest/ non-forest decision in the Swiss NFI.

2.2 DATA SOURCES

The data sources have already been mentioned in chapter 2.1.3 and 2.1.4. In this section the data sources utilised in the forest resource assessments will be specified.

A) field data

The data in the field are assessed by sample plots. The sample plot design is described in detail in Chapter 2.3. No additional field data are assessed.

B) questionnaire

The questionnaire is designed by the National Forest Inventory Department. For each forested plot a questionnaire has to be filled out. The field crews visit local foresters and fill out the questionnaire with their help. Thus non-responses do not occur. A copy of the questionnaire can be found in the field manual (Stierlin et al, 1993)

C) aerial photography

The aerial photographs used in the second NFI are obtained free of charge from the Swiss Federal Office of Topography (L+T) (*Bundesamt für Landestopographie*), Wabern. they have been taken on black-and-white film at a scale of 1:30000 from 1987 to 1993. Two digital plotters (Kern DSR1, Leica DSR 15) are used for the photo interpretation. Roughly 160,000 photo-plots have been interpreted on 3,100 stereo pairs.

D) spaceborne or airborne digital remote sensing

No spaceborne or airborne digital remote sensing techniques have been applied in the Swiss NFI.

E) maps

The following maps are used:

- Topographic map (printed, 1:25000), provided by L+T, map sheets updated and printed between 1984 and 1992.
- Soil suitability map (*Bodeneignungskarte*), University of Berne, Institute of Geography, in map and digital format, Scale 1:200000, from 1980.
- Geotechnical map (*geotechnische Karte*), Geo7, Bern, four sheets, printed in scale 1:200000, from 1963-1967
- Land-use map, Federal Office of Statistics, Department of Area Statistics, Bern, available in digital format with point coverage in 100m resolution, from 1990. From this map various information layers such as land use statistics or density of population are utilised.

F) other geo-referenced data

Digital map of forest roads, compiled by Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf. Forest roads and road types (gravel, paved etc.), which reflects the situation from 1993 to 1995. The use is restricted, available only for Swiss NFI.

2.3 ASSESSMENT TECHNIQUES**2.3.1 Sampling frame**

The sampling frame of the Swiss National Forest Inventory is given by the forest area definition. The entire country is covered by the assessment. However, areas higher than 2,400m are not visited, as they are above the timberline. Some plots (roughly 2 %) are inaccessible due to difficult terrain conditions in the Alps. They are excluded from the assessment.

2.3.2 Sampling units

Field plot

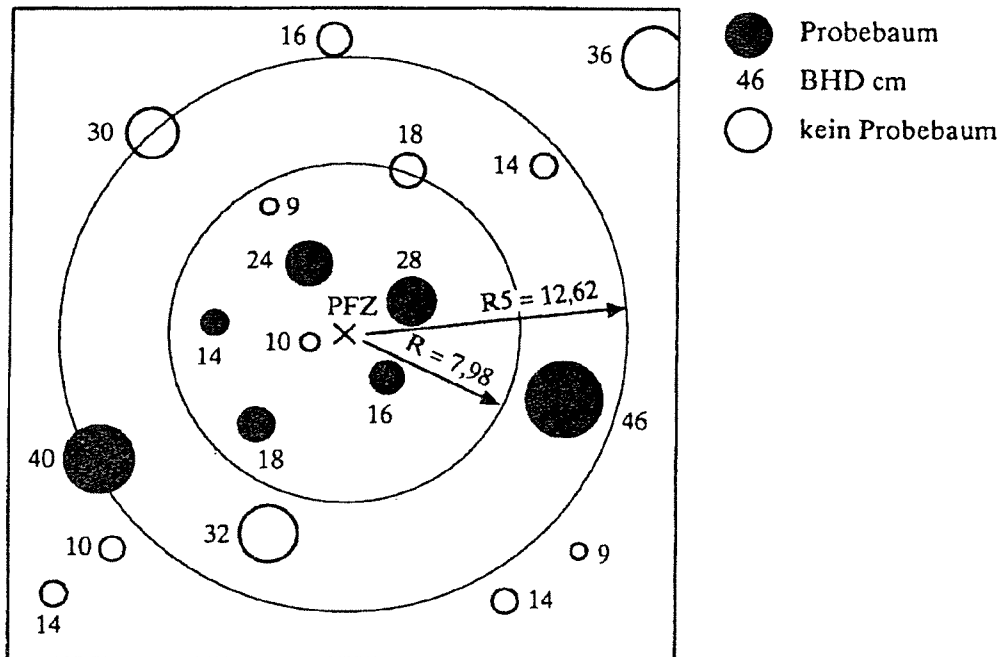


Figure 5. Field plot of the Swiss NFI (Probebaum=sample tree, BHD=d.b.h., kein Probebaum= no sample tree, PFZ= plot centre).

Concentric fixed area, circular plot. Smaller circle of 200 m² for trees with d.b.h. 12cm, and a larger circle of 500 m² for trees with d.b.h. >35cm. The plot-radii are corrected for slope. Interpretation area for area related data of 50*50m. All plots are permanently monumented and azimuth and distance of tallied trees from plot centre are recorded. The plots are systematically distributed in a 1.4*1.4 km grid (permanent plots). 600 additional field plots have been assessed for the first time in the 2nd NFI. They have the same characteristics as the permanent field plots and are distributed in a sub-grid of a 500*500m grid.

