National forest accounting plan of the Czech Republic, including a proposed forest reference level

Submission pursuant to Article 8 of Regulation (EU) 2018/841

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MINISTRY OF AGRICULTURE
OF THE CZECH REPUBLIC

Ministry of the Environment
of the Czech Republic

With the contribution of Forest Management Institute andIFER – Institute of Forest Ecosystem Research, Ltd.

Contents

List of abbreviations

CBM	*Carbon Budget Model of the Canadian Forest Sector (also abbreviated as CBM-CFS3)*
CMA	*Czech Ministry of Agriculture*
CME	*Czech Ministry of the Environment*
CP	*Compliance Period (2021-2030)*
COSMC	*Czech Office for Surveying, Mapping and Cadastre*
CP 1	*First part of Compliance period (2021-2025)*
CP 2	*Second part of Compliance period (2026-2030)*
CzechTerra	*Landscape Inventory CzechTerra (also abbreviated as CZT)*
CZT 1	*CzechTerra measurement cycle 1 (2008-2009)*
CZT 2	*CzechTerra measurement cycle 2 (2014-2015)*
DW	*Deadwood – carbon pool including standing dead trees and stem parts lying on the ground*
CzSO	*Czech Statistical Office*
EFISCEN	*European Forest Information Scenario Model*
FMI	*Forest Management Institute, Brandýs n. Labem*
FRL	*Forest Reference Level*
FRL 1	*Forest Reference Level, part 1 applicable for 2021-2025*
FRL 2	*Forest Reference Level, part 2 applicable for 2026-2030*
HWP	*Harvested Wood Products*
IFER	*IFER – Institute of Forest Ecosystem Research, Ltd.*
KP	*Kyoto Protocol*
LB	*Living Biomass - carbon pool including below- and above-ground components of living trees*
LULUCF	*Land Use, Land-Use Change and Forestry*
NDFMP	*National Database of Forest Management Plans*
ND	*Natural Disturbance*
NFAP	*National Forest Accounting Plan*
NFI	*National Forest Inventory*
NFI 1	*NFI measurement cycle 1 (2001-2004)*
NFI 2	*NFI measurement cycle 2 (2011-2015)*
NIL	*National Forest Inventory*
NIR	*National Inventory Report (on greenhouse-gas emissions) under UNFCCC*
PA	*Paris Agreement*
PP	*Projection Period (2018-2030)*
RP	*Reference Period (2000-2009)*
UNFCCC	*United Nations Framework Convention on Climate Change*

CZECH NATIONAL FOREST ACCOUNTING PLAN
-
FOREST REFERENCE LEVEL

1. General introduction

1.1 General description forest reference level (FRL) for the Czech Republic

The estimation of the forest reference level (FRL) in the Czech Republic is based on i) activity data as used in the National greenhousegas emission inventory reporting for the Land Use, Land-Use Change and Forestry (LULUCF) sector, and ii)adoption of the specifically calibrated Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3, further denoted as CBM; Kull et al., 2016). CBM is calibrated on activity data as of 2004, which represent state of the forest and management practices of the Reference period (RP; 2000-2009). CBM estimates are based on the actual (known) activity data on wood harvest for the period 2000 to 2017, and these CBM runs represent so called calibration estimates. Since 2018, CBM projection estimates (2018 to 2030, i.e. including the Compliance period) are determined using the harvest data given by the ratio of biomass removals to biomass available for wood supply, which is held identical as observed for RP. The Czech FRL includes changes in above- and below-ground biomass, standing and lying deadwood, as well as the contribution of harvested wood products (HWP). Apart from the known extent of forest wildfires, no other natural disturbance (ND) is explicitly included. Czech Republic does not intend to use the ND provision and hence no "background level" is estimated and/or included in FRL (ref. to Annex VI of the LULUCF Regulation).

1.2 Consideration of the criteria from Annex IV of the LULUCF Regulation EU 2018/841

Table 1 provides the overview of the elements of the National Forest Accounting Plan according to Annex IV B of the EU LULUCF Regulation 2018/841 and the corresponding references in the document.

Table 1: Overview of the elements of the National forest accounting plan

Annex IV B paragraph item	**Elements of the Czech national forestry accounting plan according to Annex IV B.**	**Chapter and page number(s) in the NFAP**
(a)	A general description of the determination of the forest reference level	Sections 1.1, 3.1
(a)	Description of how the criteria in LULUCF Regulation were taken into account	Section 1.2
(b)	Identification of the carbon pools and greenhouse gases which have been included in the forest reference level	Sections 2.1, 3.1
(b)	Reasons for omitting a carbon pool from the forest reference level determination	Section 2.1
(b)	Demonstration of the consistency between the carbon pools included in the forest reference level	Section 4.2
(c)	A description of approaches, methods and models, including quantitative information, used in the determination of the forest reference level, consistent with the most recently submitted national inventory report.	Section 3
(c)	A description of documentary information on sustainable forest management practices and intensity	Section 3.2.3
(c)	A description of adopted national policies	Section 2.3.1
(d)	Information on how harvesting rates are expected to develop under different policy scenarios	Section 2.3.2
(e)	A description of how the following element was considered in the determination of the forest reference level:	-
	(i) The area under forest management	Section 3.2.1
	(ii) Emissions and removals from forests and harvested wood products as shown in greenhouse gas inventories and relevant historical data	Sections 4.1, 4.2
	(iii)Forest characteristics, including: - dynamic age-related forest characteristics - increments - rotation length and- other information on forest management activities under ‘business as usual	Sections 3.2.1, 3.2.3
	(iv) Historical and future harvesting rates disaggregated between energy and non-energy uses	Sections 3.3.2, 3.3.4

2. Preamble for the forest reference level

2.1 Carbon pools and greenhouse gases included in FRL of the Czech Republic

The following carbon pools are included in the Czech FRL: aboveground biomass, below-ground biomass, and deadwood. Also included is the contribution of the harvested wood products (HWP).

Excluded from the FRL are the following carbon pools: litter and soil organic carbon. These two carbon pools have been excluded for two reasons. Firstly, adequate data on litter and soil organic carbon forest land at country level (i.e., repeated quantitative forest soil inventory sampling) do not exist to provide sufficiently robust estimates on carbon stock changes and associated emissions. Secondly, there is an evidence from a published peer-reviewed scientific study that these carbon pools are not a net source of emissions under the scenarios of sustainable forest management under the conditions of the country (Cienciala et al., 2008b). That studywas based on the EFISCEN model (Schelhaas et al., 2007)that included a soil module YASSO(Liski et al., 2005) providing estimates for the two pools combined.

The following greenhouse gases are included in the Czech FRL: CO_2, N_2O and CH_4. The latter two gases originate from the prescribed biomass burning and wildfires.

2.2 Demonstration of consistency between carbon pools included in FRL

The consistency between the carbon pools included in the FRL and those in the Czech emission inventory is fully retained. The two pools not included in the FRL estimates (litter and soil organic carbon) have been identically treated in the reporting on 4.A.1 Forest land remaining Forest land, resorting to Tier 1 assumption of no change (IPCC 2006). Similarly, the reporting of Forest management (FM) under the Kyoto Protocol (NIR 2018) adopts the above reasoning of no net emissions from these two pools based on peer-reviewed modelling analysis performed for the actual circumstances of FM in the country (Cienciala et al., 2008b).

The consistency of emission and removal estimates and for the carbon pools included in the FRL and the contribution of HWP is detailed in section 4.2 of this document.

2.3 Description of the long-term forest strategy

2.3.1 Overall description of the forest and forest management in the Czech Republic and the adopted national policies

The national policies influencing forest management with respect to climate change mitigation and adaptation are: National Forest Programme II, Strategy of the Ministry of Agriculture with an outlook to 2030, State Environmental Policy and National Action Plan for Adaptation to Climate Change.

Forest land covers 34.1% of the area of the Czech Republic (2 686 645 ha) and forest stands alone 33.1% (2 607 841 ha). Forest cover has been slightly increasing (2 000 ha per year) over last years and this trend is likely to continue. The Czech forests are dominated by coniferous tree species (71.9%), mostly by Norway spruce (50.3%) and Scotch pine (16.3%), whereas broadleaved tree species amount to 27%. The reconstructed natural tree species composition is very different with 34.7% of conifers (only 11% of spruce) and 65.3% of broadleaves. Therefore, one of the principal goals after enactment of a new forest law in 1996 was to bring the tree species composition closer to the natural one. That is why it introduced an obligation for forest owners to ensure a minimum share of so-called soil-improving and stabilizing species (mostly broadleaved), when regenerating the forest stand. The goal has also been supported by financial contribution to forest owners. Since 2000, the share of spruce decreased by 3.8% (88 580 ha) and of pine by 1.3% (28 958 ha). Face-to-face with the rather rapid climate change this is not enough yet. A new decree of the Ministry of Agriculture, to be in force since 1st January 2019, almost doubles the obligatory minimal shares of soil-improving and stabilizing species, which will accelerate the changes and will have impact on forest related carbon pools.

2.3.2 Description of the future harvest rates under different policy scenarios

The current forest sector outlooks are strongly affected by current severe impacts of climate change (increasing air temperatures and lack of precipitation in vegetation season), manifested by unprecedented bark beetle outbreak affecting coniferous (especially spruce) forest stands. After the reference period, we witnessed a decline of annual removals to the level of 15 mil. m^3 first and then, since 2015, rather abrupt increase up to 19.4 mil. m^3 in 2017. It is worth adding that in the same period the total mean increment increased from 16.8 mil. m^3 in 2000 to 18 mil. m^3 in 2017, and the total current increment increased from 19.8 mil. m^3 in 2000 to 22.1 mil. m^3 in 2017. This means, however, that annual removals already exceeded the total mean increment in 2017.

The increase of removals since 2015 can be attributed to the growing amount of salvage felling caused by windstorms, drought, bark beetle or other pests. In 2018 the bark beetle outbreak further developed and according to current estimates, the salvage felling caused by bark beetle could reach 12-14 mil. m^3 in 2018 and may further significantly rise in 2019. On the other hand, the planned harvesting of coniferous species has been completely stopped in state forests since March 2018 (at 56% of forest area) and significantly reduced in non-state forests. The harvest rates therefore become hardly predictable in the years to come and will depend mostly on ability to get the bark beetle outbreak under control.

3. Description of the estimation approach

3.1 Description of the general approach as applied for estimating FRL

The estimation of the FRL in the Czech Republic includes assessment of carbon stock changes in living biomass, changes in deadwood and emission contribution of HWP (Table 2).Potential changes in other carbon pools (litter and soil organic carbon) are not included in FRL of the Czech Republic. The estimation of changes in living biomass and deadwood is aided by a specifically calibrated Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3, further denoted as CBM; Kull et al., 2016), whereas the estimates of HWP contribution is guided by the adopted IPCC methodologies (IPCC 2006, 2014) as used in the Czech emission inventory. Spatially, FRL concerns forest land as defined by the Czech Forest Act (289/1995), which is linked to the cadastral forest land use category and the cadastral system of land use in the country. The specific details on CBM application and details on forest land are described below.

Table 2: General approach applied for estimating the Czech FRL – carbon pools as treated in FRL and estimation approach used. *Above- and below-ground biomass are reported jointly as Living biomass (LB) in this report.

Carbon pools/components	Treatment in FRL	Approach used
Above-ground biomass*	Included as a part of LB	CBM estimate
Below-ground biomass*	Included as a part of LB	CBM estimate
Deadwood	Included	CBM estimate
Litter	Excluded	n/a
Soil organic carbon	Excluded	n/a
Harvested wood products (HWP)	Included	Production approach (IPCC 2006, 2014) linked to CBM harvest estimates

The adopted concept of the CBM estimation over the relevant timeline is summarized in Figure 1. The data as of year 2004 were selected to represent Reference period (RP). These data were primarily used to feed CBM in terms of forest area and growing stock volume, and to calibrate increment functions. The model runs for the period 2000-2017 were driven by the actual (historical) harvest data and constrained as for species composition changes. These estimates were used to demonstrateconsistency with the national greenhouse gas inventory data. Since 2018, the CBM projections were generated so as to maintain a constant representation of tree species with the harvest demand determined by the ratio of "harvest to biomass available for wood supply" (Grassi and Pilli, 2017), which was held identical as in RP (including thinning, salvage logging and final cut). The annual projections for CP1 period (2021-2025) constitute the basis of estimating the average values representing FRL 1 (Table 2). Correspondingly, the annual projections for CP2 period (2026-2030) are used to estimate the average for FRL 2 They include carbon stock change for the three carbon components (above-ground biomass, below-ground biomass, deadwood) and the HWP contribution estimated with a help of the projected harvest volumes. Note that above- and below-ground biomass carbon pools are reported jointly as living biomass (LB) in this report, because below-ground biomass is determined as a function (fraction) of above ground biomass, hence being perfectly correlated.

