The Dutch forest reserves network

Documentation of monitoring design and databases

R.J. Bijlsma & A.P.P.M. Clerkx

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The Dutch forest reserves network was officially created by the Ministry of Agriculture and Fisheries (now Agriculture, Nature and Food Quality) in 1987. A total of 60 forest reserves were designated for inclusion in the network between 1983 and 2000. In 2018, one reserve was excluded from the network. Firstly, this report presents general information on the distribution, area, ownership, physical geography, woodland types, Natura 2000 woodland habitat types, and the management history of the reserves. After this, the monitoring design is described, which includes measurements taken from trees, and regeneration, in circular sample plots throughout the reserves, and in a one hectare rectangular core area in each reserve. The structure of the Access-database of tree measurements is presented, and all tables documented. An overview is given of GIS files at the network- and reserve levels, and of GIS files derived from tree measurements in core areas. All these data are available from the Data Archiving and Networked Services (DANS) portal.

Keywords: forest reserve monitoring database non-intervention dynamics

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Preface

The Netherlands no longer has any virgin forests. The small and scattered remaining 'ancient woodlands' have a long history of harvesting, mostly as coppice woods, more rarely as high forest. In the 19th Century, reforestation of degraded woodland by private owners was followed by large-scale heathland- and drift-sand afforestations, which continued until the 1960s. All these efforts resulted in the 11% national forest cover of the Netherlands of nowadays (Schelhaas et al., 2014) that includes a high proportion of plantation forest.

In the 1980s, increasing awareness of the importance of natural processes (natural regeneration, gap dynamics, dead wood, and wildlife) for forestry and nature conservation made knowledge gaps regarding the potential role of these processes in Dutch forests apparent. The instalment of a national forest reserve programme was intended to fill these gaps. Between 1983 and 2000, 60 reserves were designated, representing all major forest types. An accompanying monitoring programme, which was active up until 2010, resulted in many valuable data at several spatial levels.

The objective of this report is to describe and document the monitoring design and corresponding database of Dutch forest reserves. At the same time, all these data have been made available online.

We thank Henk Koop, Erwin Al and Jan den Ouden for their comments and long involvement in the designation and study of Dutch forest reserves. We acknowledge the support by Hilda van der Pol and Shauna Ni Fhlaithearta in making the data online available through the DANS portal.

1 Introduction

1.1 Historical background

In 1987, the Dutch Ministry of Agriculture and Fisheries (now Agriculture, Nature and Food Quality) officially installed a network of forest reserves to enlarge the knowledge of natural woodland processes in order to support forest management and policy (Broekmeyer & Hilgen, 1991). This decision was the result of an ongoing public discussion about the impoverished 'naturalness' of Dutch forests, including their wildlife. The need for a more nature-based forest management became apparent in the early 1970s, when large areas of plantation forests were blown down. This highlighted the vulnerability of these highly artificial forests. At that time, knowledge of the potential of natural regeneration and the role of dead wood in Dutch forest ecosystems was not widely available or acknowledged.

The Dutch Forest Reserves programme started in 1983, when the first five reserves were designated. Criteria for the selection of reserves were; forest type, site type and forest history. The network represents all major forest types and site types in the Netherlands (Broekmeyer & Szabo, 1993; Bijlsma, 2008). After the designation, all forest management measures were abandoned (see next paragraph). The forest reserve network comprises of not only native woodland, but also (former) plantation forests with Scots pine, Douglas fir and larch, as well and even stands dominated by the invasive exotic *Prunus serotina*. One reserve is situated in a park on the outskirts of Amsterdam.

A total of 60 forest reserves were designated and investigated at least once in the period 1983-2000. A second, and in some cases a third, inventory was carried out in 25 forest reserves, 10-15 years after the first inventory. In 2018, one reserve was excluded from the network.

1.2 Management and research

Non-intervention management
For each reserve, a letter of agreement was signed by the forest owner and the Dutch Ministry, after designation. In 2018, these letters were updated and adjusted when deemed necessary by Wageningen Environmental Research. It was agreed that management in the forest reserves would stop after designation. No cutting or planting takes place in the forest reserves, and invasive plant species are not to be removed unless this is explicitly included in the letter of agreement. Extensively used (foot)paths have frequently been closed. Tree-maintenance along regularly used paths and roads is allowed for the safety of visitors. Although most reserves are open to the public, recreational activities are banned from the forest reserves. Only hiking on existing paths and roads is allowed, new tracks may not be constructed. No special attention is drawn to the sites through the use of information signs.

Research programme
The forest reserves are used for research and education. Until 2010, the research involved a monitoring programme divided into: 1) a start-up programme executed shortly after designation and eventual 'introductory management' (see § 2.4) of a reserve; and 2) a basic programme to monitor the development of forest structure and dynamics, and the vegetation (Stuurman & Clement, 1993). The start-up programme included aerial photography, soil mapping, documentation of forest history and an initial inventory of the forest structure and vegetation. The start-up programme was implemented for all 60 forest reserves. It was intended that the basic programme should be repeated every 10 years. Indeed, the first forest reserves were monitored twice, and sometimes three times, on a ten-year basis. Funding of the basic programme was stopped in 2010. This means that the basic programme has not yet been applied on a number of reserves. Nowadays, monitoring continues to occur, but on a project basis, and as part of educational programmes. Annex 1 provides an overview of the years of inventory completed for each forest reserve.

The research programme was created and further developed in an international context. The monitoring design using 'core areas' (see § 3.3) was introduced by Koop (1981) in Hasbruch and Neuenburg (DE), and applied in several other iconic forest reserves: Bialowieza (PL), Fontainebleau and Ile de Rhinau (FR) and the New Forest (UK) (Koop, 1989; Koop & Bijlsma, 2006). The monitoring of these plots was included as part of the Dutch research programme up until 2010. Methodology, experience and results were exchanged within COST action E4 Forest Reserves Research Network (FR-NET) (Broekmeyer et al., 1993). Research in Dutch forest reserves contributed to several EU-projects in successive Framework Programmes (e.g. NatMan, DynaBeech, EFORWOOD, ADAM), as well as to other COST actions and international studies (e.g. on Prunus serotina-dynamics; Vanhellemont, 2009).

Despite the current, irregular monitoring, the scientific value of the entire network remains high, and even increases, due to ongoing natural development beyond stages considered as mature in forestry.

1.3 Outline of this report and further reading

Chapter 2 presents the network of the 60 forest reserves and describes general features and some statistics, such as area, ownership, forest type, and Natura 2000 woodland habitat type.

In Chapter 3, the monitoring design is described for different spatial levels (e.g. reserves, plots, trees).

The Access-database with all measurements on forest structure is documented in Chapter 4. The GIS database contains maps of features of the forest reserves, and is described in a separate paragraph. This chapter also presents examples of maps of forest structure, such as crown-projections and lying dead wood, derived from primary tree measurements in the Access-database, and that can be used for the analysis of forest structure development.

Chapter 5 provides a concise documentation of the online data set (DANS).

Note that the vegetation monitoring and corresponding database (maps and relevés) are not described in this report and are not part of the online data.

More information about the forest reserves, including references to reports and other publications can be found on the Dutch forest reserves website: http://www.bosreservaten.wur.nl.

2 The forest reserves network

2.1 Objectives of the research programme

Dutch forest reserves are intended for research and education. The main objective is to improve the understanding of natural processes in Dutch forest ecosystems by means of research and monitoring. This means that the programme should contribute to:

- understanding of the woody natural succession in major Dutch forest ecosystems regarding e.g. species composition, regeneration potential, mortality rates, and dead wood volumes;
- providing guidance for management of different forest ecosystems based on, or including, natural processes;
- bridging different fields of forest research, such as historical ecology (land use) regarding actual species composition and direction of succession, or research on humus profile development, as related to woodland and mycoflora succession.

The network of forest reserves provides important data and insights for policymakers in the field of climate change, carbon sequestration and Natura 2000, and serves educational purposes for students, researchers, forest managers and the public.

Some features of the forest reserve network are described in the next two paragraphs, based upon information in the online data set (tblReserveGeneral; § 4.1.1).

2.2 Distribution, area and ownership

The location of the 60 forest reserves is shown in Figure 2.1. The corresponding names are given in Table 2.1. In order to provide references for natural woodland in the Netherlands, several plots (core areas) in near-natural forests in Europe have also been monitored (see § 1.2).

The network grew to its final size between 1983 and 2000. During the first decade, the average size of the forest reserves was 31 hectares (ha). After 1995, the willingness to participate in the programme raised drastically, probably due to a changing vision regarding nature-oriented forest management. The average size of the youngest forest reserves doubled to 70 ha. The smallest forest reserve measures 4.4 ha (no 42 Bekendelle) and the largest 323 ha (no 37 Slikken van Flakkee). The overall average size is 44.2 ha. The size distribution is shown in Figure 2.2. The total area of the Dutch forest reserves is 2649.6 ha (2598.2 ha, without Leyduin-Vinkenduin[1]).

Up until 1995, all forest reserves were owned by Staatsbosbeheer (State Forest Service), with the exception of Roodaam (20). After 1995, more forest owners joined the programme: nature conservation organisations (seven provincial organisations and one national organisations) and various other owners (Figure 2.3).

[1] Note that Leyduin-Vinkenduin (no. 55) was excluded from the network in 2018, but that all data from the start-up programme are available from the database documented in this report.