Regeneration plots

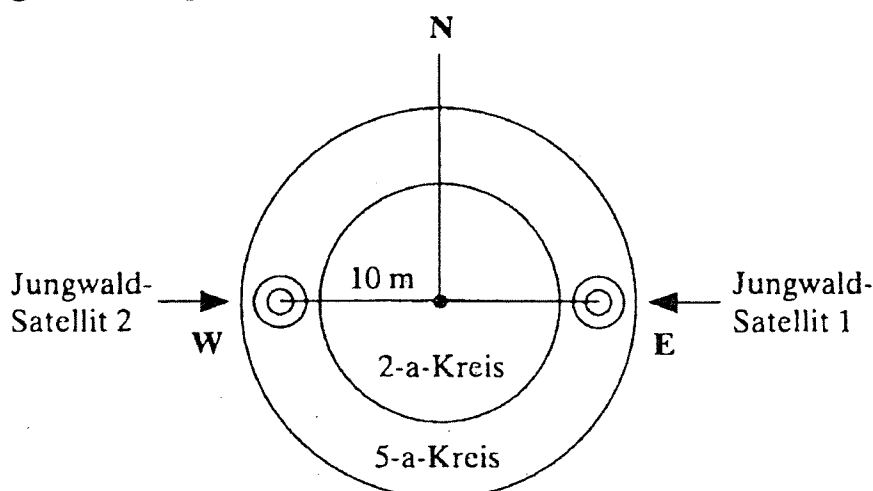


Figure 6. Regeneration plot (Jungwald-Satellit=regeneration plot, Kreis=plot).

Two concentric plots located 10m east and west of field plot centre. The smaller plot has a radius of 1m, the larger plot 2.12m. The radii are corrected for slopes. On the smaller plots all trees between 10 and 39 cm height are assessed, on the larger plots all tree between 40 cm and 130 cm height and 3.9 cm to 11.9 cm d.b.h. respectively.

Aerial photo-plot



Figure 7. Photo sample plot

Squared plot of 25*25m. Corrected for slope. The photo plots are located in a 500*500m grid. Figure 6 shows a photo sample plot, the coordinates of the plot and 3 reference point for field crews, from which they can find the plot centre by surveying.

2.3.3 Sampling designs

The sampling design applied in the second Swiss National Forest Inventory is double-sampling for stratification. In the first phase (assessment level) systematically distributed photo-plots are interpreted, a forest/non-forest decision is taken and strata assigned to the forested photo-plots. In the second phase a smaller, systematically distributed sub-sample of field plots is assessed. Both, permanent plots, which have been assessed in the first and second Swiss NFI, and new plots, which have been assessed only in the second Swiss NFI are assessed. The estimation of current values is based on the permanent and new plots, the estimation of change is based on the permanent plots only.

2.3.4 Techniques and methods for combination of data sources

The attributes assessed in field and photo sample plots are combined by a double sampling for stratification approach. Attributes for stratification are assessed in photo plots and used for estimating the strata sizes. The values of the attributes assessed on field plots are weighted with the strata sizes derived from the photo-interpretation.

Maps are used for the assessment of the accessibility and hauling distances for felled trees. The roads on maps are digitised and the attributes of interest are analysed by means of a GIS. For each plot single attributes like road density, hauling distance etc. are assigned and analysed in the same way as attributes directly assessed on the plot. The same approach is used for the information obtained by questionnaires (e.g. ownership, last management operation, protection status).

2.3.5 Sampling fraction

Table 2. Sampling fraction per data source

Data source and sampling unit	Proportion of forested area covered by sample	Represented mean area per sampling unit
aerial photography, fixed area sample plots	0.01	25 ha
field assessment, permanent fixed area sample plots	0.00025	200 ha
field assessment, new fixed area sample plots	0.000025	≈2000 ha

2.3.6 Temporal Aspects

Table 3. Inventory cycles

Inventory cycle	Time period of data assessment	Publication of results	Time period between assessments	Reference date
1st NFI	1983-1985	1988	-	none
2nd NFI	1993-1995	1997 (expected)	10 years	none

2.3.7 Data capturing techniques in the field

In the first NFI data were recorded on tally sheets and edited by hand into the computer. In the 2nd NFI data are recorded in the field by handheld computer with immediate plausibility check and are transferred to computer via diskette.

2.4 DATA STORAGE AND ANALYSIS

2.4.1 Data storage and ownership

The data of the assessment are stored in a data-base system at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) in Birmensdorf, Switzerland. The person responsible for the data is located in the National Forest Inventory Department (Dr. P. Brassel, NFI, WSL, CH-8903 Birmensdorf, Tel: +41-1-7392238, Fax: +41-1-7392215, email: brassel@wsl.ch). The submission of data and special analyses is laid down in a special regulation. Any publication of special analyses based on NFI-data has to be approved by WSL.

2.4.2 Database system used

The data of the first and second NFI as well as the data of the forest condition survey are stored in an ORACLE data-base. SAS data sets are created for each analysis.

2.4.3 Data bank design (if applicable)

The entity-relationship diagram presents the design of the NFI database (Figure 7).

2.4.4 Update level

For each record the date, when the data have been assessed, is available. The data are not updated to a common point in time and thus reflect the situation at the time of assessment.