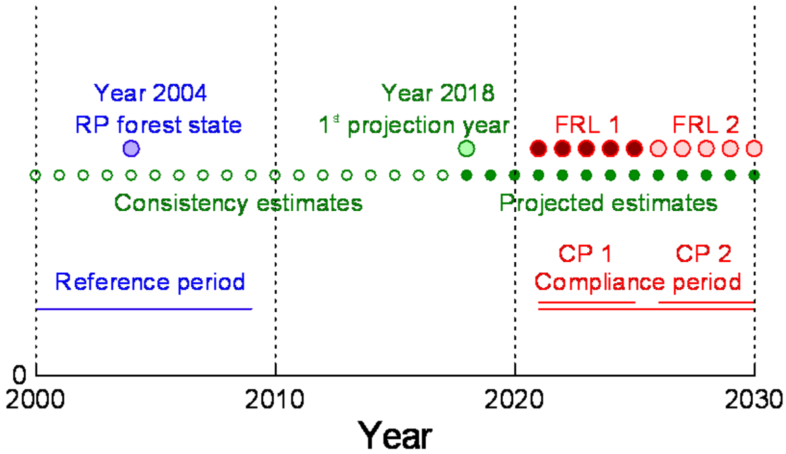

Figure 1: Timeline overview of the FRL estimation approach: Reference period (RP; 2000-2009) is represented by data on forest state as of 2004 used to calibrate growth in CBM. CBM is driven by the reported/historical harvest data for 2000 to 2017 to demonstrate the consistency with the NIR estimates. Year 2018 is the first year of the Projection period (PP; 2018 to 2030) and the CBM projectedestimates are driven by harvest based on "wood removals to biomass available for wood supply" ratio that is maintained identical (constant) in RP.The mean of the projection estimates for years 2021 to 2025 represents FRL 1, the first half of the CP (CP 1). Correspondingly, FRL 2 is given by the mean of estimates for 2026-2030, the second part of CP (CP 2).

3.2 Documentation of the data sources as applied for estimating FRL

3.2.1 Data on forest area and stratification of the managed forest land

The forest stratification used for estimating the Czech FRL is organized firstly by the categories based on legislatively designated (Forest Act 298/1995) main forest function. This categorization predetermines differences in forest management practices on these forest categories. Secondarily, the adopted stratification identifies forest management practices by the key tree species groups (Table 3).

According to the valid Czech Forest Act (289/1995), forests in the Czech Republic are defined as "forest stand with its environment and land designated for the fulfilment of forest functions". This definition links directly to the adopted system of land-use representation and land-use change identification in the Czech National Inventory of greenhouse gas emissions in the LULUCF sector, which is exclusively based on the cadastral land-use information of the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz, NIR 2018). Therefrom, forest land is the land that is declared in the cadastral land-use information of COSMC as a land designated to fulfil forest functions. It is a land with forest stand and land, where forest stands were temporarily removed to permit their regeneration, forest break and unpaved forest road, not wider than 4 m, and land, where forest stands were temporarily removed due to a decision of the state forest administration. All such assigned lands must be managed in an efficient manner in accordance with Forest Act. It is prohibited to use it for any other purposes. Moreover, according to Forest Act, it is obligatory to prepare Forest management plan (FMP) for all forest properties above 50 ha, while for smaller properties, a simpler form of FMP called Forest Management Guidelines (FMG) are mandatorily developed.

Table 3: Adopted stratification of forest land for the Czech FRL estimation (*Forest area data as for 2004).

Climatic domain	Major functional category	Species group	Forest management typestratum abbreviation	Forest area (kha)*
Czech Republic	Managed forest	Beech	CZ-MAN-BE	297.5
		Oak	CZ-MAN-OA	122.8
		Pine	CZ-MAN-PI	365.0
		Spruce	CZ-MAN-SP	1167.4
	Protection forest	Beech	CZ-PRO-BE	16.7
		Oak	CZ-PRO-OA	4.7
		Pine	CZ-PRO-PI	15.8
		Spruce	CZ-PRO-SP	42.8
	Special purpose forest	Beech	CZ-SPE-BE	128.1
		Oak	CZ-SPE-OA	43.4
		Pine	CZ-SPE-PI	71.0
		Spruce	CZ-SPE-SP	315.8

The Czech Forest Act (289/1995) divides forests in the country into three major categories according to their prevailing functions, in particular into protection forests (PRO), special purpose forests (SPE) and commercial (production) forests (MAN). The following definition applies for these categories:

Protection forests (PRO)

a. forests at exceptionally unfavourablesites (debris, stone seas, sharp slopes, ravines, unstable sediment or sand, peatland, spoil banks or spoil heaps etc.)
b. high-elevation forests below the boundary or wooded vegetation protecting forests situated lower and forests on exposed ridges
c. forests in the dwarf pine vegetation zone

Special purpose forests(SPE) - forests that are not protection forests and are situated

a. in zones of hygienic protection of water resources of 1st degree
b. in protection zones of natural healing and table mineral waters
c. on the territory of national parks and national nature reserves

The category SPE can also be applied to forests, where based on a general interest any other forest function is superior to the wood-producing functions. These include the following forests:

d. forests in the first zones of protection country areas and forests in natural reserves and at sights of natural interest
e. spa forests
f. suburban forests and other forests with an increased recreation role
g. forests serving the purposes of forestry research and forestry education
h. forests with increased functions in the area of soil protection, water protection, climate or landscape formation

i. forests necessary for the preservation of biological diversity
j. forests in recognized hunting areas and separate peasantries
k. forests where important public interest calls for a different method of management

Production forests(MAN) are forests that are not included in the category of protection forests or special purpose forests.

The national database of forest management plans and guidelines (NDFMP), administered centrally by the ForestManagement Institute (FMI) at Brandýs n. Labem,was used as the main data source on forests in the country. NDFMP represents an ongoing national stand-wise type of forest inventory. It provided detailed data (at level of individual forest stands) on area share covered by particular tree species. Within each functional forest category (MAN, PRO, SPE), tree specieswere grouped into four groups of tree species, namely Spruce (SP), Pine (PI), Beech (BE), Oak (OA). All species of the genus *Pinus* were included in the species group Pine,while all other coniferous tree species were then included in the species group SP. All species of the genus *Quercus* were included in the species group Oak, while other broadleaved tree species were included in the species group BE. This gives the stratification framework and resulting Forest Management Types (FMPs) as summarized in Table 3.

Based on the year 2004, the total forest area explicitly included for estimating the Czech FRL equals to 2 591 052 ha of timberland including clear-cut patches. However, it implicitly represents 2 645 740 ha of cadastral forest land. The area of 54 688 ha (2% of the total cadastral forest land) represents temporarily unstocked cadastral forest land not used for production at the given time, which is similarly discounted in the Czech emission inventory.

The total cadastral forest area (and timberland) marginally increased from 2.637 (2.583) Mha in 2000 to 2.655 (2.594) in 2009, the end of RP. A similar trend was retained until 2017, when the total cadastral forest area (and timberland) reached 2.672 (2.608) Mha (Figure 2). The annual net gain of forest area was about 2 kha. Note, however, that forest area is held constant as of 2004 for the entire period of 2000 to 2030 in the adopted concept of the Czech FRL.This meets the requirements of the EU LULUCF Resolution, which instructs to account for deforestation and afforestation separately.

Species composition also changed during the RP and thereafter. It followed the general trend of the National forest adaptation strategy as declared in the National Forest Programme (MA 2009). Following the species grouping used in this material, the share of Spruce species category decreased from 58.9% to 57.3% and 55.5% in 2009 and 2017, respectively. The areas of broadleaved species increased correspondingly – the share of Beech species group increased from 16.0% in 2000 to 18.0% and 19.7% in 2009 and 2017, respectively. The area share of Oaks increased from 6.3% in 2000 to 6.8% and 7.2% in 2009 and 2017, respectively. It should be noted that the modelling concept mimics this development of species change, as described in the details of CBM application below. The species areas are held constant since 2018 and across the entire CP (Figure 1).

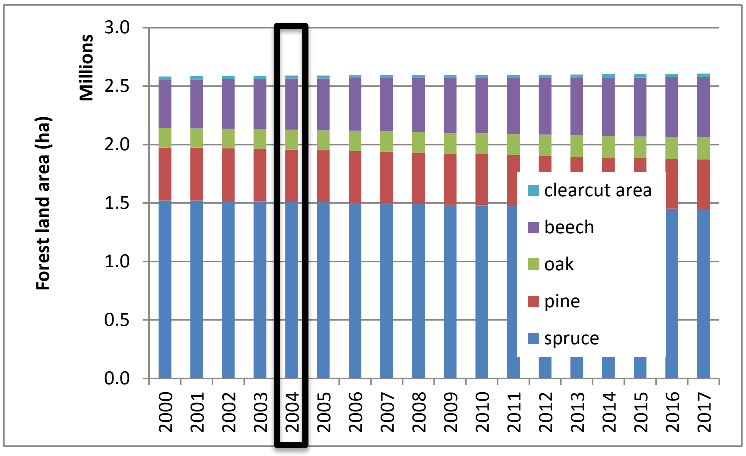

Figure 2: Forest area development and species (species group) composition in the period 2000 to 2017. Highlighted is year 2004 that was selected to represent RP (2000-2009) and used for data input and calibration of CBM.

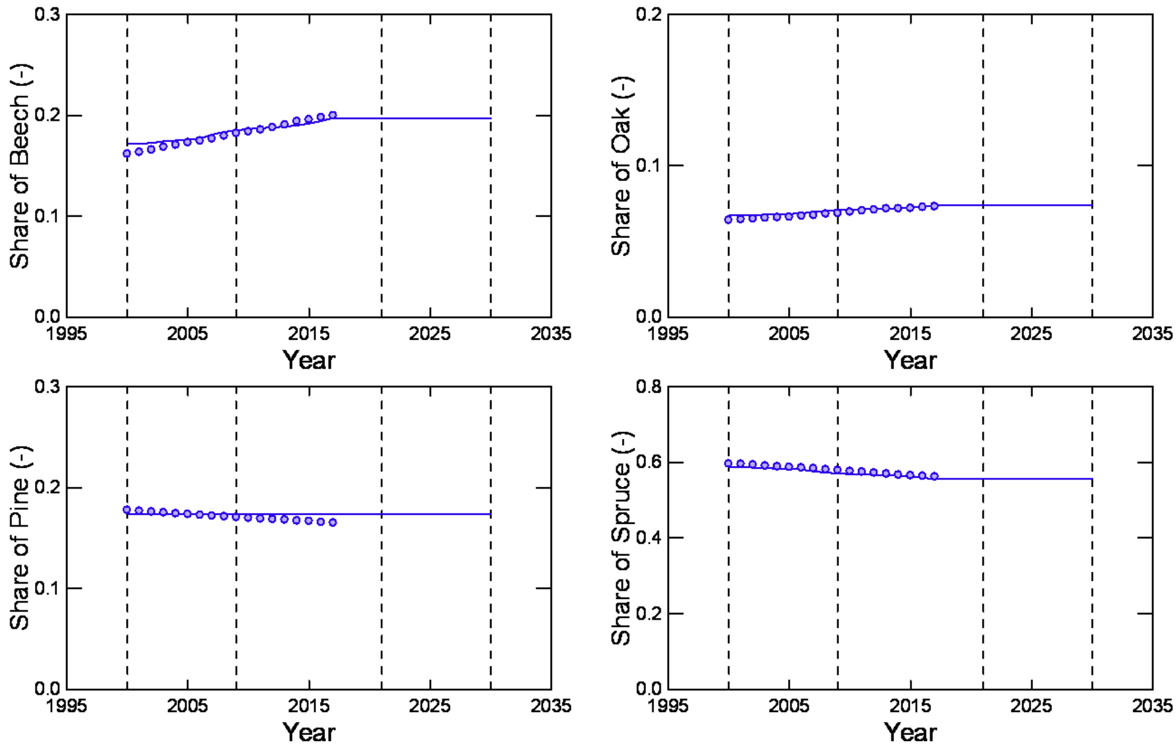

Figure 3: Actual forest area (symbols) of species groups and their representation by CBM (solid line) for the entire period from 2000 to 2030.

Apart from forest/timberland area, NDFMP contains data on growing stock volume by age classes. The development of age-structure and corresponding volume of growing stock for individual strata by functional types and species groups is shown in Figure 4 and Figure 5, respectively. Complementarily, the current annual increment (CAI) based on the valid Czech Growth and Yield tables (Cerny et al. 1996) estimated for these strata, is also shown (Figure 6). Data for years 2000, 2004, 2009 and 2017 are shown. Years 2000 and 2009 represent the start and end of RP. Year 2004 is the calibration year to represent RP in CBM (cf. Figure 1). Finally, year 2017 is the last year for which the activity data (harvest volumes) are known, including greenhouse gas emission estimates for the category Forest land remaining Forest land to be reported in the Czech NIR 2019 submission including reporting period 1990 to 2017.