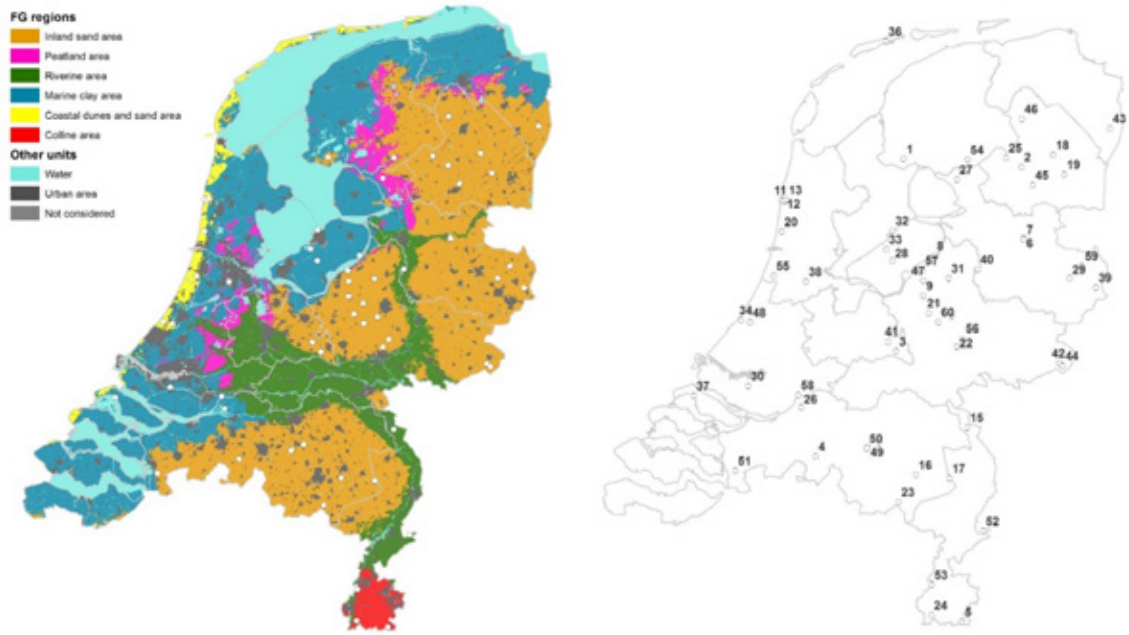

Figure 2.1 *The distribution of forest reserves in the Netherlands shown on a map with physical geographic regions (FGRs) and province boundaries. Numbers refer to reserve names in Table 2.1. FGRs according to the Landschapsleutel (Maas et al., 2018).*

Table 2.1 *Names of forest reserves as coded in Figure 2.1.*

1	Starnumansbos	21	Riemstruiken	41	Heul
2	Lheebroek	22	Zwarte Bulten	42	Bekendelle
3	Galgenberg	23	Leenderbos	43	Liefstinghsbroek
4	Tussen de Goren	24	Schone Grub	44	Rot
5	Vijlnerbos	25	Dieverzand	45	Kremboong
6	Vechtlanden	26	Keizersdijk	46	Norgerholt
7	Zeesserveld	27	Kloosterkooi	47	Stille Eenzaamheid
8	Meerdijk	28	Wilgenreservaat	48	Horsten
9	Pijpebrandje	29	Molenven	49	Kampina
10	Nieuw Milligen	30	Beerenplaat	50	Smalbroeken
11	Drieduin 1	31	Tongerense Hei	51	Mattemburgh
12	Drieduin 2	32	Houtribbos	52	Herkenboscherheide
13	Drieduin 3	33	Hollandse Hout	53	Bunderbos
14	Leesten	34	Kijfhoek	54	Heloma- en Bleekerspolder
15	Quin	35	Geelders	55	Leyduin-Vinkenduin
16	Sang	36	Berkenvallei	56	Imboschberg
17	Grootvenbos	37	Slikken van Flakkee	57	Grote Weiland
18	Schoonloerveld	38	Pilotenbos	58	Oude Kat
19	Oosteresch	39	Smoddebos-Duivelshof	59	Achter de Voort
20	Roodaam	40	Duursche Waarden	60	Ossenbos

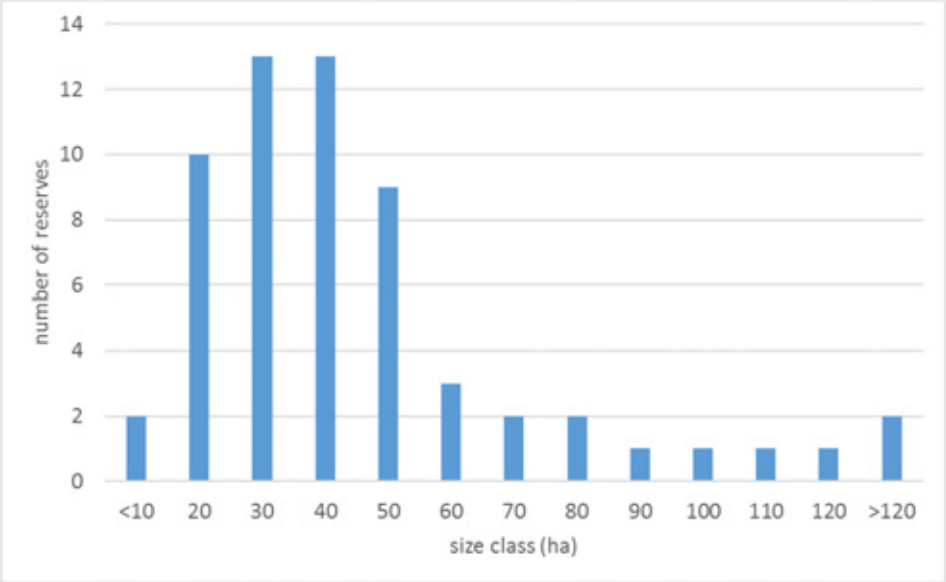

Figure 2.2 *Size distribution of the 60 forest reserves.*

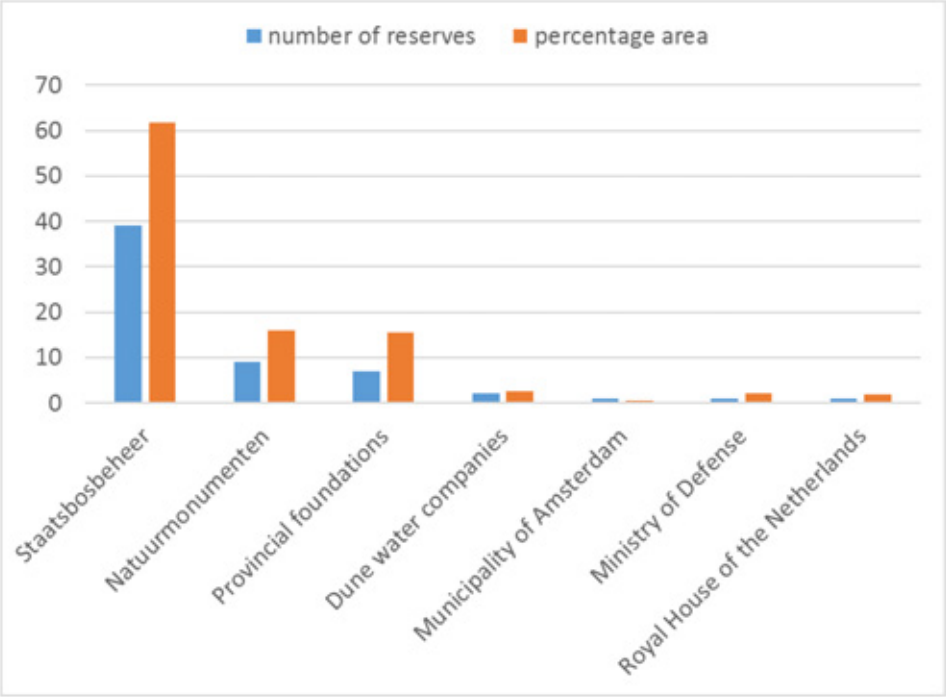

Figure 2.3 *Distribution and percentage area of the 60 forest reserves over owner categories. Provincial foundations include: Fryske Gea, Het Drentse Landschap, Landschap Overijssel/Stichting Natura Docet, Het Flevo-landschap, Geldersch Landschap & Kasteelen, Noordhollands Landschap and Brabants Landschap. Dune water companies are Dunea (Zuid-Holland) and PWN (Noord-Holland).*

2.3 Site conditions and forest types

Site conditions in the Netherlands vary strongly between physical geographic regions, including coastal dunes, peatlands, floodplains and inland sand areas (see Figure 2.1). Figure 2.4 gives the distribution of forest reserves over these regions and shows that the majority of reserves occur in regional inland sand areas (Hz).