Database NFI

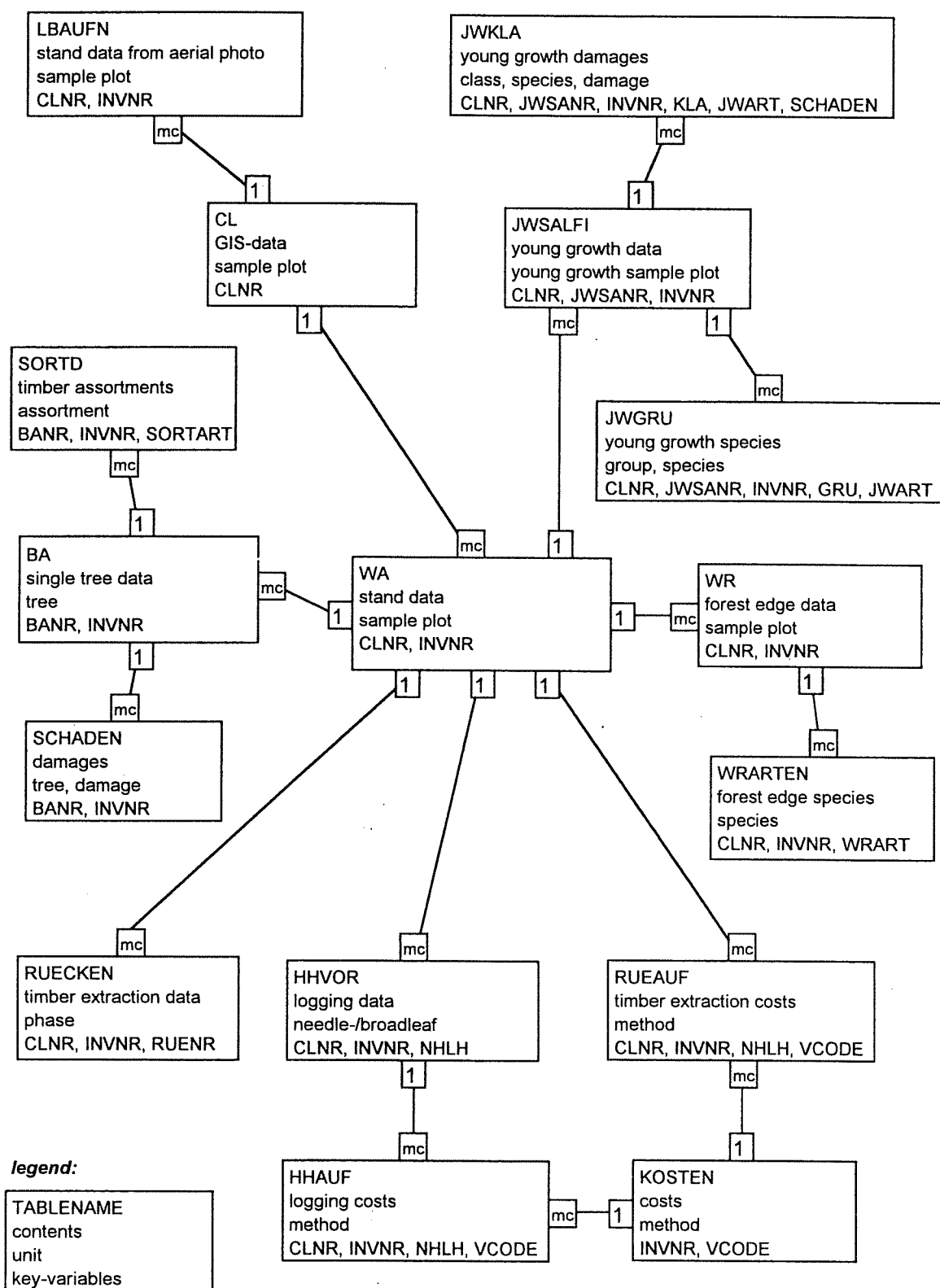


Figure 8. Entity relationship diagram.

2.4.5 Description of statistical procedures used to analyse data Including procedures for sampling error estimation

a) area estimation

The forest area and forest area proportion is assessed on aerial photos. A 500*500m systematic grid is laid over the entire country and for each point a forest/non-forest decision is made. The estimation of the proportion of forested area is done according to Cochran (1977):

$$p = a/n$$

$$v(p) = s_p^2 \quad pq/n$$

$$s_p = \sqrt{v(p)}$$

where

p = proportion of forest land

q = $1-p$ = proportion of non-forested land

$v(p)$ = variance of p

s_p = standard error of p

n = total number of points on the point grid

a = number of forested point on the point grid

The total forested area A_w is estimated by multiplying the total area of the entire country or subunits, A , by the proportion of forested land, p .

$$A_w = n_w a = n_w \frac{A}{n} = Ap$$

with variance $v(A_w)$ and standard errors $s(A_w)$

$$v(A_w) = A^2 s_p^2$$

$$s(A_w) = \sqrt{v(A_w)}$$

b) aggregation of tree and plot data

The aggregation of single tree data is done by weighting each single tree attribute Y_{ij} by

$$w_{ij} = A/a_{ij} = 1\text{ha}/a_{ij}$$

where ij stands for tree i on plot j .

As concentric sample plots are used the weighting factors (plot expansion factors), w_{ij} , have to be different for the 0.05 ha plot and the 0.02 ha plot to reflect the correct selection probability of a single tree. For plots lying entirely in a forested area the weights are constant.

$$w_{ij} = w_{0.05} = A/a = 1\text{ha}/0.05\text{ ha} = 20, \text{ for trees standing on the 0.05 ha plot } i$$

$$w_{ij} = w_{0.02} = A/a = 1\text{ha}/0.02\text{ ha} = 50, \text{ for trees standing on the 0.02 ha plot } i$$

As trees can be assigned to the two concentric plots regarding their d.b.h., the plot expansion factor can be given in relation to the d.b.h. of single trees.

$$w_{ij} = w_{0.05} = A/a = 1\text{ha}/0.05\text{ ha} = 20, \text{ for trees with d.b.h. } > 35\text{cm}$$

$$w_{ij} = w_{0.02} = A/a = 1\text{ha}/0.02\text{ ha} = 50, \text{ for trees with } 12\text{cm} \leq \text{d.b.h.} \leq 35\text{ cm}$$

The plot expansion factor has to be adjusted for plots not lying entirely in the forested area (plots at the forest edge). The procedure is treated below under e. 'Sampling at the forest edge'.

Once the single tree attributes have been related to unit area by multiplication with the plot expansion factor, the total values for plot i, Y_i , can be calculated by summing the individual single tree attributes.

$$Y_i = \sum Y_{ij} w_{ij}$$

c) estimation of total values

The statistical design of the 2nd Swiss NFI can be characterised as double sampling for stratification. The size of the strata is not known, but is estimated by means of aerial photo interpretation. Thus two kinds of sampling error have to be considered: the sampling error due to the estimation of the strata sizes and the sampling error of the attribute of interest.