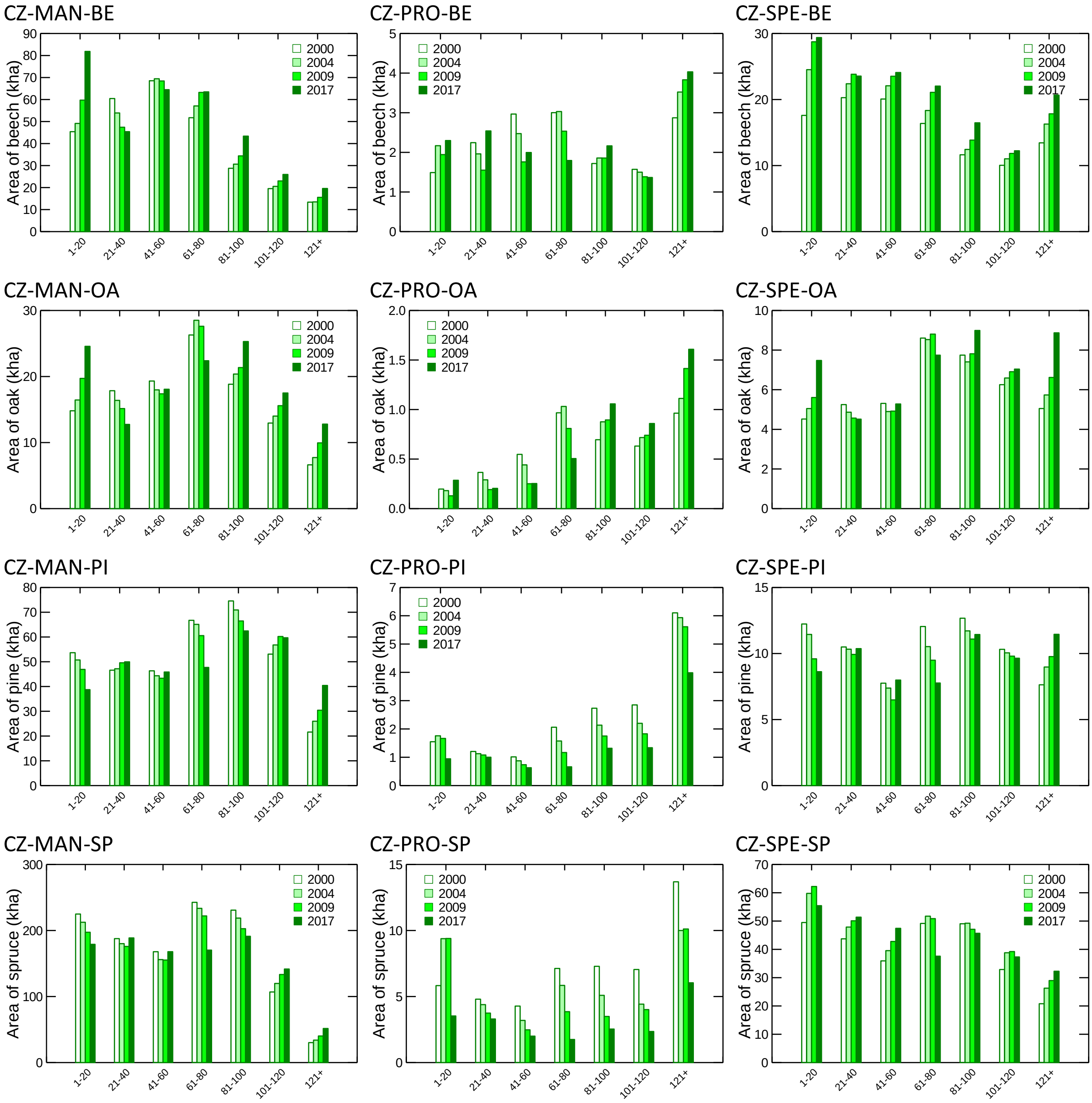

Figure 4: Age class development for the individual strata by functional category, species group and age class – years 2000, 2004, 2009 and 2017 are shown.

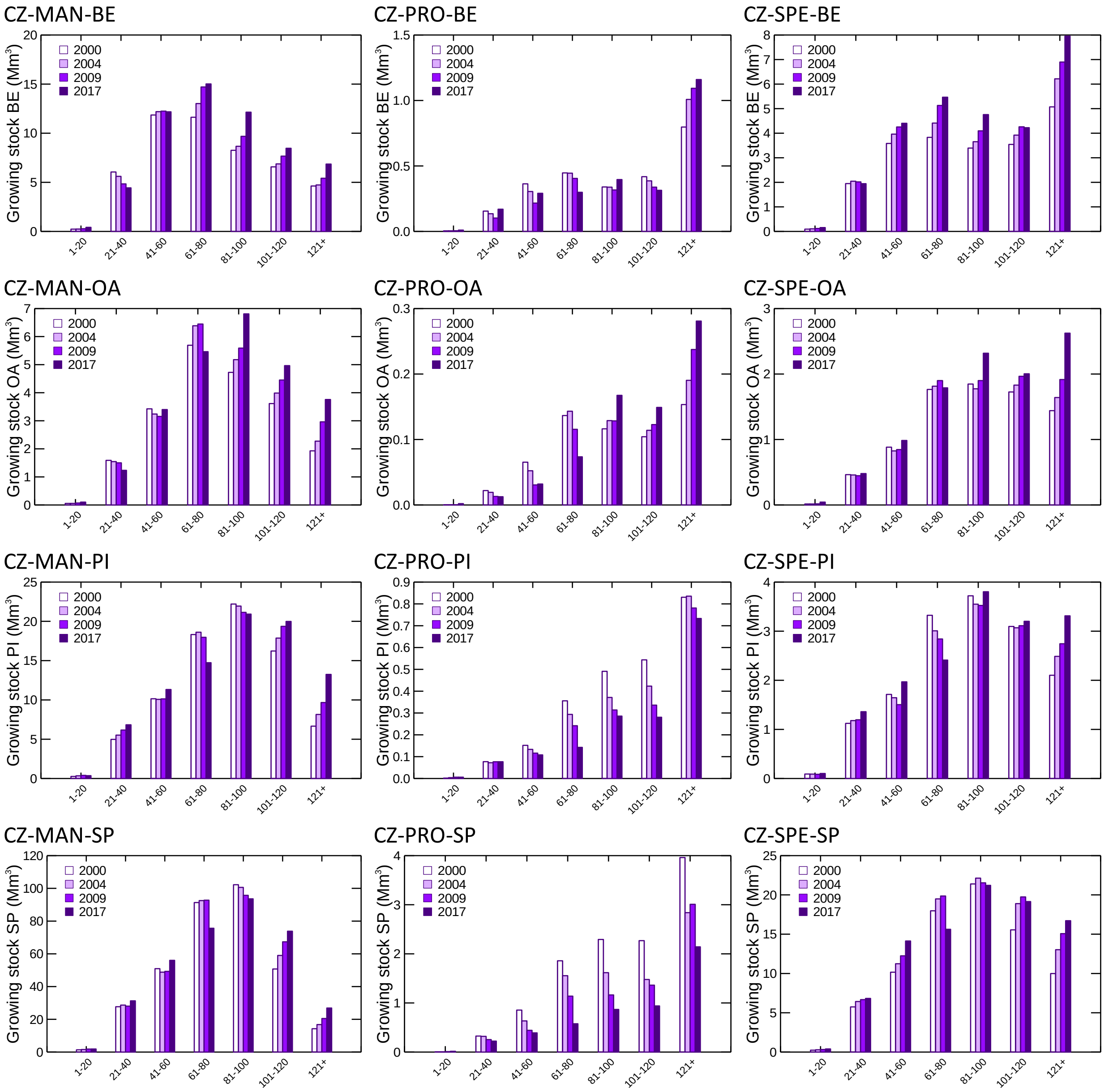

Figure 5: Growing stock volume for the individual strata by functional category, species group and age class – years 2000, 2004, 2009 and 2017 are shown.

Figure 4 and Figure 5 illustrate a common development of age structure with increasing proportion of older age classes and sub-normal proportion of younger age classes. In long-term, this development is considered as one of the potential threats to sustainable wood supply for the future decades. Figure 6 shows development of CAI during the period of 2000 to 2017: CAI increases for most of the strata. This is due to several factors including an effect of management practices on age class structure and species composition, as well as the likely effects of environmental change (N-deposition, temperature, CO_2).

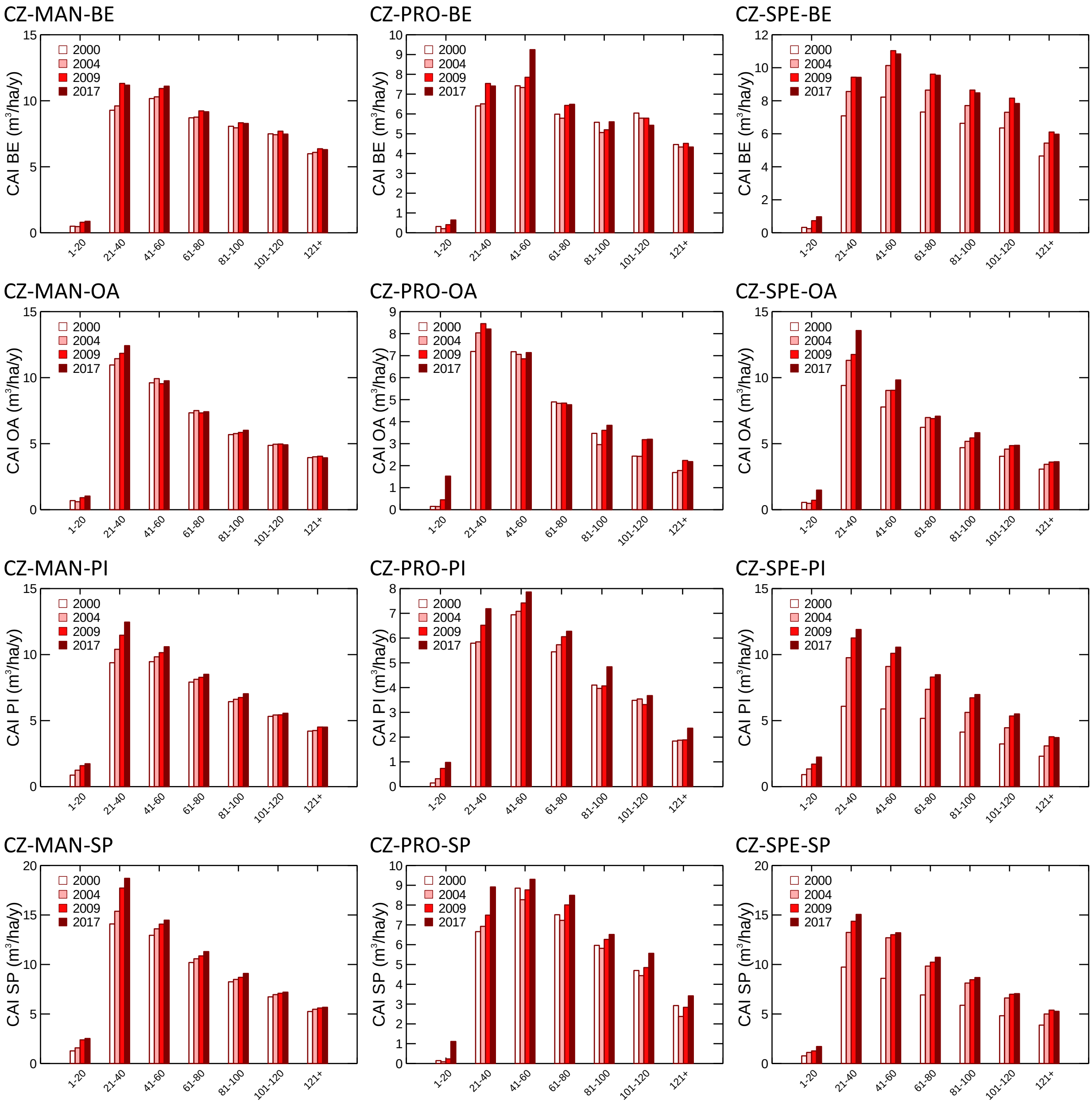

Figure 6: Current annual increment (CAI) for the individual strata by functional categories, species groups(BE, OA, PI, SP) and age classes – years 2000, 2004, 2009 and 2017 are shown.

3.2.2 Data sources on deadwood carbon pool

Data on above-ground deadwood (DW) are available from two main sources – sample-based inventory projects: the landscape inventory project CzechTerra and the National Forest Inventory (NFI). It should be noted that these data remain uncertain for deriving trends in carbon stock change in DW pool and its components. This is because these data are not fully comparable due to the adopted specific definitions of the particular DW components that differbetween the both sources. Table 4 offers the overview of the available national empirical data on deadwood that can be indicatively used to verify the estimates of CBM for changes in deadwood carbon pool at the level of two components - standing and lying DW, respectively, as used for NIR (2018, 2019).

Table 4: Deadwood(carbon pools – available estimates (Mg C/ha) at the national scape from the CzechTerra (CZT) and NFI campaigns. Pools not included in NIR (2018, 2019) are noted by italics.