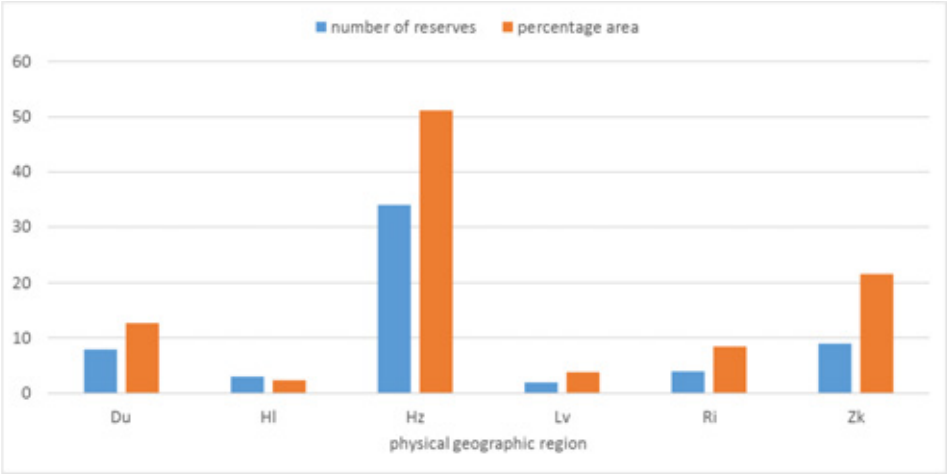

Figure 2.4 *Distribution and percentage area of the 60 forest reserves over physical geographic regions (according to Maas et al., 2018). Compare with Figure 2.1. Du: coastal dunes and sand area; Hl: colline area; Hz: inland sand area; Lv: peatland area; Ri: riverine area; Zk: marine clay area.*

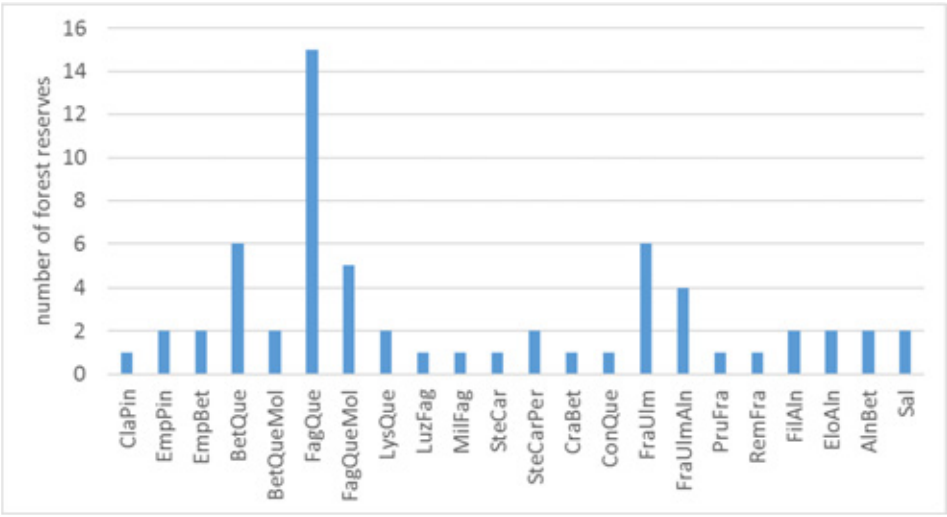

Figure 2.5 *Distribution of the 60 forest reserves over potential natural vegetation (PNV) types (according to Van der Werf 1991). PNV codes are elaborated in Table 2.2.*

Table 2.2 *Potential natural vegetation types occurring in Dutch forest reserves. Names and numbering according to Van der Werf (1991) and Koop & Van der Werf (1995).*

PNV code	PNV name	PNV code	PNV name
ClaPin	1 Cladonio-Pinetum	MelFag	14 Melico-Fagetum
EmpPin	3 Empetro-Pinetum	SteCar	17 Stellario-Carpinetum
EmpBet	4 Empetro-Betuletum	SteCarPer	18 Stellario-Carpinetum periclymenetosum
PerBet	5 Periclymeno-Betuletum	CraBet	19 Crataego-Betuletum
BetQue	6 Betulo-Quercetum	FraUlm	21 Fraxino-Ulmetum
BetQueMol	7 Betulo-Quercetum molinietosum	FraUlmAln	22 Fraxino-Ulmetum alnetosum
FagQue	8 Fago-Quercetum	PruFra	23 Pruno-Fraxinetum
FagQueMol	9 Fago-Quercetum molinietosum	RemFra	26 Carici remotae-Fraxinetum
LysQue	10 Lysimachio-Quercetum	FilAln	27 Filipendulo-Alnetum
ConQue	11 Convallaria-Quercetum	EloAln	29 Carici elongatae-Alnetum
LuzFag	12 Luzulo-Fagetum	AlnBet	31 Alno-Betuletum
MilFag	13 Milio-Fagetum	Sal	33 Salicetum albae

An important criterion for the selection of forest reserves was the type of potential natural vegetation (PNV) according to Van der Werf (1991) and Koop & Van der Werf (1995), consistent with international classifications based on the widely used PNV-concept (e.g. Bohn & Neuhäusl, 2000/2003; Suck et al., 2014). Figure 2.5 shows the distribution of reserves over PNVs; note that generally several PNVs occur in a single forest reserve. PNV codes are elaborated in Table 2.3.

All Natura 2000 woodland habitat types in the Netherlands are represented by forest reserves. See European Commission (2013) for general descriptions of these types[2]. Table 2.3 lists the woodland habitat types and their occurrence in forest reserves.

Table 2.3 *Occurrence of Natura 2000 woodland habitat types in forest reserves, as related to potential natural vegetation types (PNV) and physical geographic regions (FGR). For PNV codes see Table 2.2, for FGR codes see Figures 2.1 and 2.4, and for reserve codes see Table 2.1.*

Habitat type code	Habitat type name	PNV code	FGR	Reserve codes
2180	Wooded dunes of the Atlantic, Continental and Boreal region	EmpBet BetQue FagQue ConQue CraBet FraUlm	Du	11, 12, 13, 20, 34, 36, 55
7120	Degraded raised bogs still capable of natural regeneration (Dutch implementation: including bog woodland)	PerBet	Hz	17
9110	Luzulo-Fagetum beech forests	LuzFag	Hl	5
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrub layer (Quercinion robori-petraeae or Ilici-Fagenion)	FagQue FagQueMol MilFag	Hz	9, 14, 39, 42, 43, 46, 47, 49, 52
9160A	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli (Dutch implementation: subtype A in physical geographic region Inland sand area)	SteCar SteCarPer	Hz, Ri	39, 42, 43, 59
9160B	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli (Dutch implementation: subtype B in physical geographic region Colline area)	MelFag	Hl	5, 24, 53
9190	Old acidophilous oak woods with Quercus robur on sandy plains	BetQue BetQueMol	Hz	21, 56, 60
91D0	*Bog woodland (Dutch implementation: outside raised bogs H7110 and H7120)	AlnBet PerBet	Lv	27
91E0AB	*Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) (Dutch implementation: subtype A softwood and B hardwood forests along the great rivers)	FraUlm Sal	Ri	26, 30, 40, 59
91E0C	*Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) (Dutch implementation: subtype C along streams)	PruFra RemFra	Hl, Hz, Ri	6, 39, 42, 50, 53
91F0	Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)	FraUlm VioUlm	Ri	40

The management history of approximately 40 forest reserves is known. For the other reserves, we have assumed that the year of designation was the start of undisturbed forest development. The majority of reserves show 'only' 25-50 years of completely spontaneous development (Figure 2.6).

[2] Detailed descriptions of the Dutch implementation of habitat types is available (in Dutch) from https://www.synbiosys.alterra.nl/natura2000/gebiedendatabase.aspx?subj=profielen

In some reserves, measures were taken just before designation to direct succession towards vegetation with native species. In this case, exotic species, such as *Prunus serotina, Pseudotsuga menziesii* and *Quercus rubra* were eradicated. Even in forest reserves that already had a long history of non-intervention, this kind of 'introductory management' was sometimes applied. This doesn't mean that all exotic tree species were removed from all forest reserves. On the contrary: some forest reserves were specifically designated to study the spontaneous development of stands dominated by *Pseudotsuga* and *Larix* (Leesten) or *Prunus serotina* (Ossenbos).

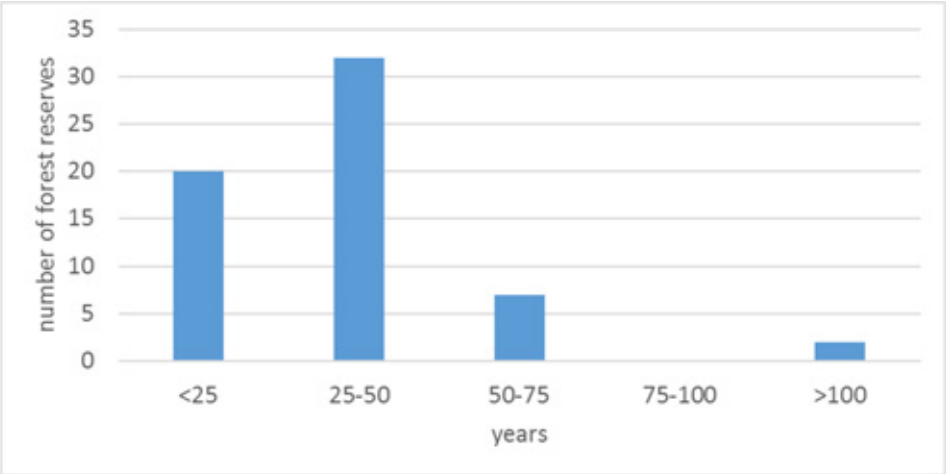

Figure 2.6 *Period of spontaneous forest development (i.e. with non-intervention management) for the forest reserves (relative to 2018).*

3 Monitoring design

The monitoring of forest reserves includes several levels of data gathering (Figure 3.1):

1. Reserve level
2. Several circular sample plots throughout the reserve
3. One (rectangular) core area
4. Living trees and dead wood within sample plots and core area

Figure 3.1 *Norgerholt forest reserve and Natura 2000 site. Layout of the monitoring design, showing the topography (grey lines), reserve boundary (white line), soil map (with labelled units), 50 x 50 m grid (dots) with selected sample plots (black squares) and the 140 x 70 m core area (black outline) with labelled vertices (A-D). Overlay: hectare grid (Dutch Rijksdriehoek system).*

3.1 Reserve level

For each reserve, a report was compiled with general information, such as selection criteria, historical maps, management history and soil- and climatic conditions. New, detailed soil maps were made according to the Dutch soil classification system (Figure 3.1). These maps were documented in a special series of reports and are available as shapefiles (see § 4.2.1). For most reserves high resolution aerial photographs were made shortly after designation. Vegetation maps have also been prepared as part of the start-up programme.