Under the assumption of known forest area total values \hat{Y}_{ds} are calculated based on the mean values of the plots, $\hat{\bar{Y}}_h$.

$$\hat{\bar{Y}}_{ds} = \sum_{h=1}^L \frac{n_h}{n} \hat{\bar{Y}}_h$$

$$v(\hat{\bar{Y}}_{ds}) = \sum_{h=1}^L \frac{n_h - 1}{n - 1} \frac{n_h}{n} v(\hat{\bar{Y}}_h) + \sum_{h=1}^L \frac{1}{n - 1} \frac{n_h}{n} (\hat{\bar{Y}}_h - \hat{\bar{Y}}_{ds})^2$$

$$\hat{Y}_{ds} = A \hat{\bar{Y}}_{ds}$$

$$v(\hat{Y}_{ds}) = A^2 v(\hat{\bar{Y}}_{ds})$$

where

$$\hat{\bar{Y}}_h = \text{mean value in stratum } h, h=1, \dots, L$$

$$v(\hat{\bar{Y}}_h) = \text{variance of } \hat{\bar{Y}}_h, h=1, \dots, L$$

$$v(\hat{\bar{Y}}_{ds}) = \text{variance of } \hat{\bar{Y}}_{ds}$$

$v(\hat{Y}_{ds})$ = variance of \hat{Y}_{ds}

n'_h = number of photo-plots in stratum h , $h=1, \dots, L$

n' = total number of photo plots = $\sum n'_h$

L = number of strata

A = forest area

The area of the unit of reference (entire country or productive regions (= subunits)) is assumed to be known without error. The strata include not only forest strata but a non-forest stratum as well. On this non-forest stratum the attributes under concern are assigned the value zero. This is necessary as the pre-specified sample size n includes not only forested plots but non-forest plots as well. If the number of forested plots is taken for n , the sample size itself becomes a random variable, which has to be considered in the sampling error calculations. The same holds, if only the number of plots falling into a reference unit of concern is considered.

The same equations are used, if area related attributes have to be analysed. Area related attributes are all attributes on nominal or ordinal scale assessed on the plot level. The attribute used for area estimation is referred X and can obtain two values:

$$X_i = \begin{cases} 1, & \text{if the plot is located in the class under concern} \\ 0, & \text{in all other cases} \end{cases}$$

The area of the attribute under concern, \hat{X}_{ds} , and its variance $v(\hat{X}_{ds})$ are calculated as follows:

$$\hat{X}_{ds} = A \sum_{h=1}^L \frac{n_h}{n} \cdot \hat{X}_h = A \hat{\bar{X}}_{ds}$$

$$v(\hat{X}_{ds}) = A^2 v(\hat{\bar{X}}_{ds})$$

The terms in these two equations are calculated by substituting X for Y in the equations previously presented.

d) estimation of ratios

Ratios are obtained by calculating the ratio of means or total values, \hat{R} .

$$\hat{R} = \frac{\hat{\bar{Y}}}{\hat{\bar{X}}} = \frac{\hat{Y}}{\hat{X}}$$

$$v(\hat{R}) = \hat{R}^2 \left\{ \frac{v(\hat{\bar{X}})}{\hat{\bar{X}}^2} + \frac{v(\hat{\bar{Y}})}{\hat{\bar{Y}}^2} - 2 \frac{S_{YX}}{n \hat{\bar{X}} \hat{\bar{Y}}} \right\}$$

where:

$$\hat{\bar{Y}} = \frac{\sum_{i=1}^n Y_i}{n}$$

$$\hat{Y} = \sum_{i=1}^n Y_i$$

$$\hat{\bar{X}} = \frac{\sum_{i=1}^n X_i}{n}$$

$$\hat{X} = \sum_{i=1}^n X_i$$

s_{YX} = covariance term

n = number of observations

For the double-sampling design applied in the Swiss NFI mean values and total values are calculated using double sampling for stratification estimators and by applying a combined ratio estimator, \hat{R}_{ds} , with variance $v(\hat{R}_{ds})$. \hat{X}_{ds} , $\hat{\bar{X}}_{ds}$ and $v(\hat{\bar{X}}_{ds})$ are calculated analogue to \hat{Y}_{ds} , $\hat{\bar{Y}}_{ds}$ and $v(\hat{\bar{Y}}_{ds})$.

$$\hat{R}_{ds} = \frac{\hat{Y}_{ds}}{\hat{X}_{ds}} = \frac{\hat{\bar{Y}}_{ds}}{\hat{\bar{X}}_{ds}}$$

$$v(\hat{R}_{ds}) = \hat{R}_{ds}^2 \left\{ \frac{v(\hat{\bar{X}}_{ds})}{\hat{\bar{X}}_{ds}^2} + \frac{v(\hat{\bar{Y}}_{ds})}{\hat{\bar{Y}}_{ds}^2} - 2 \frac{S_{YXds}}{n \hat{\bar{X}}_{ds} \hat{\bar{Y}}_{ds}} \right\}$$

e) sampling at the forest edge

As mentioned under b) 'aggregation of tree and plot data', the plot expansion factor has to be adjusted for plots that do not fall entirely into forests, but extend partially into non forested areas. The selection probability of a single tree, p_i , has to be taken into account for the estimation process. In the Swiss NFI a tree concentric method is applied, by adjusting the plot expansion factor, w_{ij} , for each tree tallied on a plot at the forest margin.

f) estimation of growth and growth components (mortality, cut, ingrowth)

The growth of a forest stand is made up of the components survivor growth, ingrowth, mortality and cut. Ingrowth is the number or volume of trees periodically growing into measurable size, mortality is the number or volume of trees periodically dying from natural causes, cut is the volume or number of trees felled between two occasions, and survivor growth is the growth related to trees observed at the first and ongoing occasions.