Deadwood pool	CZT1	CZT2	NFI1*	NFI2
Years	2008-2009	2014-2015	2001-2004	2011-2015
	Mg C/ha			
Standing deadwood	1.14	1.21	0.60	0.56
Stumps	-	-	-	0.53
Lying deadwood	0.98	0.37	0.85	1.13
Lying branches	-	-	-	0.94
Total included for NIR	2.12	1.58	1.45	3.15

* *NF1 1 data on DW were reported only in volume units. The estimation of the corresponding carbon content values shown here were derived from a ratio of DW_carbon_amount/wood_volume from CZT 1 data.*

The development in forestry sector of the very recent years (2015 to 2018) suggests a notable increase in both standing and lying deadwood due to the unprecedented decline of coniferous forest standssuffering from severe water deficit conditions accompanied by uncontrolled bark-beetle outbreak (see also Section 2.3.2). This development has not been quantified in terms of carbon in deadwood components yet.

3.2.3Description of forest management practices

The four main forest management practices (FMP) applicable for the tree species groups of Beech, Oak, Pine and Spruce, are described in qualitative terms in Table 5. The quantitative terms are listed at the level of individual FMT strata (Table 3) inTable 6. They include the following forest characteristics: actual (2004) rotation length, regeneration period, thinning regime and final felling age span.

The definition of the biomass removal as a function of the age and state of the forest (age class) was used for the description of FMPs (Table 6). Biomass removals in quantitative terms is not defined according to each specific activity, but directly as a function of the age and state of the forest and expressed as proportion of harvest to biomass available for wood supply (P_Av). These values are also shown in Table 6 and the observed P_Av values were used to calibrate harvest during Projection (PP) and Compliance (CP) period (Section 3.3.4).

Cleanings, which are also a part of the regular forest management in the Czech Republic, are not defined in Table 6, because amount of wood cut by cleanings is insignificant; it generally concerns young trees with dimensions under the limit of merchantable wood (7 cm over bark).

Determination of age classes associated with final harvest for the particular strata (Table 6) is based on the analysis of average rotation length and regeneration period, which was calculated in NDFMP.

Table 5: Qualitative terms of Forest Management Practices (FMP) applied during the RP

Forest Management Practices		
Index	**Short description of practice**	**Determination of actual biomass removal**
FMP_{spruce}	FMP_{spruce} consists of natural regeneration or planting of seedlings, pre-commercial thinning of young stands, one thinning every ten years until the age 80 and a final harvest through partial cutting or clear-cutting. Salvage fellings caused by abiotic and biotic agents occur at the age 21 to 140. The harvest schedule and biomass removals in harvests are regulated by Forest Act (Act No. 289/1995 on Forests and amendments to some acts), defined in detail in the Framework management guidelines of the Regional Plans of Forest Development.	Biomass removals used in the FRL are based on observations of actual harvests in Reference period 2000-2009. Biomass removalsare set by a ratio of "harvest to biomass available for wood supply" determined through calculating harvest probability for a given age class using the method described in JRC technical report "Projecting the EU forest carbon net emissions in line with the "continuation of forest management": the JRC method (Grassi and Pilli, 2017), listed as Alternative 1 for the harvest module in Guidance on FRL (Forsell et al. 2018).
FMP_{pine}	FMP_{pine} consists of natural regeneration or planting of seedlings, pre-commercial thinning of young stands, one thinning every ten years until the age 80 and a final harvest through partial cutting or clear-cutting. Salvage fellings caused by abiotic and biotic agents occur at the age 21 to 140. The harvest schedule and biomass removals in harvests are regulated by Forest Act (Act No. 289/1995 on Forests and amendments to some acts), defined in detail in the Framework management guidelines of the Regional Plans of Forest Development.	Biomass removals used in the FRL are based on observations of actual harvests in Reference period 2000-2009. Biomass removals are set by a ratio of "harvest to biomass available for wood supply" determined through calculating harvest probability for a given age class using the method described in JRC technical report "Projecting the EU forest carbon net emissions in line with the "continuation of forest management": the JRC method (Grassi and Pilli, 2017), listed as Alternative 1 for the harvest module in Guidance on FRL (Forsell et al. 2018).
FMP_{beech}	FMP_{beech} consists of natural regeneration or planting of seedlings, pre-commercial thinning of young stands, one thinning every ten years until the age 80 and a final harvest through shelterwood system. Salvage fellings caused by abiotic and biotic agents occur at the age 21 to 140. The harvest schedule and biomass removals in harvests are regulated by Forest Act (Act No. 289/1995 on Forests and amendments to some acts), defined in detail in the Framework management guidelines of the Regional Plans of Forest Development.	Biomass removals used in the FRL are based on observations of actual harvests in Reference period 2000-2009. Biomass removals are set by a ratio of "harvest to biomass available for wood supply" determined through calculating harvest probability for a given age class using the method described in JRC technical report "Projecting the EU forest carbon net emissions in line with the "continuation of forest management": the JRC method (Grassi and Pilli, 2017), listed as Alternative 1 for the harvest module in Guidance on FRL (Forsell et al. 2018).

Forest Management Practices		
Index	**Short description of practice**	**Determination of actual biomass removal**
FMP_{oak}	FMP_{oak} consists of natural regeneration or planting of seedlings, pre-commercial thinning of young stands, one thinning every ten years until the age 80 and a final harvest through through partialcutting or clear-cutting. Salvage fellings caused by abiotic and biotic agents occur at the age 21-140. The harvest schedule and biomass removals in harvests are regulated by Forest Act (Act No. 289/1995 on Forests and amendments to some acts), defined in detail in the Framework management guidelines of the Regional Plans of Forest Development.	Biomass removals used in the FRL are based on observations of actual harvests in Reference period 2000-2009. Biomass removals are set by a ratio of "harvest to biomass available for wood supply" determined through calculating harvest probability for a given age class using the method described in JRC technical report "Projecting the EU forest carbon net emissions in line with the "continuation of forest management": the JRC method (Grassi and Pilli, 2017), listed as Alternative 1 for the harvest module in Guidance on FRL (Forsell et al. 2018).

Table 6: Quantitative terms of Forest Management Practices (FMP) applied during RP (2000-2009)as well as during the interim period until 2017. The proportion of realized wood harvest to biomass available for wood supply (P_Av) by individual management interventions representing wood removals (CBM coding DIST2, DIST3, DIST3b, DIST4) at the level of individual strata is also shown.

FMP	Strata	Average rotation length (years)	Average regenera-tion period (years)	Parameter	Thinnings (DIST2)	Salvage fellingswith clear-cut (DIST3)	Salvage fellingswithout clear-cut (DIST3b)	Final harvest (DIST4)
FMP_{beech}	CZ-MAN-BE	108.2	29.5	Age (years)	21-80	21-140	21-140	91-190
				P_Av (%)	0.45	0.36	0.18	2.08
	CZ-PRO-BE	147.5	54.7	Age (years)	21-80	-	-	121-190
				P_Av (%)	0.40	-	-	1.83
	CZ-SPE-BE	123.6	35.4	Age (years)	21-80	21-140	21-140	101-190
				P_Av (%)	0.32	0.19	0.09	0.95
FMP_{oak}	CZ-MAN-OA	126.8	29.0	Age (years)	21-80	21-140	21-140	111-190
				P_Av (%)	0.41	0.26	0.13	1.84
	CZ-PRO-OA	153.5	54.9	Age (years)	21-80	-	-	121-190
				P_Av (%)	0.59	-	-	2.90
	CZ-SPE-OA	135.4	33.5	Age (years)	21-80	21-140	21-140	111-190
				P_Av (%)	0.37	0.17	0.08	0.74
FMP_{pine}	CZ-MAN-PI	113.6	26.6	Age (years)	21-80	21-140	21-140	101-190
				P_Av (%)	0.61	0.31	0.15	1.88
	CZ-PRO-PI	154.9	58.0	Age (years)	21-80	-	-	121-190
				P_Av (%)	1.11	-	-	2.21

FMP	Strata	Average rotation length (years)	Average regenera-tion period (years)	Parameter	Thinnings (DIST2)	Salvage fellingswith clear-cut (DIST3)	Salvage fellingswithout clear-cut (DIST3b)	Final harvest (DIST4)
	CZ-SPE-PI	123.6	28.3	Age (years)	21-80	21-140	21-140	111-190
				P_Av (%)	0.88	0.42	0.21	2.17

FMP	Strata	Average rotation length (years)	Average regenera-tion period (years)	Parameter	Thinnings (DIST2)	Salvage fellingswith clear-cut (DIST3)	Salvage fellingswithout clear-cut (DIST3b)	Final harvest (DIST4)
FMP_{spruce}	CZ-MAN-SP	109.1	32.0	Age (years) (years)	21-80	21-140	21-140	91-190
				P_Av (%)	0.85	0.66	0.33	2.19
	CZ-PRO-SP	145.9	55.9	Age (years)	21-80	-	-	111-190
				P_Av (%)	1.52	-	-	3.99
	CZ-SPE-SP	123.2	36.3	Age (years)	21-80	21-140	21-140	101-190
				P_Av (%)	0.96	0.57	0.29	2.69

3.3 Detailed description of the modeling framework and estimation approaches

The mandatory components of FRL includecarbon changes in living tree biomass and deadwood, as well as the contribution of HWP. These components were estimated by adopting the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3, here denoted also as CBM),which was originally developed to meet the carbon accounting needs in Canada (Kull et al., 2016). CBM represents a flexible modelling framework that has also been applied for carbon-accounting purposes in European countries (Pilli et al., 2017, 2013). CBM is an inventory based, yield-data driven model that simulates the stand- and landscape-level carbon (C) dynamics of above- and below-ground biomass, and dead organic matter (DOM) including soil(Kurz et al., 2009). In its spatial representation beyond single stands, it can be flexibly set up so as to represent administrative and climate regions.

3.3.1 Input data - climate, forest growing stock, biomass equations and increment

Since the model application is guided by retaining maximum consistency with the greenhouse gas inventories (requested by the LULUCF regulation of EU 2018/841), no detailed climate stratification was used in for the simulated domain of the country. The mean representative climate indices including mean annual temperature (8.0°C) and precipitation (801 mm/year) were used. These were derived from the historical climatic records (2000-2009) derived from the data derived at the level of individual forest plots (n=604) of the statistical Landscape inventory CzechTerra (Cienciala et al. 2016). No climate trend was considered for the simulated period since 2018 (or since 2000 for consistency estimates) until 2030.

Within the simulated domain, the individual species-specific forest stand strata (Table 3) are primarily characterized by age classes (10-year bins used for CBM), corresponding areas and growing stock volumes. At that level they are linked to appropriate yield curves and parameters of the adopted silvicultural treatment. During the model run, a library of yield tables defines the gross merchantable volume production by age and species group, representing volume production in absence of natural disturbance and management practices (Pilli et al., 2013). In annual time step, CBM applies the net annual increment determined by actual periodic increment in managed stands as derived from actual data. Merchantable stem volume is converted to biomass using species specific stand-level equations (Boudewyn et al., 2007), partitioning volume production into stemwood, other (tops, branches, sub-merchantable trees) and foliage components.

For the Czech FRL, we used the country-specific biomass equations that were identical as used for the country by Pilli et al. (2017) with exceptions of the species-specific stem volume to above-groundbiomass equations (Eq. 7 of Boudewyn et al, 2007). These were reparametrized on the basis of tree biomass equations that include beech (Wutzler et al., 2008), oak (Cienciala et al., 2008a), pine (Cienciala et al., 2006) and spruce (Wirth et al., 2004) on the empirical material collected within the CzechTerra landscape survey (Cienciala et al., 2016). The details of this parametrization are reported in Supplementary material S1. The default (Pilli et al., 2017) and the altered parameters are listed in Table 7.

Table 7: Altered parameters of Eq. 7 (Boudewyn et al., 2007) for conversion of merchantable volume into above-ground tree biomass; new (default as in Pilli 2017) values are shown, together with the database code number

Species	Parameter *a*	Parameter *b*	CBM Database Code
Beech sp.	0.837 (0.825)	0.946 (0.957)	314
Oak sp.	0.807 (0.791)	0.965 (0.962)	320
Pine sp.	0.466 (0.830)	0.995 (0.874)	319
Spruce sp.	0.495 (0.914)	0.987 (0.871)	318

NDFMP data for year 2004 were used as activity data on forest resources to characterize forest growing stock during RP (Table 2) and to calibrate the increment as used in CBM at the level of individual strata. The input data included forest growing stock (V, merchantable volume under bark in m^3), corresponding areas (A, ha) and current annual increment (CAI, m^3) for age classes defined by 10-year bins. The

The applicable CAI was estimated by FMI based on the current growth and yield tables (Cerny et al. 1996), which are an inherent part of the Czech Forest Act. The historical increment was derived from the actual age class structure for the individual species-specific strata (Table 3). Both CAI and historical increment were expressed as function of age, using the combined exponential and power function (Sit 1994) as used by (Pilli et al., 2013), namely

$$CAI_t = a \times t^b \times c^t \qquad \text{Eq. 1}$$

where$t$ is age (years), and a, b, c are the parameters to be fitted, with a controlling the maximum increment and b, c controlling the shape of the curve. The details of this parametrization are reported in Supplementary material S2.