3.2 Sample plots

In each reserve, a 50 x 50 m grid was laid out and about half of the points were selected as the centre of sample plots (Figure 3.1). Woodland structure and vegetation are monitored in these plots. The centres of the plots were permanently marked. Sample plots are circular with a radius of 12.6 m (area of 500 m^2). All trees and shrubs with one or more stems with a diameter at breast height (dbh) ≥ 5 cm are recorded in the plots with regard to their position and other features (species, height etc.). See § 4.1.2 for a full account of the measured variables per tree (tblSamplePlotsCanopy) and Annex 1 for the years of recording of sample plots.

Most sample plots also include a second, square plot of 18 x 18 m (Figure 3.2), in which regeneration of trees and shrubs (with dbh < 5 cm and height > 50 cm) is recorded. See § 4.1.2 for a full account of the variables measured (tblSamplePlotsRegeneration).

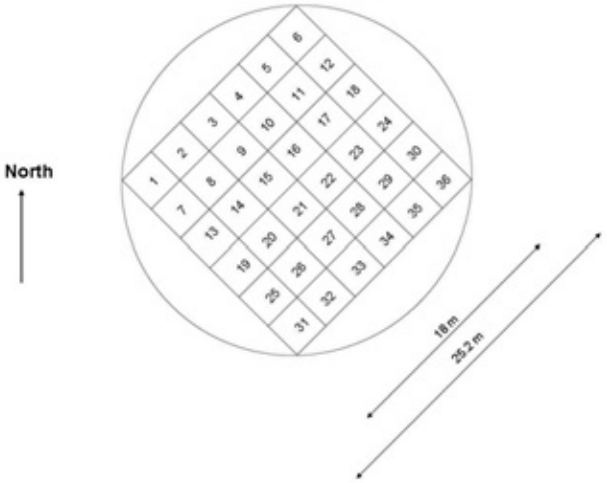

Figure 3.2 *Schematic view of a circular sample plot, in which shrubs and trees are recorded (with dbh ≥ 5 cm,) as well as the arrangement of a square plot with subplots, within which regeneration (with dbh < 5 cm and height > 50 cm) is counted.*

The central 10 x 10 m square inside the sample plot (note: different from the square plot in Figure 3.2) is used to monitor vegetation development. The vegetation relevés include those for the tree-, shrub-, herb- and moss layers.

3.3 Core area

The core area is approximately one hectare in size, generally 140 x 70 m, but sometimes with another dimension (given in tblReservesGeneral, fields xmaxkv and ymaxkv; § 4.1.1). This plot is used to study canopy development including interactions (competition) between individual trees, within and between tree- and shrub layers, as well as gap dynamics. In the core area, all living- and dead trees with dbh ≥ 5 cm are recorded for the same features as in the sample plots. Additionally, several crown measurements are made, including coordinates of the crown projection (elaborated in § 3.4). See § 4.1.3 for a full account of the variables measured per tree (tblCoreAreaCanopy) and Annex 1 for the years of recording of core areas.

A core area has its own local coordinate system with (in the most common case of a 140 x 70 m rectangle) x-values running from 0-140 and y-values from 0-70. The origin was assigned by practical considerations for each reserve separately and is denoted as the A-vertex. The other vertices are labelled clockwise as B-D (Figure 3.1).

A core area is divided in strips 10 m wide. A 140 x 70 m core area has seven strips. Trees are numbered within each strip starting from 1. Within a core area, each tree has a unique number (named STN: strip-treenumber), mostly consisting of five digits[3]. The first digit denotes strip number, digits 2-4 define tree number, and the last digit addresses multi-stemmed trees (or separate parts of lying dead wood), with 0 for single-stemmed trees (or intact lying dead wood) and for the main i.e. highest stem of multi-stemmed trees and clusters (or the main part of lying dead wood). Consecutive numbers (1, 2, ...) are used for subordinate stems (or parts). Example: STN 20853 could refer to Stem 3 of a tree with Number 85 in Strip 2.

Vegetation monitoring in the core area takes place in a 10 x 10 m grid (98 adjacent plots in the case of a 140 x 70 m core area). In these plots, vegetation relevés are made of the herb- and shrub layers. The number of regenerating individuals of woody species is counted as well. These data are not available for all reserves and not included in the online database.

3.4 Trees

In the core area, additional tree measurements are made of the size and shape of the crown, based on the geometric tree model described by Koop (1989) and Koop & Bijlsma (1993). Figure 3.3 shows the main features of the model.

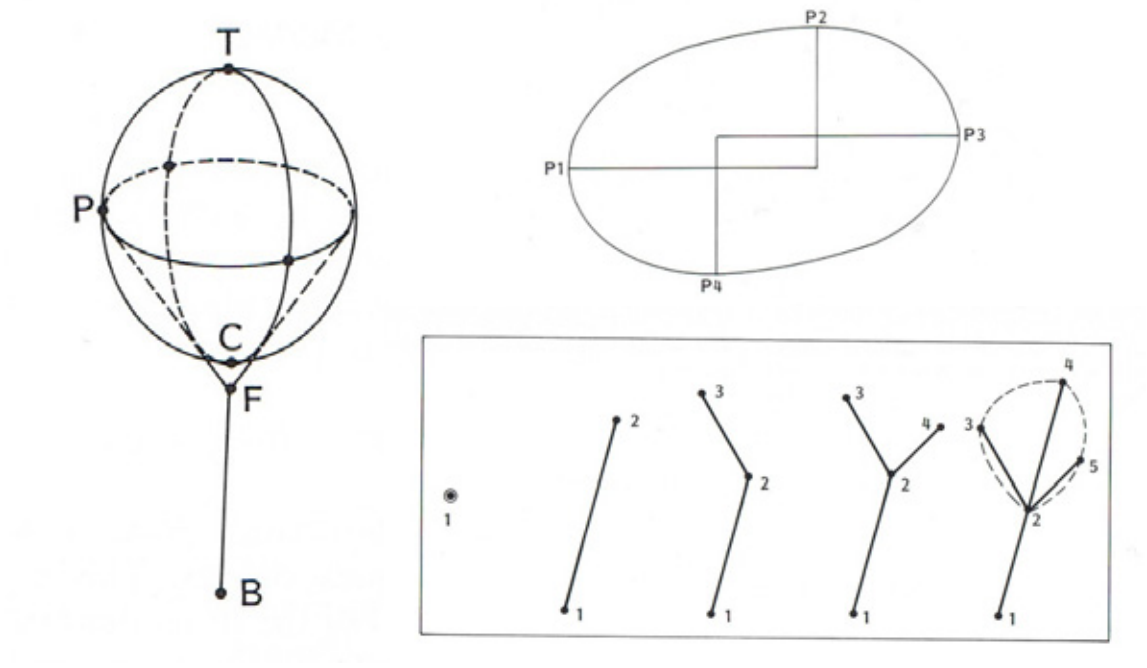

Figure 3.3 *The geometric tree model (left) with tree top (T), point on the crown-periphery (P) at height with largest circumference (corresponding to the crown-projection), crown-base (C), principal-fork (F) and stem-base (B). The crown projection (upper-right) is described by four points (P1-P4) being the extreme points in x- and y-direction. In reconstructing the crown-projection digitally, the points P1-P4 define axes of four (quarters of) ellipses as shown in the figure. The geometry of lying and standing dead wood (lower-right) is described by at most five points, as indicated (after Koop, 1989).*

The height of tree-top, crown-periphery (at largest circumference), crown-base and -fork are measured in the field. The x- and y-coordinates (relative to the origin of the core area; see § 3.3) of stem base, crown-projections (P1-P4) and dead wood are digitized from charts of tree positions, crown-projections and lying dead wood drawn at scale 1:200 (see Koop, 1989 § 3.2.1).

[3] Reserve Liefstinghsbroek (code=43) has a 100 x 100 m core area and, therefore, STN-values with five- or six digits.

The extended set of tree measurements in the core area allows a digital reconstruction of the canopy, and of GIS-analyses of changes in crown projections and canopy gaps (Koop, 1989). Relevant GIS shapefiles and grids are discussed in § 4.2.2 and included in the online data set.

4 Database documentation

4.1 Access database

All tree measurements in the forest reserves have been structured in an Access-database with tables for data collected in core areas and sample points related to both general information at the reserve level and detailed reference tables. The relationships between the tables is given in Figure 4.1.