For each tree growth is calculated by means of growth functions. Tree species and d.b.h. at the second measurement occasion are among the input variables for the growth functions. The functions have been derived separately for productive regions, altitude classes, etc. Using the diameter of the most recent (second) measurement means that growth is backdated. For ingrowth only half of the value obtained by the growth function is assigned as single tree value. For mortality and cut the diameter of the measurement taken in the first NFI is taken as input. As the exact date of death or cut for single trees is not known, growth is not estimated for the whole period between two inventory cycles, but only for half of the period, assuming that by this procedure the mean growth of mortality and cut is estimated correctly. As growth figures are obtained as single tree attributes, the equations described under b to e can be applied.

In the Swiss NFI different growth terms will be reported. Successive tree volumes are paired to determine the growth contribution of each tree. This approach is widely known as the tree level approach. Although the equations presented stress volume growth, the terms are equally appropriate if another characteristic such as basal area growth is considered.

- V_1 = volume of trees measured on the first occasion
- V_2 = volume of trees measured on the second occasion
- V_{s1} = initial volume of survivor trees
- V_{s2} = final volume of survivor trees
- G_s = survivor growth
- M = initial volume of trees dying in between two inventories
- C = initial volume of trees cut in between two inventories
- I = volume of trees at the second inventory that were below the measurable size on the first occasion

Table 8. Equations for growth estimation (after Beers, 1962).

Type of growth	Individual tree growth figures
Gross growth of initial volume	$=V_{s2} + I + M + C - I - V_{s1} - M - C$ $=V_{s2} - V_{s1} = G_s$
Gross growth	$=V_{s2} + I + M + C - V_{s1} - M - C = G_s + I$
Net growth of initial volume	$=V_{s2} + M + C - I - V_{s1} - M - C$ $=G_s - M$
Net growth	$=V_{s2} + M + C - V_{s1} - M - C$ $=G_s + I - M$
Net increase	$=V_{s2} + I - V_{s1} - M - C$ $=G_s + I - M - C$

g) allocation of stand and area related data to single sample plots/sample points.

The class of categorical, area related attributes, in which the plot centre is located, is assigned to the entire plot. The only exception occurs for plots at the forest margin, where the exact plot area located within the forest is reported.

h) Hierarchy of analysis: how are subunits treated?

In the Swiss NFI results have to be calculated for five productive regions (Jura, Plateau Region, Pre-Alps, Alps and Southern Slopes of the Alps) and the entire country. As a first step the results are calculated for the productive regions, and afterwards summed up for the entire country. This is done for metric attributes as well as for categorical (area related) attributes.

$$\hat{Y}_{CH} = \sum_{k=1}^5 \hat{Y}_k$$

$$\hat{X}_{CH} = \sum_{k=1}^5 \hat{X}_k$$

where \hat{Y}_k and \hat{X}_k are double-sampling estimators. As this is the sum of random variables, the variance of the total values is obtained by

$$v(\hat{Y}_{CH}) = \sum_{k=1}^5 v(\hat{Y}_k) = \sum_{k=1}^5 A_k^2 v(\hat{Y}_k)$$

$$v(\hat{X}_{CH}) = \sum_{k=1}^5 v(\hat{X}_k) = \sum_{k=1}^5 A_k^2 v(\hat{X}_k)$$

Ratios are calculated using the following equations:

$$\hat{R}_{CH} = \frac{\hat{Y}_{CH}}{\hat{X}_{CH}}$$

$$v(\hat{R}_{CH}) = \frac{v(\hat{Y}_{CH}) + \hat{R}_{CH}^2 v(\hat{X}_{CH}) - 2 \hat{R}_{CH} s_{YXCH} / n}{\hat{X}_{CH}^2}$$

where

$$s_{YXCH} = \sum_{k=1}^5 A_k^2 s_{YXk}$$

2.4.6 Software applied

The analysis software is based on the SAS-system products Base-SAS, SAS-Access, SAS-Stat and SAS-Graphics. The SAS-procedure 'proc sql' is used to extract data from the Oracle-data base and to built up SAS data files. The SAS data files are used for further calculations according to the procedures described in section 2.4.5. and 2.4.6. A user interface based on SAS-AF has been developed and is used for the data evaluation.

2.4.7 Hardware applied

'Paravant' hand-held computers (DOS) were used for data acquisition in the field. The Oracle database is installed on a SUN-Server running under UNIX. The analysis is done on SUN SPARC 20 workstations running under UNIX as well.

2.4.8 Availability of data (raw and aggregated data)

All raw data and derived attributes stored in the database are available on request for external users as long as the purpose for which the data will be used is clearly declared. However, data on ownership is restricted by law. The exchange of data is defined in a special regulation available from the Swiss Federal Institute for Forest, Snow and Landscape Research. Users have to pay for data extraction and preliminary analysis. Analysis on special requests are possible, but WSL reserves all rights to reject any request for analysis. WSL is linked to Internet, which may be used for data exchange. It is also possible to submit data on disc.

2.4.9 Subunits (strata) available

Results are available for entire Switzerland and for the five productive regions Jura, Plateau Region, Pre-Alps, Alps and Southern slopes of the Alps. In addition results for individual cantons (federal states), communities and forest districts can be provided as well as analyses for arbitrarily delineated geographical regions.

2.4.10 Links to other information sources

This section relates to other sources from which information is obtained, but not to organisations or institutions which are provided with data and results. The type of data and the institution providing the data are listed in tabular form. The list is strictly related to data sources actually used in the survey.