3.3.2 Input data – harvest volumes

The activity data on annual harvest volumes in period 2000-2017 are available from regular surveys performed annually by the Czech Statistical Office (CzSO). Since 2010 this data source includes also the estimates of the logging residues volume, while that fraction was estimated based on expert judgement (IFER) for earlier period. All logging residues are considered to be used as an energy source. The reported harvest data are summarized in Table 8.

Table 8:Annual harvest volumes of roundwood (used as industrial roundwood and fuelwood) as reported to FAO by the Czech Republic (source FAO, FMI, CzSO), and the estimated removals of logging residues (sources - IFER until 2010 and CzSO since 2011).

Year	Roundwood	of which		Logging residues
		Industrial roundwood	Fuelwood	
	th. m^3	th. m^3	th. m^3	th. m^3
2000	14 441	13 467	974	921
2001	14 374	13 283	1 091	846
2002	14 541	13 526	1 015	1 003
2003	15 140	13 930	1 210	1 451
2004	15 601	14 381	1 220	1 116
2005	15 510	14 236	1 274	1 041
2006	17 678	16 240	1 438	1 490
2007	18 508	16 638	1 870	2 414
2008	16 187	14 307	1 880	1 884
2009	15 502	13 769	1 733	1 438
2010	16 736	14 771	1 965	1 483
2011	15 381	13 467	1 914	1 700
2012	15 061	13 041	2 020	1 900
2013	15 331	13 041	2 182	1 800
2014	15 476	13 365	2 111	1 800
2015	16 163	13 827	2 336	2 000
2016	17 617	15 273	2 344	1 900
2017	19 387	17 011	2 376	2 100
Averageof RP	**15 748**	**14 378**	**1 371**	**1 360**

3.3.3 Implementation of forest management and disturbance interventions

All forest management interventions as well as unplanned disturbances (fires) are defined within CBM by so called disturbance events. For the purpose of the Czech FRL estimation, the following disturbance events (DIST.) were considered and implemented: forest fire (DIST. 1), removals by thinning (DIST. 2), salvage logging interventions defined as sanitary felling of dead, dying or damaged trees after windstorm, insect or fungal infestation or other reasons (DIST. 3, 3a, 3b), planned final cut (DIST. 4) and clear-cut with slash-burn (DIST. 5). These interventions are summarized inTable 9.

The activity data on the spatial extent of forest wildfires since 2000 until 2017 and the applied average of RP (343 ha/year) for the projection years 2018 to 2030 (DIST. 1) are shown in Figure 7. Due to a high inter-annual variability, there is no significant trend neither in area or number of forest fires during RP. However, when considering a longer time frame such as from 1970s until 2017, there is a significant trend in number of fires ($p=0.003$; data not shown), although area burnt remains about constant due to the gradually improving national fire prevention system.

Table 9: Set of specific disturbance events used in CBM for the Czech FRL estimation

Identification and name	Input type	Description, data source and CP projection set-up
DIST. 1 Forest fire	Area	Unintended fire events (wildfires) due to natural or unplanned human intentional or negligent causes of ignition. Excludes prescribed burning of forest residues. **Data source:** official statistics collected by Fire Rescue Service of the Czech Republic **CP projection:** average area burnt by fires in RP 2000-2009 (343 ha/year) was used for CP by CBM
DIST. 2 Thinning	Mass (Volume)	Specific thinning intensities are recommended in the Forest act for the main tree species (Spruce, Pine, Oak, Beech) based on stocking and age class. **Data source:** official statistics collected by Czech Statistical Office – area, total amount of wood cut by thinning **Methodology:** data from the official statistics were recalculated for the defined strata using the share of main tree species removals to total removals and the proportion of forest area AGEID3 - AGEID8 (21-80 year) according to prevailing functional category. **CP projection:**The specific quantity for individual strata (Forest Management Types) was derived as described in Section 3.3.4
DIST. 3 Salvaging with clear-cut and species change	Mass (Volume)	Salvage felling caused by biotic and abiotic agents results in clear-cut areas. The salvage felling occurs mainly in production forests (MAN) and special purpose forests (SPE) in the country. **Data source:** official statistics collected by Czech Statistical Office – total amount of wood from salvage fellings **Methodology:**salvage felling was allocated in the categories of production forests (MAN) and special purpose forests (SPE). Data from the official statistics were attributed to the defined strata using the share of main tree species removals to total removals and the proportion of annual clear-cut area of production forests (MAN) and special purpose forests (SPE) as registered in the NDFMP. In case of tree species group Spruce, tree species composition change was implemented modelled using Transitions in CBM. Spruce stands after salvage felling werereplaced by beech (53%), oak (14%) and spruce (33%). These percentage shares were calibrated on real change of tree species compositions reported in NDFMP. **CP projection:**DIST. 3 is not applicable for CP, as it is used only during the period 2000-2017 to reproduce actual (historical) tree species composition change.
DIST. 3a Salvaging with clear-cut and no species change	Mass (Volume)	Salvage felling caused by biotic and abiotic agents which results in clear-cut area arising during CP projection (2018-2031). This type of disturbance was used to maintain constant tree species composition since 2018, i.e., after the change defined in DIST. 3 during 2000-2017 in order to meet the requirements of the LULUCF Regulation. **CP projection:**DIST3a is used to counterpart DIST. 3 with no species change The specific quantity for individual strata (Forest Management Types) was derived as described in Section 3.3.4

Identification and name	Input type	Description, data source and CP projection set-up
DIST. 3b Salvaging (soft) without clear-cut and species change	Mass (Volume)	Salvage felling caused by biotic and abiotic agents which do not result in clear-cut areas, but only distributed fragmental biomass removals. It means it is not a stand replacing disturbance event. **Data source:** official statistics collected by Czech Statistical Office –total amount of wood cut by salvage fellings **Methodology:**Salvage felling that occurred in protection forests (PRO) was included in production forests (MAN) and special purpose forests (SPE) salvage fellings. They were not calculated separately. Figures from the official statistics were recalculated on the defined strata using the share of main tree species removals to total removals and the proportion of annual clear-cut area of production forests (MAN) and special purpose forests (SPE) registered in the NDFMP. **CP projection:**The specific quantity for individual strata (Forest Management Types) was derived as described in Section 3.3.4
DIST. 4 Final harvest	Mass (Volume)	Final harvest represents intentional fellings which are based on rotation and regeneration period. **Data source:** official statistics collected by Czech Statistical Office - total wood removals minus amount of thinning and minus amount of salvage fellings. **Methodology:** Figures from the official statistics were recalculated on the defined strata using the share of main tree species removals to total removals and the proportion of annual clear-cut area of production forests (MAN), special purpose forests (SPE) and protection forest (PRO) registered in the NDFMP. **CP projection:**The specific quantity for individual strata (Forest Management Types) was derived as described in Section 3.3.4
DIST. 5 Clear-cut with slash-burn	Area	Clear-cut with slash-burn is a disturbance type which is used in CBM only for stand initialization.

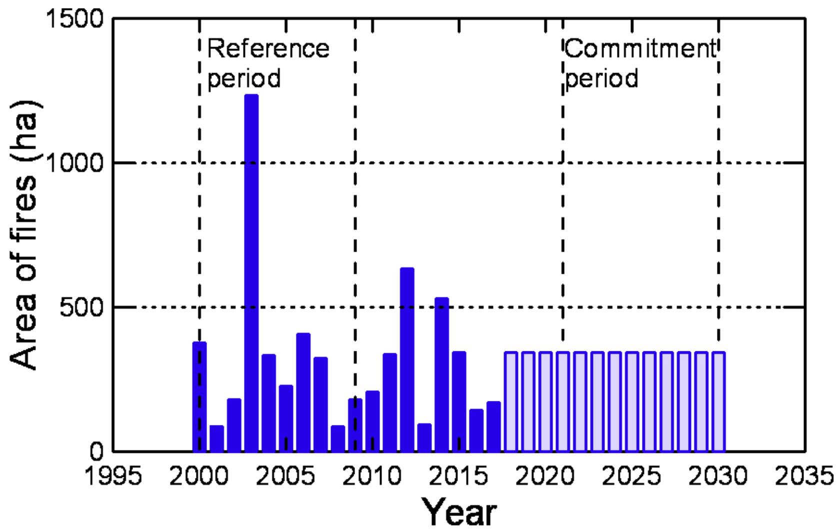

Figure 7: The reported area of forest fires in 2000-2017 and that projected for the period 2018-2030 given by the average of the RP (2000-2009) values.

The flow of carbon among various ecosystem carbon pools caused by a disturbance or management event represented in CBM is described by so the called disturbance matrices. Composing the CBM simulations, the default disturbance matrices were specifically calibrated to domestic conditions and prevailing management procedures according to available information and expert judgement.

The specific adjustments are explained in a form of disturbance matrices, where rows define the originating pools and columns represent the target pools.The key aspects of particular disturbance matrices are summarized inTable 10. The complete disturbance matrices as used in CBM are documented in Annex S3.

Table 10: List of disturbance events and description of the applicable disturbance matrices used in CBM for the Czech FRL estimation

Disturbance event	Description of corresponding disturbance matrix
DIST. 1 Forest fire	Disturbance matrix leaves the main part (75%) of merchantable wood untouched and assumes burning most of the relevant part of foliage and above ground fine deadwood
DIST. 2 Thinning	Disturbance matrix assumes using 10% of merchantable wood in products, relevant part of other carbon pools (foliage etc.) representing the harvest residues follows natural processes of decay.
DIST. 3 Salvaging with clear-cut, with species change	Disturbance matrix assumes using 80% of softwood merchantable and 92% of hardwood merchantable together with the majority of standing deadwood (stem snags) as a product.The relevant parts of logging residues are burnt.
DIST. 3a Salvaging with clear-cut, no species change	
DIST. 3b Salvaging (soft) without clear-cut,no species change	Disturbance matrix assumes harvesting 20% of merchantable volume as products. The relevant part of other carbon pools (foliage etc.) follows natural processes of decay.
DIST. 4 Final harvest	Disturbance matrix describes regular final cut being carried out in country. Major part of merchantable wood (82% softwood, 88% hardwood) is harvested as products.The relevant parts of logging residues are burnt.
DIST. 5 Clear-cut with slash-burn	Disturbance matrix describes final cut together with burning the remaining residues. Major part of merchantable wood (95%) is harvested as products – used only for model initialization.

3.3.4Calibrating wood removals - assuring consistency of management practices

The approach for modellingmanagement practices applicable for the projection period since 2018 to 2030 (PP) followed the JRC methodology (Grassi and Pilli, 2017), which corresponds to Alternative 1 of Forsell et al (2018) – Maintain the “harvest to biomass available for wood supply” ratio. It was used at the level of individual strata (Table 3) and implemented in the following steps:

1) The main disturbance events DIST. 2 Thinning, DIST. 3 Salvaging with clear-cut and species change, DIST. 3a Salvaging with clear-cut and no species change, DIST. 3b Salvaging (soft) without clear-cut and species changeand DIST. 4 Final harvest were all defined in the import file by target type “Merchantable carbon” for the period 2000-2017 based on the official statistics.

2) For the simulation period (2018-2030) the average value calculated for RP (2000-2009) were used as static figures defined by target type “Merchantable carbon” in the CBM import file.
3) The first CBM run was made.
4) The amount of harvest reported by CBM as output (tonnes of merchantable C per year) was directly used and compared with the merchantable carbon available for each stratum, in order to assess "proportion of harvest to biomass available for wood supply" for RP. It was done for each stratum.
5) An average "proportion of harvest to biomass available for wood supply"(P_Av) was calculated, for each stratum for RP.
6) These average proportions were applied for every strata on biomass available for wood supply to derive the new amounts of merchantable carbon to harvested during PP in the following run of CBM.
7) Second version of the import file with the revised figures was imported and the simulation was carried out.
8) Steps 4 to 7 were repeated several times until equilibrium was reached. It means that the P_Avduring PP (and CP)basically equals the corresponding average P_Avobserved during RP.

In this way, consistency of management practices was fully ensured, both in terms of adopted removals (using the identical P_av at the level of individual strata) and in terms of other quantitative parameters, which are preserved identical for PP (CP) as observed for RP.The specific P_Av values and other quantitative parameters of management practices are reported jointly in Table 6.