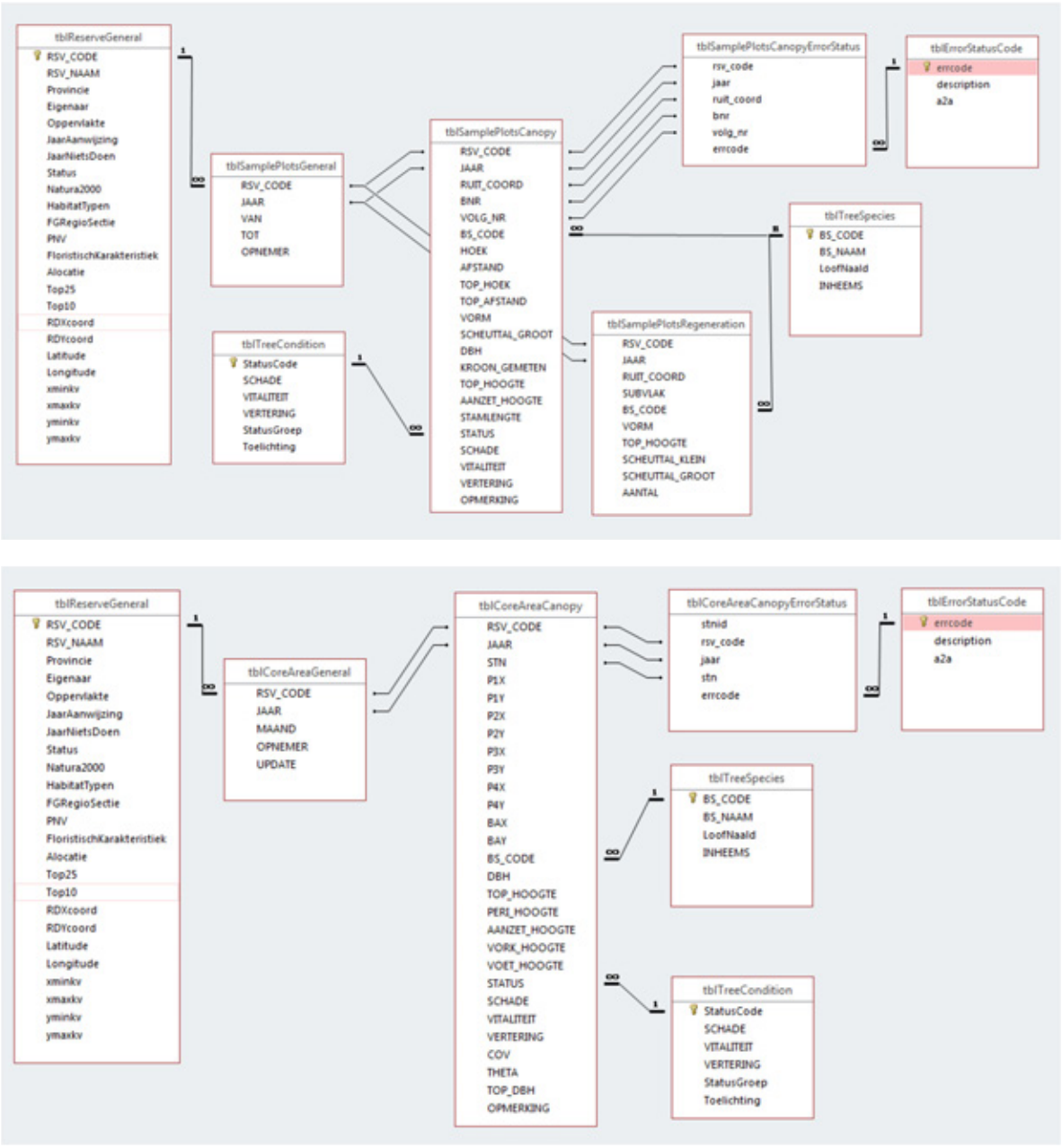

Figure 4.1 *Relationships between tables in the Access-database of forest reserve data from sample plots (above) and core areas (below).*

4.1.1 General information at the reserve level

Access-table tblReserveGeneral contains general information on the forest reserves (Table 4.1). The field FGRegioSectie is elaborated in Table 4.2 (and see Figure 2.1).

Table 4.1 *Fields of tblReserveGeneral.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code; see Table 2.1
RSV_NAAM	Short Text	reserve name; see Table 2.1
Provincie	Short Text	Province
Eigenaar	Short Text	Owner
Oppervlakte	Number (Single)	area (ha)
JaarAanwijzing	Number (Integer)	year of designation
JaarNietsDoen	Number (Integer)	year of start of non-intervention management
Status	Short Text	remark on current status (2018): included with original boundary, adjusted or excluded
Natura2000	Short Text	name of Natura 2000 site
HabitatTypen	Short Text	code(s) of Natura 2000 woodland habitat type(s),(only for reserves in Natura 2000 sites); see Table 2.3
FGRegioSectie	Short Text	physical geographic region and section according to Landschapssleutel (www.landschapsleutel.wur.nl); see Table 4.2
PNV	Short Text	potential natural vegetation type according to Van der Werf (1991); see Table 2.2
FloristischKarakteristiek	Short Text	J: the structure and species composition correspond to the PNV; N: not so (non-native species, plantation forest)
Alocatie	Short Text	name of A-location according to J.B. den Ouden c.s. (1995-1998)
Top25	Short Text	sheet number of topographical map 1:25,000
Top10	Short Text	sheet number of topographical map 1:10,000
RDXcoord	Number (Single)	x-coordinate of (centre of) reserve (Dutch Rijksdriehoek-system, m)
RDYcoord	Number (Single)	y-coordinate of (centre of) reserve (Dutch Rijksdriehoek-system, m)
Latitude	Number (Single)	latitude of (centre of) reserve (decimal degrees, DD.ddddd)
Longitude	Number (Single)	longitude of (centre of) reserve (decimal degrees, DD.dddd)
xminkv	Number (Integer)	minimum (local) x-coordinate of the core area (mostly 0)
xmaxkv	Number (Integer)	maximum (local) x-coordinate of the core area (mostly 140)
yminkv	Number (Integer)	minimum (local) y-coordinate of the core area (mostly 0)
ymaxkv	Number (Integer)	maximum (local) y-coordinate of the core area (mostly 70)

Table 4.2 *Physical geographic regions (FGR) and sections (FGS) relevant for forest reserves. Based on the Landschapsleutel (www.landschapsleutel.wur.nl; Maas et al., 2018).*

FGR	Description	FGS	Description
Du	Coastal dunes and sand area	DuG	Grey inner dunes with plains and hollows
		DuL	Hollows and sandy (beach) plains
		DuX	Association of yellow and grey dunes
Hl	Colline area	HlD	Valleys
		HlH	Slopes
		HlT	Terraces
Hz	Inland sand area	HzB	Stream valleys
		HzD	Cover sand areas
		HzG	Glacial areas
		HzO	Old agricultural fields
		HzS	Drift sand areas
Lv	Peatland area	LvM	Peat marshes
		LvR	Remaining peat in reclaimed land or peat polders
Ri	Riverine area	RiL	Lowland rivers
		RiT	Incised rivers with terraces
		RiZ	Incised rivers without terraces
Zk	Marine clay area	ZkB	Marine clay areas inside the dikes
		ZkG	Marine clay areas outside the dikes

4.1.2 Tree data from sample plots

Measurements on canopy structure and regeneration in sample plots are stored in four Access-tables (see also Figure 4.1):

- tblSamplePlotsGeneral: general information about recording date(s) and name(s) of recorder(s) in a particular year (fields explained in Table 4.3);
- tblSamplePlotsCanopy: tree measurements in circular plots for trees and shrubs with dbh ≥ 5 cm (fields explained in Table 4.4);
- tblSamplePlotsCanopyErrorStatus: the error status of records (trees) in tblSamplePlotsCanopy (fields explained in Table 4.5);
- tblSamplePlotsRegeneration: regeneration measurements in the square plot (see § 3.2) for trees and shrubs with dbh < 5 cm (fields explained in Table 4.6).

Table 4.3 *Fields of tblSamplePlotsGeneral.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
VAN	Number (Integer)	from (first date, format YYYYMMDD)
TOT	Number (Integer)	to (last date, format YYYYMMDD)
OPNEMER	Short Text	name(s) of recorder(s)

Table 4.4 *Fields of tblSamplePlotsCanopy.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
RUIT_COORD	Short Text	sample plot code
BNR	Number (Integer)	tree number
VOLG_NR	Number (Integer)	serial number extending the tree number (e.g. in case of multiple stems) starting with 0 for the main stem
BS_CODE	Number (Integer)	tree species code; see § 4.1.4 tblTreeSpecies
HOEK	Number (Integer)	angle (degrees) of stem base relative to North (clockwise), measured from the centre of the plot
AFSTAND	Number (Integer)	distance (dm) of stem base measured from the centre of the plot
TOP_HOEK	Number (Integer)	angle (degrees) of stem top (of lying or overhanging trees) relative to North (clockwise), measured from the centre of the plot
TOP_AFSTAND	Number (Integer)	distance (dm) of stem top (of lying or overhanging trees) measured from the centre of the plot
VORM	Number (Integer)	appearance; 1: with single stem; 2: with multiple stems arising from a common trunk; 3: with multiple stems, connected below-ground ('cluster')
SCHEUTTAL_GROOT	Number (Integer)	number of stems with dbh <5 cm and height >2 m for VORM=2 or 3
DBH	Number (Integer)	trunk diameter at breast height (cm)
KROON_GEMETEN	Number (Integer)	1: height (TOP_HOOGTE, AANZET_HOOGTE) measured; 2 or null (empty): height estimated
TOP_HOOGTE	Number (Single)	crown top height (m) with 0.5 m accuracy
AANZET_HOOGTE	Number (Single)	crown base height (m) with 0.5 m accuracy
STAMLENGTE	Number (Single)	length or height of stem (m) of snags, overhanging trees and lying dead wood
STATUS	Number (Integer)	tree condition code; see § 4.1.4 tblTreeCondition
SCHADE	Number (Integer)	damage code; see § 4.1.4 tblTreeCondition
VITALITEIT	Number (Integer)	vitality code; see § 4.1.4 tblTreeCondition
VERTERING	Number (Integer)	decomposition stage code; see § 4.1.4 tblTreeCondition
OPMERKING	Short Text	Comments