Topic and spatial structure	age/period availability	Responsible agency	Kind of data-set
map of natural hazards Switzerland	since 1962 available	BUWAL Eidgen. Forstdirektion. Tel. 031-677778	map, pre-processed data
geological atlas for Switzerland Switzerland, Regions	since 1930 1:25000 available	BUWAL Abt. Geologie Tel. 031-677771	map, pre-processed data interpretation
geological and hydrological maps Switzerland	limited data-set available	BUWAL Tel. 031-677758	map
water balance of large areas Switzerland	1901-1980 monthly/yearly available	BUWAL Abt. Hydrologie Tel. 031-677758	map, pre-processed data interpretation
hydrological atlas for Switzerland: snow cover and glaciers Switzerland	since 1990 monthly/yearly available	BUWAL Abt. Hydrologie Tel. 031-677758	map, table, pre-processed data interpretation
mean annual rainfall 1951-1980 Switzerland	1951-1980 monthly/yearly available	BUWAL Abt. Hydrologie Tel. 031-677758	map, pre-processed data interpretation

Topic and spatial structure	age/period availability	Responsible agency	Kind of data-set
annual rainfall (measurement) stations Switzerland	since 1989 monthly/yearly available	BUWAL Abt. Hydrologie Tel. 031-677758	map, table pre-processed data interpretation
forest statistics Switzerland, Cantons forest regions	since 1975 monthly/yearly limited	BFS Abt. Raumwirtschaft Tel. 031-618656	map, tables, data-file
natural forest vegetation (simulated) Switzerland	since 1992 permanent available	WSL Landschaftsentw. Tel. 01-7392366	map, pre-processed data, GIS (ARC/INFO)
distribution of rainfall Switzerland, Cantons Regions, Communities	1930-1960 available	WSL Landschaftsentw. Tel. 01-7392366	map, pre-processed data, GIS (ARC/INFO)
plant-sociology and ecology map for Switzerland Switzerland (km-grid)	1980 available	WSL Landschaftsentw. Tel. 01-7392465	data-file, pre-processed data, GIS (ARC/INFO)
digital terrain model Switzerland (25m grid)	1994 available	L+T Landvermessung Tel. 031-9632111	data-file
digital map data-sets in vector format Switzerland, Cantons Regions, Communities	since 1990 permanent update available	L+T Landvermessung Tel. 031-9632111	data-file, pre-processed data

Topic and spatial structure	age/period availability	Responsible agency	Kind of data-set
intensity of recreation in forests Switzerland, Regions	1980-2000	ETH H�nggerberg FB Landschaft Tel. 01-3772982	map, pre-processed data interpretation

BFS: Bundesamt f r Statistik, Bollwerk 27, 3003 Bern,

BUWAL: Bundesamt f r Umwelt, Wald und Landschaft, 3003 Bern

L+T: Bundesamt f r Landestopographie, Seftigenstr. 264, 3084 Wabern

WSL: Eidgen. Forschungsanstalt f r Wald, Schnee und Landschaft, 8903 Birmensdorf,

2.5 RELIABILITY OF DATA

Data quality and reliability of data have been a major issue in the Swiss NFI. Several investigations have been undertaken to validate the reliability of data. The studies cover the quality of data assessed in the field, the validity of models and the combination of different sampling and non-sampling errors in an error budget. Besides intensive training check assessments are regularly conducted to guarantee high data quality.

2.5.1 Check assessments

a) The way how check assessments are organised and carried out

Field plots

5-8% of the field plots are visited a second time by check crews. The check crew is a well trained and experienced crew, mainly dealing with check assessments, but not regular field work. The field plots to be checked are randomly selected from the list of already assessed plots. All attributes are assessed a second time independently from the assessment of the regular field crews, i.e., no data recorded by the field crews are available for the check crews. The measurement procedures for locating the plot centre are not repeated. For each field crew an identical proportion of plots is checked. The field crews do not know in advance, which plots will be checked. The check crews visit the plots after the field crews have assessed them. The organisation and the analysis of the check assessments is done at the main office.

Photo-interpretation

1-2 % of the sample photo-plots are interpreted a second time. Due to the high workload by orienting the stereo models, not single photo-plots but groups of plots (plots on the same sheet of the topographic map) are selected. These plots are interpreted by all photo-interpreters. As the photo-plots are selected after they had been interpreted for the first time in the regular assessment and as photo-plots

interpreted by different photo-interpreters are selected, it is possible to quantify the accuracy of each photo interpreter.

Part of the photo-interpretation work is done by an external company. The proportion of plots checked is higher for these plots.

Questionnaire

No check assessments are conducted.

Maps

New forest roads are digitised especially for the NFI. For a part of the map sheets the accuracy of the newly digitised roads is checked.

Analysis of check assessments

All data assessed by both field crews and check crews are analysed. For measured variables the mean difference deviation between field and individual check crews and its standard deviation is calculated and visually represented in graphs. Attributes on nominal or ordinal scale are presented in contingency tables with the classes for field crews and check crews as rows and columns, respectively.

b) Use of the results of check assessments in the inventory system

The check assessments are used for the following purposes:

- feedback to field crews to improve the data quality
- revision of the assessment instructions
- interpretation of inventory results
- the results will not be used to set up error budgets and to quantify the total error
- if the field crews and the check crews differ by 10% for measurable attributes and by more than two classes for attributes on nominal or ordinal scale the results of the check crews instead of the field crews are used for further analysis
- the results will not be used to correct any raw data or results.

2.5.2 Error budgets

Due to the estimation process in sample based surveys and the possibilities to commit errors in the assessment of data the results of forest resource assessments are subject to different kinds of errors. In the Swiss NFI sampling errors are presented for each estimate using the procedures described in Chapter 2.4. In the second NFI the sampling errors will be used to calculate 95%-confidence intervals, which render the interpretation of the precision of parameter estimates more easy.

In a special investigation some non-sampling errors, such as measurement errors, prediction errors, grouping errors or other non-statistical errors have been quantified and summarised in an error budget (see Gertner and Köhl, 1993)⁴. An error budget will not be included in the final publication of the second NFI, but will be subject of a separate study.