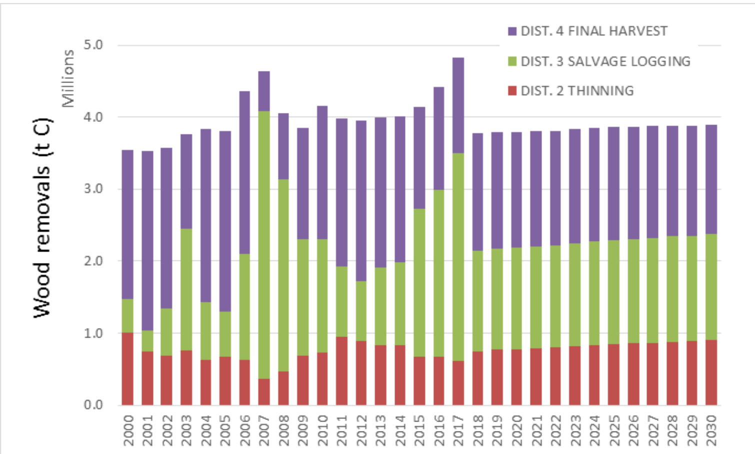

Figure 8: Wood removals (Mt C) associated with thinning (DIST. 2), salvage logging (DIST. 3) and final harvest (DIST. 4) for period 2000 to 2030. Wood removals until 2017 are based on the reported harvest data (CzSO), whereas the removals since 2018 are derived with help of CBM based on calibrated P_Av (identical as in RP).

The resulting wood removals expressed in amount of carbon at the level of the relevant management interventions for PP (2018-2030), as well as removals based on reported harvest until 2017, are graphically summarized in Figure 8.This figure shows the removals aggregated at the level of management practices thinning (DIST. 2), salvage logging (DIST. 3) and final cut (DIST. 4). A companion Figure 9 details the information on removals by management practices at the level of individual strata – given by forest category and species group.

It is apparent in Figure 8that the share of wood removals changes during CP. Since the applied management practices remain constant by its spectrum (types of management interventions), restrictions given by predefined age span (Table 6) and intensity due to the constant strata-specific P_Av, the only reason for the observed development in PP (CP) is the dynamic development of age structure. Functioning of age class module of CBM is demonstrated in Section 4.2.1.

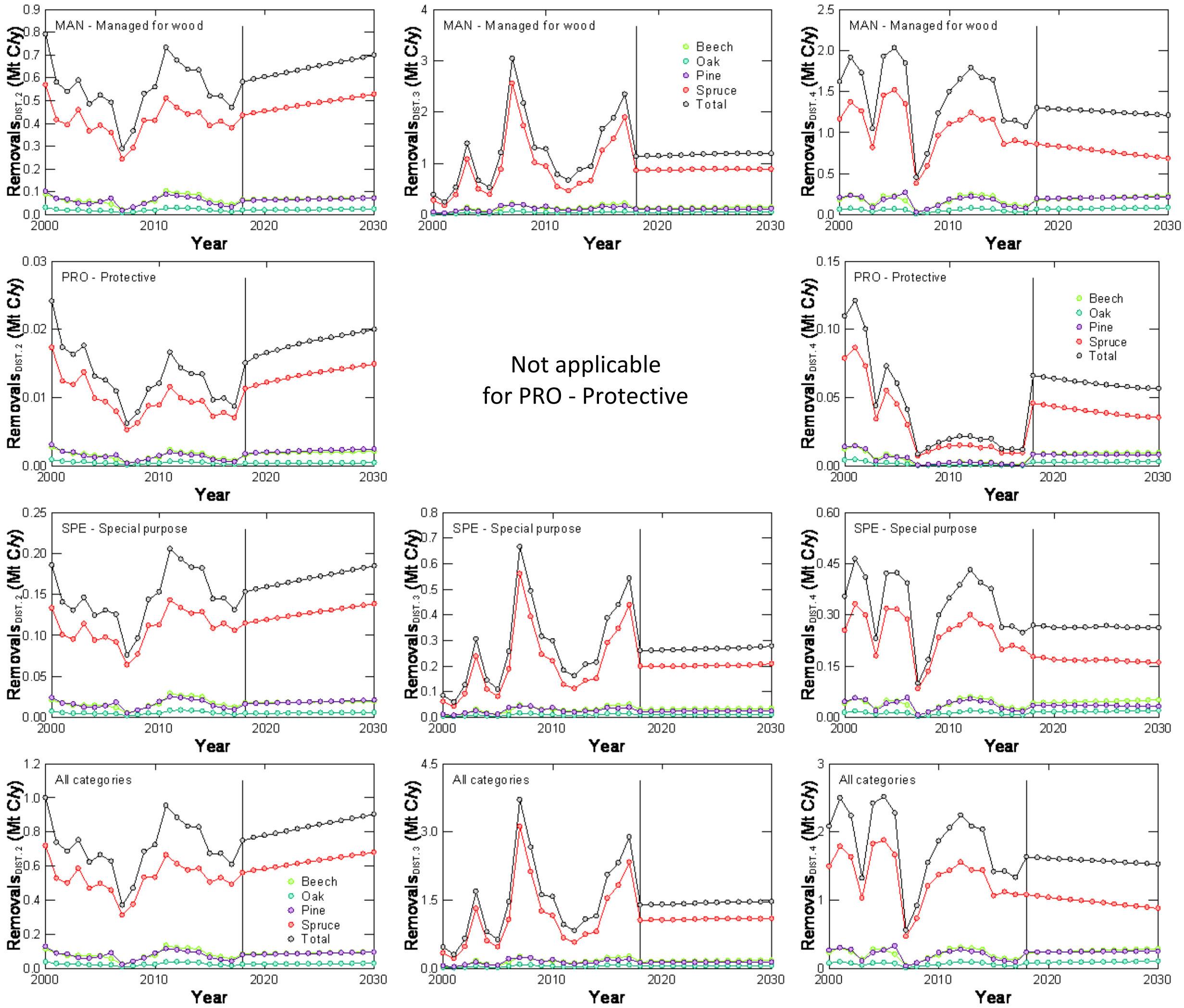

Figure 9: Strata-specific removals by the relevant disturbances – thinning (DIST. 2; left), salvage logging (DIST. 3; middle) and final cut (DIST. 4). The calibration and projected estimates are visually split by a horizontal line at year 2018, the first year of the projected period.

3.3.5 Carbon stock change in deadwood components by CBM

Carbon flow among deadwood and other carbon components in CBM are driven by disturbance matrices (S3) and by the implemented disturbance events (Section 3.3.3). The CBM deadwood components definitions do not fully match the deadwood components as used in NIR (2018, 2019). The deadwood components with their relevant description are summarized inTable 11.

Table 11: Matching deadwood components as used in NIR and CBM

NIR deadwood components	Description (NIR 2018, 2019)	CBM deadwood components	Description (Kurz et al., 2013)
Standing deadwood	Standing dead trees (DBH>7cm)	Stem snags	Dead standing stemwood of merchantable size including bark
Lying deadwood	Lying timber (diameter > 7cm)	Snag branches	Dead branches, stumps and small trees including bark
-	-	Medium DOM	Coarse woody debris on the ground

The NIR component of Standing deadwood is well-mirrored in CBM by the component Stem snags.However, this does not fully apply for lying deadwood. The CBM component Snag branches includes additional carbon components that are not covered by Lying deadwood as used for NIR (2018, 2019). As for the Medium DOM (dead organic matter) in CBM, this does not have a corresponding link to the NIR background data at all. Hence, for FRL, only the CBM components Snag stems and Snag branches are included. They correspond to Standing deadwood and Lying deadwood, respectively, together representing Deadwood in NIR.

3.3.6 Overview of the assumptions adopted for CBM estimates

There are several important assumptions adopted for the FRL estimation aided by CBM, which concern forest management practices, state of forest, climate and carbon pools. These are summarized in Table 12, detailed for the three key periods, namely for Reference period (RP), interim period (IP) and Projection period, which includes the selected starting projection year 2018. Additional clarifying comments are also provided.

Table 12: Adopted estimation assumption for the FRL estimation aided by CBM

ADOPTED ESTIMATION ASSUMPTIONS				
INPUT DATA	RP 2000-2009	IP 2010-2017	PP 2018-2030	COMMENTS
Forest Management Practices				
Disturbance types	FIXED	FIXED	FIXED	Disturbance types are stable during the whole period (2000-2030), only the tree species change was implemented in DIST. 3 until 2017.
Harvest to biomass available for wood supply share (% of biomass)	DYNAMIC	DYNAMIC	FIXED	An average harvest to biomass available for wood supply share for the period 2000-2009 is used in PP and CP.
Harvested area	DYNAMIC	DYNAMIC	DYNAMIC	Changes are based on harvest to biomass available for wood supply share and selected thinning intensity.
Harvested amount	DYNAMIC	DYNAMIC	DYNAMIC	Real figures are used for the period 2000-2017. Changes in CP are based on harvest to biomass available for wood supply share, potential wood supply and selected thinning intensity.
State of forest				
Total area of the stratum	FIXED	FIXED	FIXED	Afforestation and deforestation are not taken into account.
Age structure within a	DYNAMIC	DYNAMIC	DYNAMIC	Changes are related to starting age structure,

ADOPTED ESTIMATION ASSUMPTIONS				
INPUT DATA	RP 2000-2009	IP 2010-2017	PP 2018-2030	COMMENTS
stratum				growing stock, CAI, disturbance type and amount of wood affected by disturbance type.
Biomass available for wood supply	DYNAMIC	DYNAMIC	DYNAMIC	Changes are related to starting age structure, growing stock, CAI, disturbance type and amount of wood affected by disturbance type.
Tree species composition	DYNAMIC	DYNAMIC	FIXED	Based on real figures, tree species composition change was included until 2017.
Parameterization of the model for each stratum-FMP-age-class	FIXED	FIXED	FIXED	No changes were implemented.
Climate				
Mean annual temperature	FIXED	FIXED	FIXED	No changes were implemented.
Mean annual precipitation	FIXED	FIXED	FIXED	No changes were implemented.
Carbon pools				
Living biomass	DYNAMIC	DYNAMIC	DYNAMIC	Changes are related to disturbance type, amount of wood affected by disturbance type and transition matrices.
Deadwood	DYNAMIC	DYNAMIC	DYNAMIC	Changes are related to disturbance type, amount of wood affected by disturbance type and transition matrices.
HWP –harvest by CBM (HWP contribution estimated externally)	DYNAMIC	DYNAMIC	DYNAMIC	Changes are related to disturbance type, amount of wood affected by disturbance type and to defined transition matrices.
Litter	n/a	n/a	n/a	Not taken into account.
Soil organic matter	n/a	n/a	n/a	Not taken into account.

3.4 Contribution of HWP

3.4.1 Estimation of HWP contribution for the period 2000 (1990) to 2017

The methodology for estimating the contribution of HWP to emissions and removals was based on IPCC (2006) and IPCC (2014). The latter material was followed to adopt the agreed principles on accounting for HWP, which includes only domestically produced and consumed HWP. The estimation follows the Tier 2 method of first order decay, which is based on Eq. 2.8.5 of IPCC (2014). This equation considers carbon stock in the particular HWP categories, which is reduced by an exponential decay function using the specific decay constants. The default half-life constants were used for the major HWP categories: 35 years for sawnwood, 25 years for wood-based panels and 2 years for paper and paperboard. The second part of Eq. 2.8.5 (IPCC 2014) adds the material inflow in the particular year and HWP categories.

The activity data (production and trade of sawnwood, wood-based panels and paper and paperboard) were derived and/or directly used from the FAO database on wood production and trade (http://faostat3.fao.org/download/F/FO/E). The following criteria for HWP activity data apply:

- Only data originating from domestic harvest are considered.
- HWP data originate exclusively to area of land use category 4.A.1 Forest land remaining Forest land, as used in NIR for UNFCCC reporting. This means that it is assumed that no HWP originate from the category 4.A.2 Land converted to Forest land (a conservative assumption for the young forests stands until 20 years in the Czech conditions, noting also the related

provision of IPCC (2014) of good practice on HWP entering the accounting framework). Next, it also means that the fraction of wood products (sawnwood, wood-based panels, paperboard) originating from Deforested land (Forest land converted to other land use categories and Deforestation activity under KP LULUCF accounting) is discounted and treated on the basis of instantaneous oxidation. This is fully retained using the appropriate (identical) share of Deforested land as documented in the Czech NIR (2018, 2019). Hence, although the fraction corresponding to source material originating from deforested land is quantitatively insignificant (0.02% in both 1990 and 2017), the HWP contribution of this fraction was estimated using instantaneous oxidation (IPCC 2014), which is a formal requirement of the EU LULUCF Regulation.

- Any HWP from solid waste disposal sites (not occurring in the national circumstances) and HWP harvested for energy purposes (Table 8) is accounted for in the basis of instantaneous oxidation

The activity data of HWP that results from the above criteria are shown in Figure 10. They represent exclusively data originating from domestic forest, with the share attributed to Deforestation (D; permanent land-use conversion from Forest land in the context of Kyoto Protocol LULUCF activity under Art. 3.3), identical as used in in the Czech NIR (2018, 2019). The fraction of D of the total forest area is low, with maximum of 0.053% (1998) and minimum of 0.015 % (1990). The average fraction of D estimated for RP is 0.023 %.

The estimation procedure of HWP contribution is identical as that used and described in the Czech NIR (CHMI 2018, 2019), but differs in adopting the initial estimation year, which is in this case 1990. The inflow activity data for this year are represented by 5-year averages for the period 1990-1994 as recommended by Forsell*et al*. (2018).