Table 4.5 *Fields of tblSamplePlotsCanopyErrorStatus.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
RUIT_COORD	Short Text	sample plot code
BNR	Number (Integer)	tree number
VOLG_NR	Number (Integer)	serial number within tree number (e.g. for multiple stems) starting with 0 for the main stem
ERRCODE	Number (Integer)	error code for records in tblSamplePlotsCanopy for given RSV_CODE, JAAR, RUIT_COORD, BNR and VOLG_NR; see § 4.1.5 tblErrorStatusCode

Table 4.6 *Fields of tblSamplePlotsRegeneration.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
RUIT_COORD	Short Text	sample plot code
SUBVLAK	Number (Integer)	subplot number 1-36; see Figure 3.2
BS_CODE	Number (Integer)	tree species code; see § 4.1.4 tblTreeSpecies
VORM	Number (Integer)	appearance; 1: with single stem; 2: with multiple stems arising from a common trunk; 3: with multiple stems, connected below-ground ('cluster')
TOP_HOOGTE	Number (Integer)	Crown-top height (dm) with 0.5 m accuracy
SCHEUTTAL_KLEIN	Number (Integer)	number of stems with dbh <5 cm and 0.5 m < height < 2 m for VORM=2 or 3
SCHEUTTAL_GROOT	Number (Integer)	number of stems with dbh <5 cm and height >2 m for VORM=2 or 3
AANTAL	Number (Integer)	number of individuals (with given VORM)

4.1.3 Tree data from core areas

Measurements on canopy structure in core areas are stored in three Access-tables (see also Figure 4.2):

- tblCoreAreaGeneral: general information about recording date(s) and name(s) of recorder(s) in a particular year (fields explained in Table 4.7);
- tblCoreAreaCanopy: tree measurements in the core area for trees and shrubs with dbh ≥ 5 cm (fields explained in Table 4.8);
- tblCoreAreaCanopyErrorStatus: the error status of records (trees) in tblCoreAreaCanopy (fields explained in Table 4.9).

Table 4.7 *Fields of tblCoreAreaGeneral.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
MAAND	Number (Integer)	month of recording
OPNEMER	Short Text	name(s) of recorder(s)
UPDATE	Yes/No	Yes: update of changes only; No: complete survey

Table 4.8 *Fields of tblCoreAreaCanopy.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
STN	Number (Long Integer)	tree number
P1X	Number (Single)	local x-coordinate of leftmost point (P1) of crown-projection or point (2) of lying dead wood (m); see Figure 3.3
P1Y	Number (Single)	local y-coordinate of leftmost point (P1) of crown-projection or point (2) of lying dead wood (m); see Figure 3.3
P2X	Number (Single)	local x-coordinate of uppermost point (P2) of crown-projection or point (3) of lying dead wood (m); see Figure 3.3
P2Y	Number (Single)	local y-coordinate of uppermost point (P2) of crown-projection or point (3) of lying dead wood (m); see Figure 3.3
P3X	Number (Single)	local x-coordinate of rightmost point (P3) of crown-projection or point (4) of lying dead wood (m); see Figure 3.3
P3Y	Number (Single)	local y-coordinate of rightmost point (P3) of crown-projection or point (4) of lying dead wood (m); see Figure 3.3
P4X	Number (Single)	local x-coordinate of lowermost point (P4) of crown-projection or point (5) of lying dead wood (m); see Figure 3.3
P4Y	Number (Single)	local y-coordinate of lowermost point (P4) of crown-projection or point (5) of lying dead wood (m); see Figure 3.3
BAX	Number (Single)	local x-coordinate of trunk-base or corresponding point (1) of standing- or lying dead wood (m); see Figure 3.3
BAY	Number (Single)	local y-coordinate of trunk-base or corresponding point (1) of standing or lying dead wood (m); see Figure 3.3
BS_CODE	Number (Integer)	tree species code; see § 4.1.4 tblTreeSpecies
DBH	Number (Integer)	trunk-diameter at breast height (cm)
TOP_HOOGTE	Number (Single)	crown-top height (m) with 0.5 m accuracy
PERI_HOOGTE	Number (Single)	crown-periphery height (m) with 0.5 m accuracy
AANZET_HOOGTE	Number (Single)	crown-base height (m) with 0.5 m accuracy
VORK_HOOGTE	Number (Single)	principal-fork height (m) with 0.5 m accuracy
VOET_HOOGTE	Number (Single)	trunk-base height (m) with 0.5 m accuracy (mostly 0)
STATUS	Number (Integer)	tree condition code; see § 4.1.4 tblTreeCondition
SCHADE	Number (Integer)	damage code; see § 4.1.4 tblTreeCondition
VITALITEIT	Number (Integer)	vitality code; see § 4.1.4 tblTreeCondition
VERTERING	Number (Integer)	decomposition stage code; see § 4.1.4 tblTreeCondition
COV	Number (Integer)	internal crown cover: 1 < 15%, 2 15-25%, ..., 9 >85%
THETA	Number (Single)	(projected) angle of overhanging tree (degrees); see Koop (1989), Forest Dynamics, Fig. 4.3
TOP_DBH	Number (Single)	lying dead wood diameter (cm)
OPMERKING	Short Text	Comments

Table 4.9 *Fields of tblCoreAreaCanopyErrorStatus.*

Field Name	Data Type	Description
RSV_CODE	Number (Integer)	reserve code
JAAR	Number (Integer)	year of recording
STN	Number (Long Integer)	tree number
ERRCODE	Number (Integer)	error code for records in tblCoreAreaCanopy for given RSV_CODE, JAAR and STN; see § 4.1.5 tblErrorStatusCode

4.1.4 Reference tables for tree features

The following tables are linked to tree features in tables of measurements in both sample plots and core areas:

- tblTreeSpecies: reference table for codes of woody species and corresponding scientific names at the species or genus level (fields explained in Table 4.10);
- tblTreeCondition: explanation of codes for VITALITEIT (vitality), SCHADE (damage) and VERTERING (decomposition) and derived overall code for the STATUS of trees; fields and codes given in Tables 4.11 and 4.12.

Table 4.10 *Fields of tblTreeSpecies.*

Field Name	Data Type	Description
BS_CODE	Number (Integer)	species code
BS_NAAM	Short Text	scientific name (species or genus level)
LoofNaald	Short Text	L: deciduous; N: coniferous
INHEEMS	Number (Byte)	native status in the Netherlands: 0 not native, not naturalised; 1 originally native; 2 archeophyte, 3 naturalised before 1900; 4 naturalised after 1900 (source: www.verspreidingsatlas.nl)

Table 4.11 *Fields of tblTreecondition. Table 4.12 gives the contents of this table.*

Field Name	Data Type	Description
StatusCode	Number (Integer)	overall status code of measured objects (living trees, lying dead wood, uprootings) in sample plots and core areas
SCHADE	Number (Integer)	damage code
VITALITEIT	Number (Integer)	vitality code
VERTERING	Number (Integer)	decomposition stage code
StatusGroep	Short Text	status group: L living tree, W uprooting, D dead tree
Toelichting	Short Text	description of overall status

Table 4.12 *Contents of tblTreecondition explaining the status of measured objects (living trees, dead wood, uprootings)*

Status code	Damage	Vitality	Decomposition	Status group	Description
0					Data incomplete, status unknown
10	1	0		L	Living tree without damage. Vitality unknown
11	1	1		L	Living tree without damage. Very vital with high leaf/needle density
12	1	2		L	Living tree without damage. Vital with normal leaf/needle density
13	1	3		L	Living tree without damage. Vitality reduced with poor leaf/needle density
20	2	0		L	Living tree with damage. Vitality unknown
21	2	1		L	Living tree with damage. Very vital with high leaf/needle density
22	2	2		L	Living tree with damage. Vital with normal leaf/needle density
23	2	3		L	Living tree with damage. Vitality reduced with many dead branches and poor leaf/needle density
30	3	0		L	Living tree with lying trunk (mostly reiterating fallen trees)
50	5		0	W	Uprooting. Stage unknown
51	5		1	W	Uprooting. Recent, largely intact
52	5		2	W	Uprooting. Soil between roots of mound washed away, trunk partly decomposed
53	5		3	W	Uprooting. Pit more or less filled, trunk largely decomposed
54	5		4	W	Uprooting. Mound and pit hardly recognisable
60	6		0	D	Dead hanging tree. Decomposition stage unknown