⁴Gertner, G., Köhl, M., 1992. An Assessment of Some Non-sampling Errors in a National Survey Using an Error Budget, Forest Science, Vol.38, No.3: 525-538

2.5.3 Procedures for consistency checks of data

Data assessed in the field

The data are directly put into a hand-held computer on the field plot. After editing the data a first consistency check is done, using data from the first assessment and cross-checks of different attributes for plausibility tests. When the data are loaded in the data base, a second, more intensive check is conducted. Of special interest in this phase is the assignment of tree numbers, which allow to combine information from different assessments for individual trees.

Data assessed on photo-plots

The data are immediately checked with data from previous assessments and via cross-checks. No additional check is conducted, when the data are stored in the database.

Questionnaire

No checks.

Before the data in the database are released for analysis, cross checks based on attribute inputs from different data sources are conducted. Any inconsistency is printed out and has to be checked manually.

2.6 MODELS

2.6.1 Volume

a) outline of the models

In Swiss NFI, d.b.h is measured from all sample trees. In the second NFI, a subsample of 18% of the inventory trees, the so called tariff trees, has been selected with probability proportional to $d.b.h^2$ for measuring of d7 (diameter at 7m height) and h (tree height). In the first NFI, a proportion of 35% of the trees has been selected as tariff trees.

Bole volumes with bark of the tariff trees are estimated as a function of d.b.h, d7 and h. Nine volume functions have been developed for the main species. The augmentation of precision would be neglectable, when separate functions for different geographical regions would have been derived. Based on the tariff volumes, 30 tariff functions have been constructed for all main species or species groups in the five productive regions of Switzerland. Beside d.b.h., site index, d_{dom} , height above sea level, bifurcation of bole are input variables. With the same set of explanatory variables, bole volume, d7 and tree height of each tree are estimated. With the same input variables, but with the crown length as an additional parameter, volumes of branches (diameter 7 cm) and twigs (diameter < 7 cm) as well as dry weight of foliar biomass are estimated.

b) overview of prediction errors

A single tree volume with a function of the form $v=f(d.b.h,d7,h)$ can be estimated with a precision of 7-10% (standard deviation of the residuals in % of the mean). The precisions of the tariff functions range from 20% to 30%. Functions for branches, twigs and foliar biomass are being elaborated. Thus, precision of these functions are not yet known.

c) data material for model derivation

About 38,500 single tree measurements (2m sections) from growth and yield research plots are available to derive volume functions. Because these sample trees do not cover the whole range of observed tree shapes in NFI, about 500 additional trees of the upper diameter classes and with extremely high or extremely low form quotients have been measured on NFI plots. About 40,000 tariff trees have been measured for d7 and h in the first NFI and about 12,000 trees in the second NFI to derive tariff functions.

d) model validation

Models have been validated by cross validation, by estimating volumes of independent data sets, by comparing estimates with volumes that have been predicted with volume functions of other countries, by comparing volume estimates with volumes of geometric solids. Sensitivity analysis have been performed in order to test the influences of measurement errors or unusual tree shapes on volume estimates.

2.6.2 Assortments

In order to estimate volumes of merchantable pieces of a bole, taper functions have been developed with the same data set that has been used to construct volume functions. Stem forms are described in dependency of d.b.h, d7 and h. For trees without d7- and h- measurements, estimated d7 and h are used instead of measured values. The taper functions predict single tree volume with the same precision as the volume functions. All estimated stem curves are monotonously decreasing from the bottom to the top of a tree. Thickness of bark is estimated by bark models with tree species and mean diameter of an assortment as input variables.

Assortment tariffs are also available. With these tariffs, average volume proportions of merchantable pieces are estimated in dependency of d.b.h, tree species and geographical region. These tariff are not suitable to estimate volume proportions of single trees, they estimate average proportions of pieces for a set of trees in the same region with the same d.b.h. .

2.6.3 Growth components

NFI sample plots consist of two concentric circles. In one of the circles, only trees with $d.b.h > 35$ cm are registered. Thus, there is a calliper threshold at 35 cm d.b.h.,

and in successive inventories, the increment of ongrowth trees, that have not been registered in a former inventory, but actually having a d.b.h. of > 35 cm, has to be estimated with growth functions.

Growth of basal area and volume of a single tree is estimated using site index, total basal area of trees on a plot, basal area of all trees on a plot larger than the actually considered tree and the stand age as input variables. The precision of these functions is low, due to the considerable amount of measurement errors compared with the real increment in 10 years. This is true especially in alpine regions. Standard deviations of residuals of basal area increment estimates for the species spruce e.g. are about 40% of the mean increment of 10 years in flat regions, 50% in mountainous regions and 60% in alpine regions. The corresponding precision of volume increment estimates are 50%, 65% and 85% of the mean volume increment.

Stand age is an explanatory variable in the growth functions. The age of stumps has been recorded by the field crews on NFI sample plots in even aged stands. After two inventories, a relatively reliable stand age is known from a quarter of all plots in evenaged stands. Age models have been constructed with these plot information. The models predict a stand age with auxiliary variables such as average single tree volume, height above sea level, site index, d_{dom} . The models allow only a rough estimate of stand age. With standard deviations of the residuals in the magnitude of 30% of the mean, less than 50% of the variation can be explained by the models.