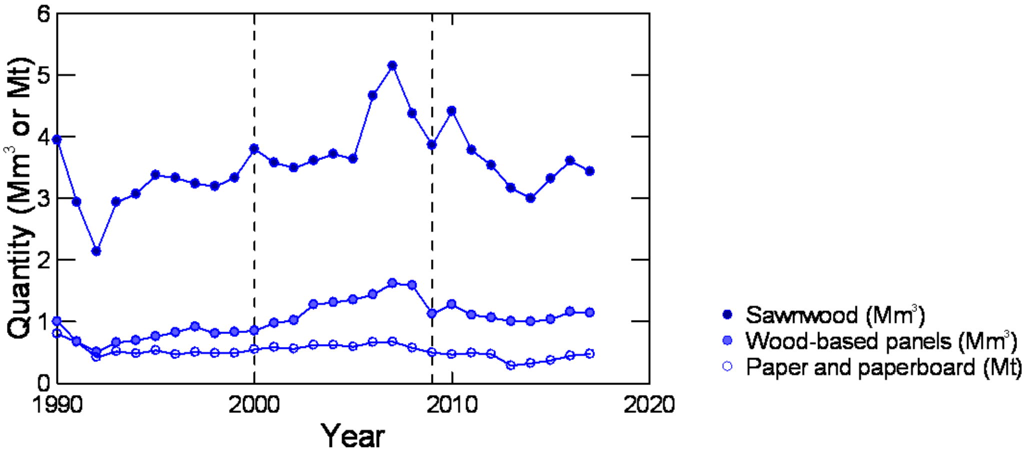

Figure 10: HWP activity data for the period 1990 to 2017– Sawnwood, Wood-based panels and Paper and paperboard. Vertical dashed lines indicate RP.

3.4.2 Projection of HWP contribution for the period 2018 to 2030

The methodological approach for projection of HWP contribution meets the requirement of EU LULUCF regulation (criterion e) of Annex IV.A) on preserving a constant ratio between solid and energy use of forest biomass as documented in RP. This is ensured by adopting the following estimation procedure:

- Calculating the annual rate of change of the projected harvest as compared to the average of the historic harvest within RP (2000-2009). The harvest projected for the period 2018 to 2030 is the CBM output expressed in units of carbon.
- Using these annual change rates to the RP average of carbon inflow to the HWP pool in order to project the future carbon inflow to the HWP pool (i.e., feedstock for production of the HWP categories sawnwood, wood-based panels and paper and paperboard, reflecting the solid wood use)
- Estimating future emissions using the methods outlined in Section 3.4.1 and activity data (carbon inflow) as in the above two points of this section

The historical (2000-2017) and projected (2018-2030) carbon inflow represented by the major HWP categories is visualized in Figure 11.

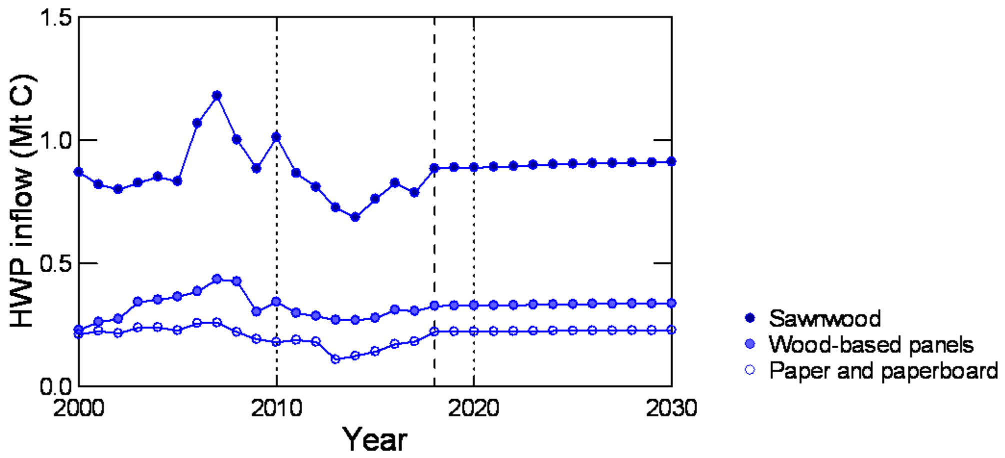

Figure 11: HWP inflow by the major categories – Sawnwood, Wood-based panels and Paper and paperboard. The dashed line indicates the first year of the projection period since 2018, when inflow is estimated on the basis of the harvest ratio during RP.

4. Forest reference level

The forest reference level (FRL) for the Czech Republic is estimated for its first part (FRL 1, 2021-2025) as-7 685.13 kt CO_2 eq., in which the HWP pool constitutes -1 099.49ktCO_2 eq. If instantaneous oxidation of HWP was assumed, the FRL 1 would be -6 585.64Mt CO_2 eq. The estimated values for FRL 1,as well as the tentative estimates for FRL 2,are shown in Table 13, together with the underlying data for all contributing components, i.e., Living biomass, Deadwood and HWP contribution. Complementary information and comments to the estimated FRL and individual carbon pools is provided in the text below.

Table 13: FRL and its components – underlying data for CP 1 and CP 2 in terms of carbon and the resulting FRL 1 and tentative FRL 2 expressed in units of CO_2 eq.

	CP 1 (Mt C/y)	FRL 1 (kt CO_2 eq.)	CP 2 (Mt C)	FRL 2 (kt CO_2eq)
Living biomass	1.759	**-6 450.17**	1.671	-6 127.27
Deadwood	0.037	**-135.46**	0.066	-240.21
HWP contribution	0.300	**-1 099.49**	0.275	-1 007.94
Total (with HWP)	2.096	**-7 685.13**	2.011	-7 375.42
Total (without HWP)	1.796	**-6 585.64**	1.737	-6 367.49

4.1 Development of carbon pools

The development of the individual carbon pools contributing to FRL is described below, showing the CBM calibration (2000 to 2017) and projection (2018 to 2030) estimates. The corresponding data as reported in and/or estimated for the Czech NIR (2018, 2019) are shown overlaid by symbols.

4.1.1 Living biomass (above- and below-ground carbon pools)

Above- and below-ground biomass carbon pools are reported jointly as living biomass (LB; Section 3.1). The development of carbon stock changes in LB (ΔLB) is shown in total in Figure 12. The specific development and contribution of individual tree species groups (Beech, Oak, Pine, Spruce) on ΔLB is offered in Figure 13. The coefficient of determination (R^2) and well-matching ΔLB values on y-axis generally indicate a strong relative and absolute correspondence, respectively, between the NIR data and CBM estimates. It can be observed that ΔLB remains overall relatively constant during PP (Figure 12), although the contribution of particular species groups differs – beech shows a slightly increasing removals (rising ΔLB), while the contribution of spruce start to decline during CP 2 (Figure 13).

The values of ΔLB entering the FRL estimate (shown by square symbols in Figure 12) make an average of 1.759 and 1.671 Mt C for CP 1 and CP 2, respectively.

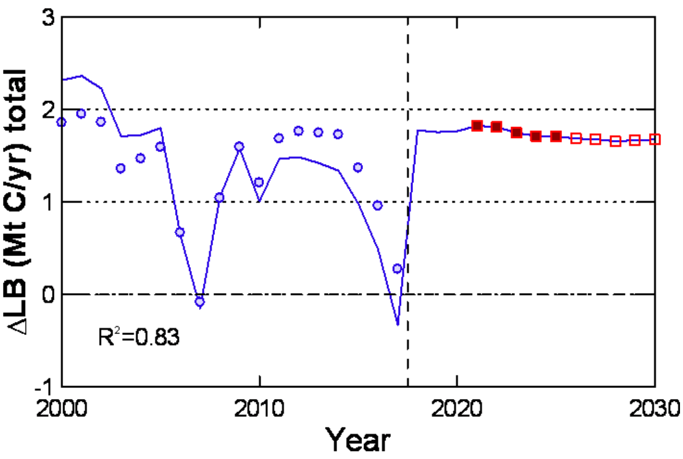

Figure 12: Carbon stock change in living biomass (ΔLB) - the NIR estimates for years 2000 to 2017 (circles) and the CBM consistency (2000 to 2017) and CBM projection (2018-2030) estimates, respectively, by the solid line. Coefficient of determination (R^2) for linear regression between NIR and CBM estimates for period 2000-2017 (n=18) is also shown. The overlaid filled and open red square symbols show the values used to calculate the average ΔLB for CP 1 and tentatively for CP 2, respectively.

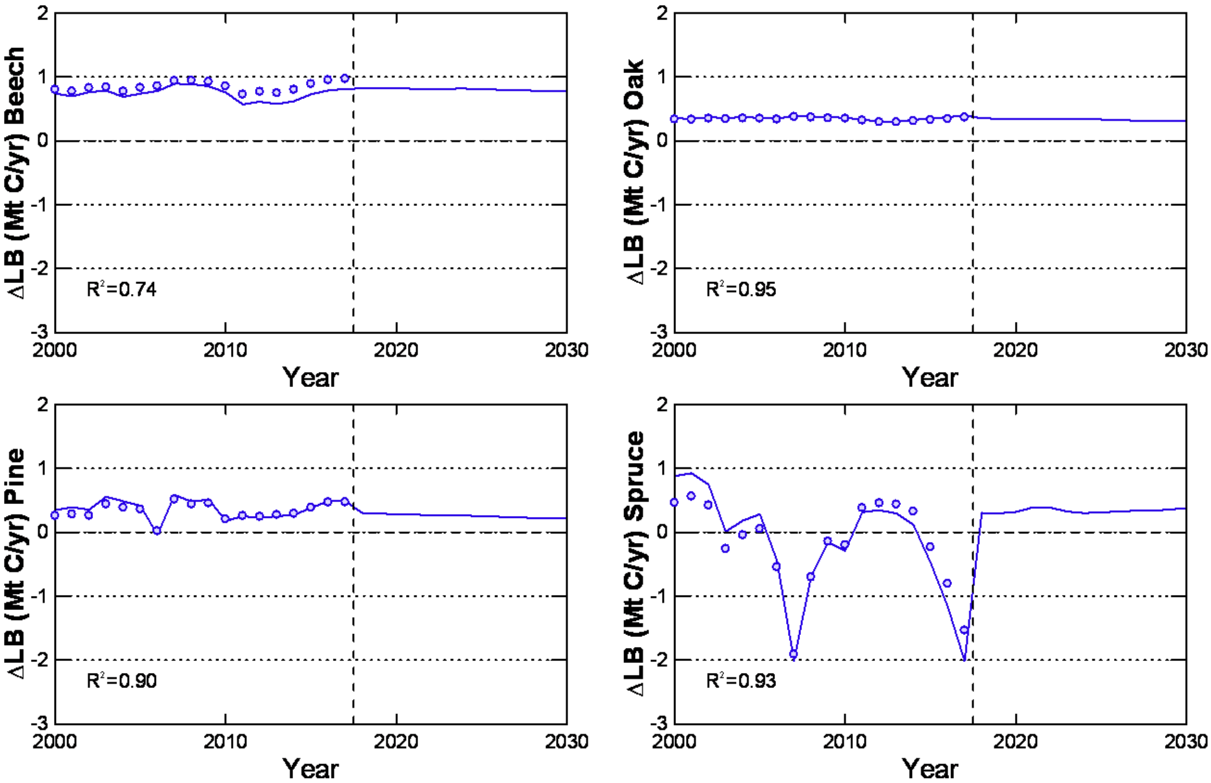

Figure 13: Species- specific carbon stock change in living biomass (ΔLB) - the estimates for the NIR for years 2000 to 2017 (symbols) and the CBM consistency (2000 to 2017) and projection (2018-2030) estimates, respectively, both by solid line. Coefficient of determination (R^2) for linear regression between NIR and CBM estimates for period 2000-2017 (n=18) is also shown.

4.1.2 Deadwood

As described in Section 3.3.5, the amount of carbon in the relevant deadwood components in CBM (Table 11) is based on disturbance events and its related disturbance matrices. The estimation of carbon stock change in deadwood (ΔDW) is shown in Figure 14 together with the reported NIR estimates. It can be observed that ΔDW oscillates around zero line. The peaks reflect the increased harvest rates, e.g. in 2007 and during 2015-2017. CBM assumes a correspondingly increased share of felling residues contributing to DW carbon pool.

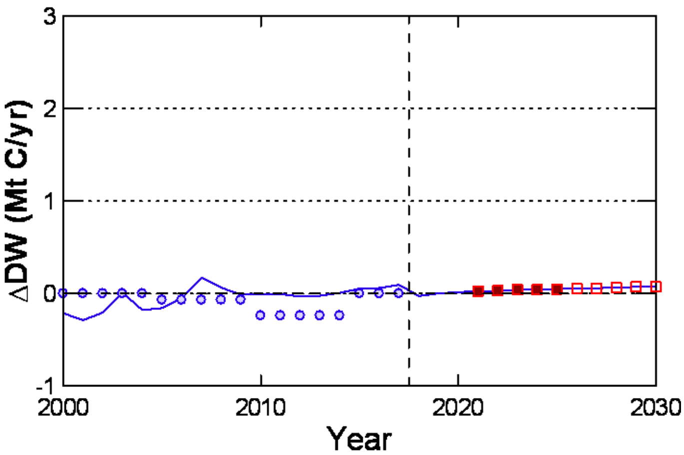

Figure 14: Carbon stock change in deadwood (ΔDW) - the NIR estimates for 2000 to 2017 are shown by circles, the CBM consistency (2000 to 2017) and projection (2018-2030) estimates, respectively, by the solid line. The overlaid filled and open red square symbols show the values used to calculate the average ΔDW for CP 1 and tentatively for CP 2, respectively. The y-scale is held identical as for ΔLB to facilitate an easy comparison of changes in these two pools.