Status code	Damage	Vitality	Decomposition	Status group	Description
61	6		1	D	Dead hanging tree. Fresh; wood hard; bark largely still present
62	6		2	D	Dead hanging tree. Wood superficially decomposed; loosened bark largely fallen off
63	6		3	D	Dead hanging tree. Wood moderately decomposed, soft, easily crushed; bark completely gone
64	6		4	D	Dead hanging tree. Wood largely decomposed; trunk fallen apart
70	7		0	D	Dead standing tree. Decomposition unknown
71	7		1	D	Dead standing tree. Fresh; wood hard; bark largely still present
72	7		2	D	Dead standing tree. Wood superficially decomposed; loosened bark largely fallen off
73	7		3	D	Dead standing tree. Wood moderately decomposed, soft, easily crushed; bark completely gone
74	7		4	D	Dead standing tree. Wood largely decomposed. Trunk fallen apart
75	7		5	D	Dead standing tree. Only visible in the litter layer or by a divergent vegetation
80	8		0	D	Dead lying tree. Decomposition unknown
81	8		1	D	Dead lying tree. Fresh; wood hard; bark largely still present
82	8		2	D	Dead lying tree. Wood superficially decomposed; loosened bark largely fallen off
83	8		3	D	Dead lying tree. Wood moderately decomposed, soft, easily crushed; bark completely gone
84	8		4	D	Dead lying tree. Wood largely decomposed; trunk fallen apart
85	8		5	D	Dead lying tree. Only visible in the litter layer or by a divergent vegetation
90	9		0	D	Dead cut stump. Decomposition unknown
91	9		1	D	Dead cut stump. Fresh; wood hard; bark largely still present
92	9		2	D	Dead cut stump. Wood superficially decomposed; loosened bark largely fallen off
93	9		3	D	Dead cut stump. Wood moderately decomposed, soft, easily crushed; bark completely gone
94	9		4	D	Dead cut stump. Wood largely decomposed; trunk fallen apart to pieces
95	9		5	D	Dead cut stump. Only still visible in the litter layer or by a divergent vegetation

4.1.5 Error codes

All measurements in the sample plots and core areas, i.e. all records in tblSamplePlotsCanopy and tblCoreAreaCanopy, have been checked for completeness and consistency within and between recording dates. Erroneous, unlikely and inconsistent records have been indicated in the Access-tables tblSamplePlotsCanopyErrorStatus (see Table 4.5) and tblCoreAreaCanopyErrorStatus (see Table 4.9) with error codes explained in tblErrosStatusCode (Table 4.13).

Table 4.13 *Fields of tblErrorStatusCode.*

Field Name	Data Type	Description
ERRCODE	Number (Integer)	error code
DESCRIPTION	Short Text	explanation of the error code
A2A	Number (Byte)	used to prepare GIS shapefiles and grids in core areas: 0 invalid, 1 valid; see text for explanation

The consequence of error codes for the selection of data will depend upon the kind of analyses. E.g. for the calculation of the basal area of living trees, all data with valid status code and dbh can be used, regardless of whether other measurements are complete and valid or not.

The field A2A ('Access to Arc') signals error codes considered fatal in the preparation of GIS shapefiles and grids for core areas. The GIS files available in the online data set (see § 4.2.2 and Chapter 5) are, therefore, based on records in tblCoreAreaCanopy without error codes and records with error codes, for which A2A is valid.

4.2 GIS data

GIS (Geographic Information System) data are available at the level of the forest reserve network (§ 4.2.1) and for core areas of forest reserves for each year of recording (§ 4.2.2).

4.2.1 Shapefiles at the network- and reserve levels

The following ESRI-shapefiles for the forest reserve network are available:

- ReserveBoundary: polygon shapefile with the boundaries of all forest reserves; attributes include the forest reserve codes and names according to Table 2.1, as well as the perimeter length (m) and the area (m^2) of the reserve. Some reserves consist of several polygons.
- ReserveSamplePlots: point shapefile with the 50 x 50 m grid points for all reserves (see § 3.2); attributes include the code and name of the reserve according to Table 2.1, RUIT_COORD, which is a unique code used to denote sample plots (e.g. in tblSamplePlotsCanopy), as well as the x and y coordinates (rdx, rdy) of the grid points in the Dutch Rijksdriehoek system (m).
- ReserveCoreAreaPolygon: polygon shapefile with the core areas of all relevant forest reserves and reserve code as attributes.
- ReserveCoreAreaVertices: point shapefile with vertices of the core areas; attribute hoek (=vertex) contains the labels A-D (see § 3.3 for details and compare Figure 3.1).
- ReserveSoil: polygon shapefile of the soil maps of all relevant forest reserves; attributes include the code and name of the reserve according to Table 2.1, soil code (BODEM), prefix (TOEVOOR), suffix (TOEACHT) and ground-water table class (TOEGWT), as well as the length of the perimeter (m) and the area (m^2) of each polygon. These codes are explained in a series of (online) reports (in Dutch) that present and describe the soil conditions for each reserve (see the Dutch forest reserve website). De Bakker (1978) and De Vries et al. (2003) have described the Dutch soil classification system.

The shapefile ReserveCoreAreaVertices can be used to transform the local coordinate system of the core area to any desired projection, e.g. for overlaying aerial photographs or elevation models with measured tree data. Note that the shape and size of core areas can also be derived from the fields xminkv, xmaxkv, yminkv and ymaxkv in tblReserveGeneral (see Table 4.1).

All these shapefiles have RD_New as Projected Coordinate System (Dutch RijksDriehoek system), a Double_Stereographic Projection, GCS_Amersfoort as Geographic Coordinate System, D_Amersfoort as Datum and metre (m) as Linear Unit.

4.2.2 Shapefiles and grids for core areas

To facilitate the analysis of woodland structure and its development in the core areas, several GIS files are available. Crown-projections, canopy surface and lying dead wood can be reconstructed for core areas using an Access VBA-module (Acces2Arc) based on the tree-model presented in § 3.4. This module selects records (tree measurements) in tblCoreAreaPolygon without, or with, acceptable error codes in tblCoreAreaPolygonErrorStatus (see § 4.1.5). Next, for these valid records, the module creates ASCII data exchange files, from which ESRI shapefiles and grids can be made.

For each core area for a given reserve (rsv code) and year of recording, the following files are available:

- cp<rsv code>_<year>: arc shapefile of crown projections with tree number (STN) as attribute.
- dl<rsv code>_<year>: arc shapefile of lying dead wood with tree number (STN) as attribute.
- ds<rsv code>_<year>: point shapefile of positions of standing dead wood with treenumber (STN) as attribute.

- tb<rsv code>_<year>: point shapefile of positions of trunk-bases of living trees with treenumber (STN) as an attribute.
- bs<rsv code>_<year>.asc: ASCII GRID (exchange) file of a 25 x 25 cm raster of the core area with species code as a (an integer) pixel value as given in tblTreespecies (see § 4.1.4); the species code refers to the tree with greatest height of the crown-surface in the particular grid cell ('canopy height'), or 0 in the case of a canopy gap.
- zu<rsv code>_<year>.asc: ASCII GRID (exchange) file as bs<rsv code>_<year>, but with the corresponding canopy height as a (single, float) pixel value.

Figure 4.3 presents the shapefiles and converted ASCII GRID files (using the ASCII To Raster tool in ArcMap) for the core area of forest reserve Galgenberg, as recorded in 1986.