2.7 INVENTORY REPORTS

2.7.1 List of published reports and media for dissemination of inventory results

Table 4. Inventory reports

Inventory	Year of publication	Citation	Language	Dissemination
First Swiss NFI	1988	EAFV, 1988: Schweizerisches Landesforstinventar: Ergebnisse der Erstaufnahme 1982-1986. Eidgen. Anst. Forstl. Versuchswes., Bericht Nr. 305, 375 p.	German	printed
First Swiss NFI	1990	EAFV, 1990: Inventaire forestier national suisse: résultats du premier inventaire 1982-1986, Institut fédéral de recherches forestières, Bericht Nr. 305, 375 p.	French	printed
First Swiss NFI	1989	OFEFP and D+F, 1989: La forêt suisse aujourd'hui - une interprétation de politique forestière de l'inventaire forestier nationale suisse, Office fédérale de l'environnement, des forêts et du paysage (OFEFP) and Direction fédérale des forêts (D+F), Bern, 46 p.	French, also available in German and Italian	printed

2.7.2 List of contents of latest report and update level

Reference of latest report:

EAFV, 1988. Schweizerisches Landesforstinventar: Ergebnisse der Erstaufnahme 1982-1986. Eidgen. Anst. Forstl. Versuchswes., Bericht Nr. 305, 375 p. and

EAFV, 1990. Inventaire forestier national suisse: résultats du premier inventaire 1982-1986, Institut fédéral de recherches forestières, Bericht Nr. 305. 375 p. (same content but different languages).

Update level of inventory data used in this report:

Field data and questionnaire: 1982-1986

Aerial photography: 1979-1984

Content:

The content of the inventory report is presented in Table 5 based on the German publication. For the French version the page numbers are slightly different.

Table 5. Content of inventory report.

Chapter	Title	Number of pages
1	Introduction	4
2	Methods of data assessment and data analysis	8
3	Units of reference	9
4	Forest area and ownership	10
5	Standing volume	18
6	Forest sites	15
7	Forest structure	84
8	Regeneration	37
9	Forest condition	68
10	Accessibility and harvesting	41

2.7.3 Users of the results

A special assessment of information needs was conducted. 211 questionnaires have been sent out to research institutes, political administrations, environmental groups, foresters' schools and others. The users' needs for specific topics have been reported as follows. The percentages given reflect the proportion of users interested in the information provided in the specific field.

Methods of data assessment and data analysis	32%
Units of reference	46%
Forest area and ownership	56%
Standing volume	61%
Forest sites	66%
Forest structure	74%
Regeneration	63%
Forest condition	69%
Accessibility and harvesting	54%
Summary of important figures	79%

An assessment of special analyses by user groups has been conducted additionally. The percentage of number of special requests by user groups and by topics are as follows.

Special requests by institutions:⁵

Cantonal administrations	39%
Research institutions	34%
Federal administrations	7%
Associations	5%
Foreign countries	5%

Special requests by topics:

Forest structure	49%
Timber volume	47%
Forested area	44%
Forest site	32%
Forest condition	21%
Accessibility and harvesting	16%
Regeneration	10%
Potential yield	<10%

⁵Percentages give relative number of request out of total number of requests

2.8 FUTURE DEVELOPMENT AND IMPROVEMENT PLANS

2.8.1 Next inventory period

The data assessments (field assessment, aerial photo interpretation, enquiry) for the third Swiss NFI are planned to be conducted between 2003 and 2005. The analyses of the results and the preparation of the result publication are expected to be finished in 2007, the publication of the results of the 3rd Swiss NFI will be available in 2008.

2.8.2 Expected or planned changes

2.8.2.1 Nomenclature

Additional attributes focusing on the assessment of non-wood goods and services, especially protective function, forest diversity issues and nature protection, will be included.

2.8.2.2 Data sources

The data sources of the first and second NFI will be maintained. In addition other geo-referenced data will be analysed by means of a GIS. Satellite imagery might be used in addition to aerial photography.

2.8.2.3 Assessment techniques

The interpretation of aerial photographs by analytical instruments is likely to be replaced by digital photogrammetry. The location of plot centres might be done by GPS (global positioning system).

2.8.2.4 Data storage and analysis

The analyses of the data will be based on a software system such as SAS. A conventional data base system will be applied for data storage. An interactive analysis system is planned, which could be used from cantonal services and others from outside the institute.

2.8.2.5 Reliability of data

The past experience has shown that data quality is heavily depending on the training of crews. In the third NFI the training programme of field crews and photo-interpreters will be intensified. As in the first and second NFI training workshops held at regular intervals during the assessment period will supplement the initial training. Field crews and photo-interpreters will have to pass a test before they are permitted to work in the regular assessments. The system of check assessments will be maintained.

New attributes will be tested in a pilot survey before they are included in the regular assessment. The careful analysis of the check assessments of the second NFI will be utilised to improve the definitions and the measurement rules of attributes for the next assessment period.

2.8.2.6 Models

Additional model for the quantification of biodiversity, biomass, naturalness, carbon cycle, habitat classification and others will be included

2.8.2.7 Inventory reports

The inventory reports will be published in printed version both in French and in German. In addition the dissemination by electronic media (CD-Rom, WWW etc.) might be realised.

2.8.2.8 Other forestry data

The integration of other national data on forestry and the NFI is planned to set up a Swiss Forestry Information System.

2.9 MISCELLANEOUS

Additional modules will be included in the 3rd NFI. At the moment projects concerning a soil survey, ground vegetation, wildlife and biodiversity are evaluated.

The methodology of the second Swiss NFI is provided for cantonal and regional surveys. The WSL provides assistance in planning the surveys, optimising the design, training the field crews and in the storage and analysis of the data.

Price (excluding VAT) in Luxembourg: ECU 98.50

ISBN 92-827-9848-8



OFFICE FOR OFFICIAL PUBLICATIONS
OF THE EUROPEAN COMMUNITIES

L-2985 Luxembourg



This document has been prepared for use within the Commission. It does not necessarily represent the Commission's official position.

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>)

Cataloguing data can be found at the end of this publication

Luxembourg: Office for Official Publications of the European Communities, 1997

Vol. 2: ISBN 92-827-9848-8

Vol. 1 + 2: ISBN 92-827-9846-1

© European Communities, 1997

Reproduction is authorized, except for commercial purposes, provided the source is acknowledged

Printed in Belgium