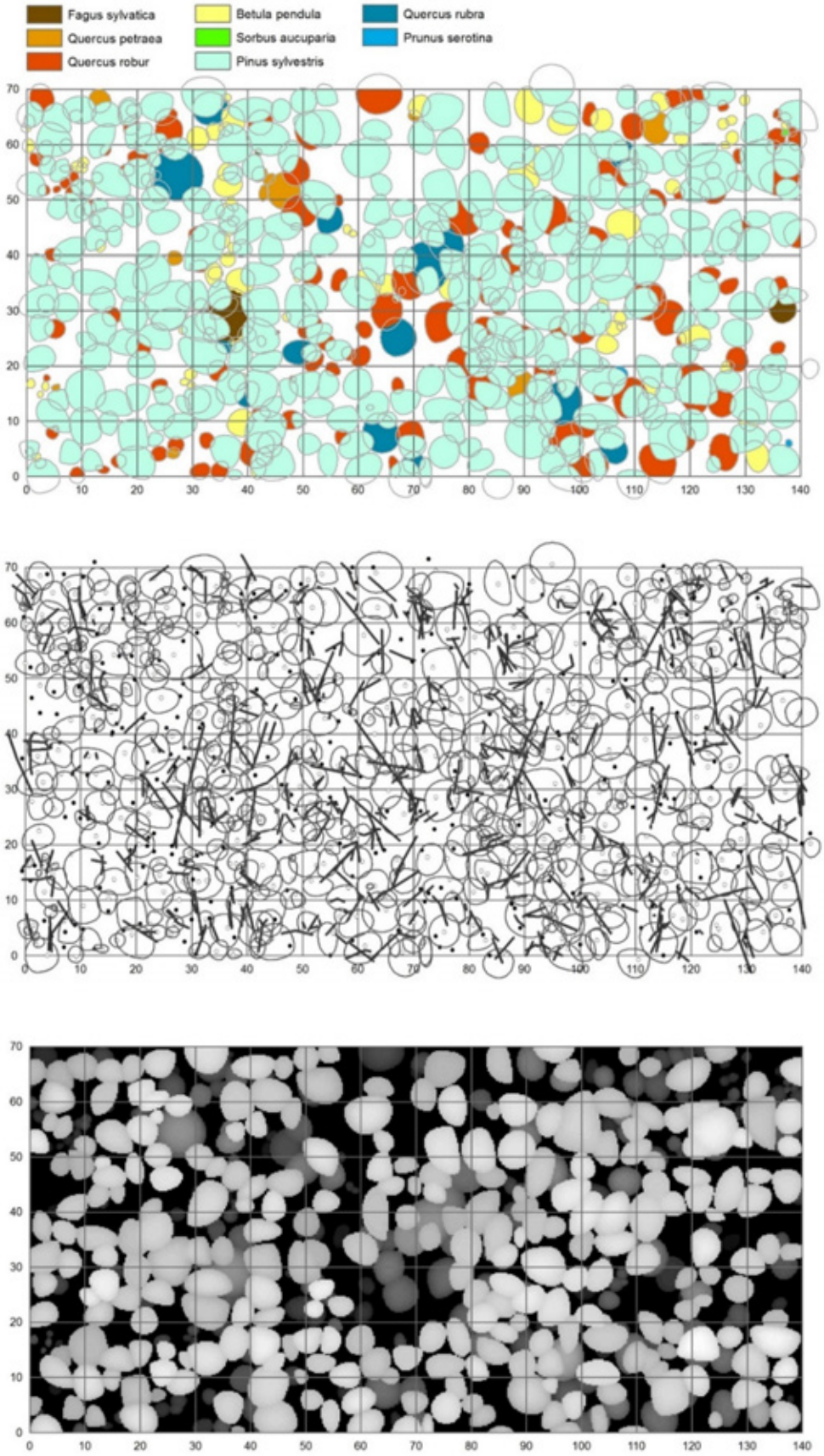

Figure 4.3 *Core area of forest reserve Galgenberg (reserve code 3) reconstructed in GIS from tree measurements recorded in 1986. Top: bs3_1986 (species grid) + cp3_1986 (crown-projections). Centre: cp3_1986 + dl3_1986 (lying dead wood)+ ds_1986 (standing dead wood; black dots) + tb3_1986 (trunk-bases living trees; open circles). Bottom: zu3_1986 (canopy height grid). See text for explanation. The 10 x 10 m core area grid is a separate shapefile.*

5 Online data (DANS)

5.1 The DANS portal

DANS (Data Archiving and Networked Services) is the Netherlands Institute for permanent access to digital research resources. DANS encourages researchers to make their digital research data and related outputs Findable, Accessible, Interoperable and Reusable. Core services are: DataverseNL for short-term data management, EASY for long-term archiving, and NARCIS, the national portal for research information. DANS is an institute of the Dutch Academy KNAW and funding organisation NWO (see https://dans.knaw.nl/en).

Wageningen University & Research (WUR) Library is 'front office' for DANS-EASY, which means that the Library helps in preparing and depositing data sets as a free service to WUR researchers. For more information on this service, contact the Library via data@wur.nl.

5.2 File formats for tree data

The tables and their relationships presented in Figures 4.1 and 4.2 are available as Access-database NLForestReserves2018.accdb. Moreover, all tables have been exported as separate csv files. Database and csv files are stored in the folder \database. Table 5.1 gives an overview of all tables, including references to the documentation in Chapter 4.

Table 5.1 *Overview of tables in the Dutch forest reserves Access-database NLForestReserves2018.*

Access-table	Description	Documentation: see
tblReservesGeneral	general information about forest reserves, including reserve codes and names	Table 4.1
tblSamplePlotsGeneral	general information about the recording of sample plots	Table 4.3
tblSamplePlotsCanopy	primary data for trees in sample plots	Table 4.4
tblSamplePlotsCanopyErrorStatus	error codes for records in tblSamplePlotsCanopy	Table 4.5
tblSamplePlotsRegeneration	primary data for regeneration in sample plots	Table 4.6
tblCoreAreaGeneral	general information about the recording of core areas	Table 4.7
tblCoreAreaCanopy	primary data for trees in core areas	Table 4.8
tblCoreAreaCanopyErrorStatus	error codes for records in tblCoreAreaCanopy	Table 4.9
tblTreeSpecies	reference table for species codes	Table 4.10
tblTreeCondition	reference table for tree condition codes	Tables 4.11 and 4.12
tblErrorStatusCode	reference table for error status codes	Table 4.13

5.3 File formats for GIS data at the network and reserve level

The GIS files at network- and reserve levels, as documented in § 4.2.1, are available as ESRI shapefiles in the folder \gisnetwork. Table 5.2 gives an overview of these GIS files.

Table 5.2 *Overview of GIS files of the Dutch forest reserve network at the reserve level. See § 4.2.1 for details.*

GIS file	Description
ReserveBoundary	boundaries of the forest reserves (shapefile)
ReserveSamplePlots	50 x 50 m grid points for all reserves including sample plots (shapefile)
ReserveCoreAreaPolygon	core areas for all relevant forest reserves (shapefile)
ReserveCoreaAreaVertices	labelled vertices of core areas for all relevant forest reserves (shapefile)
ReserveSoil	soil maps of the forest reserves (shapefile)

5.4 File formats for GIS data for core areas

The GIS files for core areas, as documented in § 4.2.2, are available as ESRI shapefiles and ASCII GRID exchange files in reserve-specific folders named \gisreserve<rsv code>, e.g. \gisreserve03 for the Galgenberg reserve. Table 5.3 gives an overview of these files. Annex 1 lists all reserves (with reserve codes) and years of recording of the core areas.

Table 5.3 *Format of GIS filenames of core areas of Dutch forest reserves. <rsv code> refers to the unique reserve code and <year> the year of recording of the core area. See § 4.2.2 for details and examples.*

GIS file	Description
cp<rsv code>_<year>	crown projections (shapefile)
dl<rsv code>_<year>	lying dead wood (shapefile)
ds<rsv code>_<year>	standing dead wood (shapefile)
tb<rsv code>_<year>	trunk bases of living trees (shapefile)
bs<rsv code>_<year>.asc	tree species raster (ascii grid file)
zu<rsv code>_<year>.asc	canopy height raster (ascii grid file)

5.5 How to obtain these data?

The forest reserve data, as described is this chapter, are available from

https://doi.org/10.17026/dans-2bd-kskz

under the title 'Dutch forest reserves database and network'. The data further include the present WENR-report and a readme.txt with concise metadata.

The data are available under the licence agreement Open access for registered users (CC BY-NC). This means that every registered user has unlimited access.

Future additions to the forest reserve data set will be referenced by new dois along former dois, such that references to either set will remain unique and valid.

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Annex 1 Years of recording of sample plots and core areas

Years between parentheses refer to data not yet available in the online data set.

Reserve code	Reserve name	Sample plots	Core area
1	Starnumansbos	1989, 1997	1986, 1996
2	Lheebroek	1988, 1999, 2009	1987, 1999, (2009)
3	Galgenberg	1988, 1995, 2005	1986, 1995, 2005
4	Tussen de Goren	1988, 1996	1987, 1996
5	Vijlnerbos	1989, 1996	1987, 1996
6	Vechtlanden	1989, 2000	1986, 2000
7	Zeesserveld	1989, 2000	1986, 2000
8	Meerdijk	1991, 2000	(1985), 1999
9	Pijpebrandje	1988, 1998, 2018	1987, 1999
10	Nieuw Milligen	1989, 2002	1986, 2001
11	Drieduin 1	1990	1991
12	Drieduin 2	1990	1995
13	Drieduin 3	1990	1993
14	Leesten	1988, 2000, 2018	1988, 2000
15	Quin	1990, 2010	1991
16	Sang	1991, 2003	1993, 2003
17	Grootvenbos	2001	2001
18	Schoonloerveld	1993, 2004	1993, 2004
19	Oosteresch	1991, (2009)	1991
20	Roodaam	1992	1992
21	Riemstruiken	1991, 2007	1992
22	Zwarte Bulten	1991, 2005	1991, (2005)
23	Leenderbos	1992	1992
24	Schone Grub	1992	1983, 1996
25	Dieverzand	1992, (2010)	1992, (2010)
26	Keizersdijk	1992, 2002, 2008	1986, 1993, 2002, (2008)
27	Kloosterkooi	1994, (2003)	1993, 2003
28	Wilgenreservaat	1994	1983, 1993
29	Molenven	1995	1997
30	Beerenplaat	1993, 1995	(1981/85, 1991/95)
31	Tongerense Hei	1994	1993
32	Houtribbos	1997	1997
33	Hollandse Hout	1995, 2009	1996
34	Kijfhoek	1997	1983, (1993)
35	Geelders	1996	1996
36	Berkenvallei	(1998)	(transect 1985, 1998)
37	Slikken van Flakkee	(2004)	no core area
38	Pilotenbos	1997, 2010	1997
39	Smoddebos-Duivelshof	1998/99	1998
40	Duursche Waarden	no sample plots	no core area
41	Heul	1999	1999, (2011)
42	Bekendelle	no sample plots	(transect 1980, 1985, 1991), 1998
43	Liefstinghsbroek	2001	1983, 1993, (2001)
44	Rot	1998, 2009	1998, (2009)
45	Kremboong	1998	1998
46	Norgerholt	2002, 2009	1982, 1992, 2002
47	Stille Eenzaamheid	2000	2000
48	Horsten	1999	1999
49	Kampina	1998	1998

Reserve code	Reserve name	Sample plots	Core area
50	Smalbroeken	1998	(1998)
51	Mattemburgh	1998, (2010)	1997, (2010)
52	Herkenboscherheide	2000	2001
53	Bunderbos	2002	2002
54	Heloma- en Bleekerspolder	no sample plots	(2003)
55	Leyduin-Vinkenduin	2003	2002
56	Imboschberg	2000	2000
57	Grote Weiland	1999	1999
58	Oude kat	no sample plots	2004
59	Achter de Voort	2004	no core area
60	Ossenbos	2003	2003
101	Amerongen Galgenberg 1	no sample plots	2000

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