The values of ΔDW entering the FRL estimate (shown by square symbols in Figure 12) make an average of 0.037 and 0.066 Mt C for CP 1 and CP 2, respectively.

4.1.3 HWP contribution

The resulting values of HWP contribution are shown in Figure 15. Data for the period 2000-2017 are identical as reported in the Czech NIR (2000-2017) due to the identical methodology and constraints adopted. The projection estimates since 2018 are based on the approach described in Section 3.4.2. The CBM and NIR estimates of HWP contribution, expressed in terms of carbon stock change (ΔHWP), are shown in Figure 15.ΔHWP reflects a specific, longer-term dynamics of carbon pool stored in products, and it is just partially correlated with harvest rate.

The resulting HWP contribution applicable for CP 1 is -1099.49Gg CO_2, given as an average of the estimates for years 2021-2025. Correspondingly, the tentative estimate of HWP contribution applicable for CP 2 (2026-2030) is -1007.94Gg CO_2.

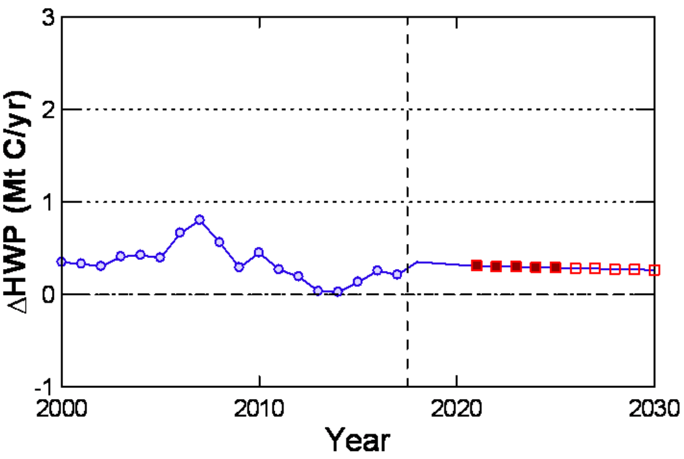

Figure 15: HWP contribution in terms of carbon stock change (ΔHWP) for the period 2000 to 2030. - the NIR estimates for 2000 to 2017 are shown by circles and while the consistency and projection estimates are denoted by solid line. The dashed line indicates the start of PP, the red-filled bars shows the values applicable for CP 1 (2021-2025), white-filled bars are estimates applicable for CP 2 (2026-2030).

4.2 Consistency between FRL and the latest NIR

Verifying consistency between the estimates of the modelling tool used to asses FRL (i.e. CBM in this case) and the NIR (2018, 2019) data has three phases (Forsell et al. 2018):

- i) consistency of management practices
- ii) consistency of emission and removal estimates (level and trend)
- iii) consistency of the time series

Ensuring consistency of management practices (Phase i) is described separately in Sections 3.3.4 and 3.2.3 of this document. This is because the information concerned is not explicitly reported in NIR and relates more to documentation of management practices (Section 3.2.3) and methodology ensuring consistency of management practices (Section 3.3.4). Hence, it differs from the data under phase ii and iii. Therefore, the following text complements the information on consistency by describing Phase ii and Phase iii for individual components of FRL, as well as for the total of all components concerned.

4.2.1 Living biomass (above- and below-ground carbon pools)

The ability of CBM to reproduce the empirical data and estimates concerning living biomass is demonstrated on a) age class structure (areas by age classes) and b) carbon stock change in LB (ΔLB), merging both above- and below ground biomass pools (Section 3.1).

Age structure development is one of the relevant indicators for assessing model performance and ability to reproduce empirical data. Figure 16 demonstrate this comparing the age structure from empirical data of NDFMP as used in NIR, and CBM estimates based on the calibration year 2004. Figure 16 shows both first (2000) and last (2017) year of 18-year long period of consistency estimates (Figure 1), where CBM is driven by known harvest demand, but dynamic strata-specific age structure (Table 12). The good match (insignificant differences) of the empirical and CBM areas by age class was statistically confirmed for both years by Two-Sample Kolmogorov-Smirnov and Sign Tests as implemented in Systat v. 13.1 (Systat Inc., USA).

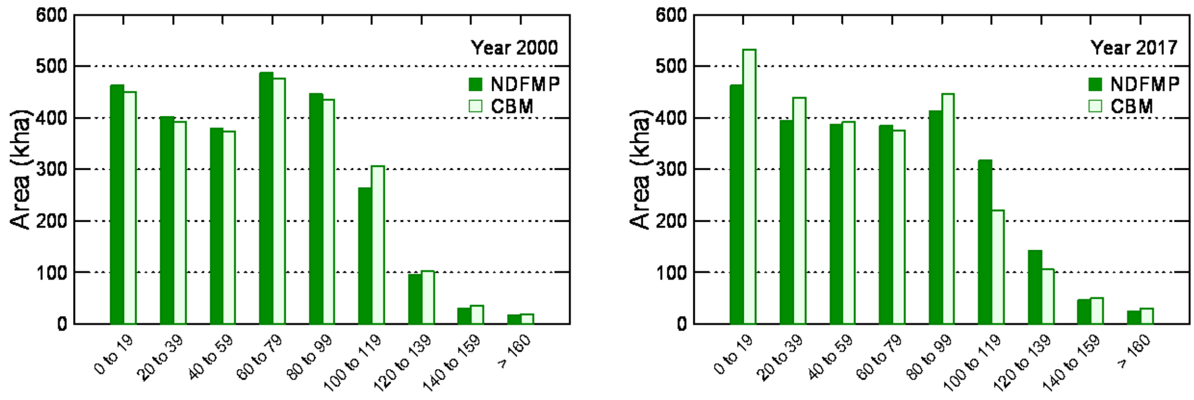

Figure 16: Age class distribution – empirical (known) data of NDFMP and estimates by CBM based on the calibration year 2004. Data of 2000 (left), the first year of consistency estimates (see Figure 1) are shown, as well as data of 2017 (right), the last year of consistency estimates.

Consistency of emission estimates are demonstrated on estimated ΔLB, comparing CBM and NIR estimates for the calibration period (Figure 1; n = 18 years). These are shown in Figure 12 and Figure 13 for total and species specific ΔLB, respectively.

The consistency of the estimated ΔLB level was tested by Student's t-test as implemented in Systat v. 13.1 (Systat Inc., USA). This test confirmed no statistical differences in ΔLB for total LB between CBM and NIR estimates (P=0.820), hence confirming consistency of level estimates for living biomass. Also, a paired t-test was also run to confirm consistency in the two datasets (p=0.520).

Complementarily, t-test was also run at the level of individual species, although this disaggregation is not reported in NIR (2018, 2019). At species group level, t-test p-valueswere larger than 0.05 for Oak (0.065), Pine (0.485) and Spruce (0.981), while for Beech species group, the test indicated significant differences ($p<0.05$). No adjustments were done for this species group, since the mandatory consistency is required at the level of reported values, i.e., ΔLB for total forest growing stock on Land remaining Forest Land.

Verifying trends of CBM and NIR estimates of ΔLB includes checking inter-annual variability and trendlines when applying moving average (Forsell et al 2018). For this, variance was checked by hypothesis of equality of two variances, which was confirmed by p-value (0.244) for total biomass. Similarly, the corresponding check at the level of individual species groups confirmed consistency for all species groups including Beech (p=0.306), Oak (p=0.613), Pine (p=0.327) and Spruce (0.414).

As the last step, the consistency of the time series for historical/calibration and projected estimates was conducted for ΔLB. Following the procedure of quantifying inconsistency as outlined by Forsell et al. (2018), within one iteration step a consistency of the time series was confirmed. This procedure is documented in detail in Supplementary material S4.

4.2.2 Deadwood

Consistency of ΔDW estimates can be judged by comparing CBM and NIR estimates as shown in Figure 14. As the available empirical information on deadwood components for the country is limited, no reasonable consistency check of CBM deadwood estimates could be elaborated. It should be noted that deadwood emissions are generally negligible relative to the other major carbon pools entering FRL estimation. This applies also for the Czech NIR (NIR 2018), where ∆LB and HWP contribution constitute so called key categories by level and trend, whereas ∆DW remains quantitatively insignificant.

4.2.3 HWP contribution

An explicit demonstration of the consistency in the estimated HWP contribution as described in this report and in the NIR (2018, 2019) is not needed – activity data, methods and constraints are identical for the consistency estimates in period 2000-2017 (Figure 1). This applies both for the level and the trend consistency checks, as well as the related time series consistency check.

4.2.4 Sum of living biomass, deadwood and HWP contribution

The total sum of the components (∆Total), i.e., ∆LB, ∆DW andentering the FRL estimate are shown inFigure 17. This composite estimate is used to derive the applicable means for CP 1 and CP 2, which expressed in terms of carbon reach 2.096 and 2.011 Mt C/year, respectively. The contribution of individual carbon pools is summarized in Table 13.

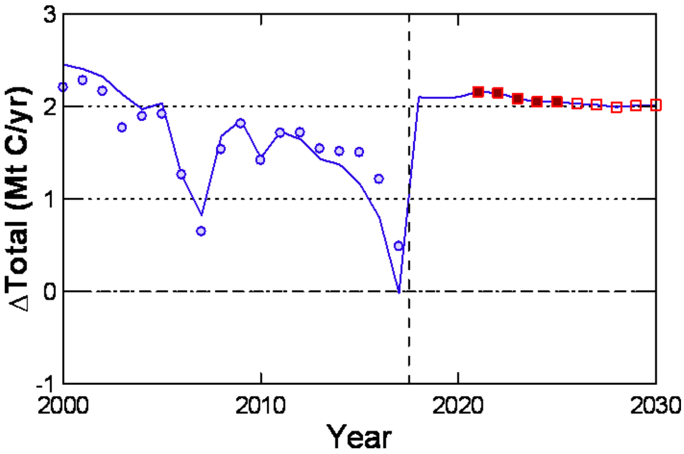

Figure 17: Total change in carbon including living biomass, deadwood and HWP components. Data based on NIR are shown by circles, CBM simulation is shown by solid line. The dashed line indicates the start of PP, the red-filled bars shows the values applicable for CP 1 (2021-2025), white-filled bars are estimates applicable for CP 2 (2026-2030).

Consistency check of the model outputs and the actual NIR (2018, 2019) data applicable to ∆Total includes comparing a) level and trend of emission estimates and b) consistency of the time series.

Similarly as for ∆LB (Section 4.2.1), the level and trend of ∆Total was checked using two sample t-test and hypothesis of equality of two variances, respectively (Figure 18). The two samples (and paired) t-test resulted in $p=0.978$ ($p=0.923$), i.e., insignificant differences in means (level) were confirmed. Similarly, the hypotheses of equality of two variances was confirmed ($p = 0.254$). This means that inter-annual variability within the projected time series in not larger than that reported in NIR.

The consistency check of the time series was applied similarly as described for ∆LB. Following the procedure of quantifying inconsistency as in Forsell et al. (2018), a consistency of the time series was confirmed within several iteration steps. This procedure is documented in Supplementary material S5.

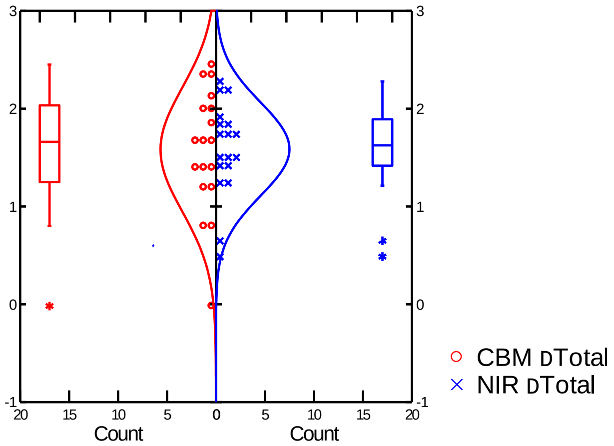

Figure 18: Graphical ΔTotal representation in t-test and variance test for projected (CBM) and historical/reported (NIR).

4.3 Interpretation and comments to the estimated FRL

It is apparent from the emission trends that the estimated FRL for PP is overly optimistic in its expectation of the sink strength realized in the Czech Forestry. As clearly seen from the overall trends given by NIR data and FRL 1level (Figure 19), respectively, the discrepancy between these lines is almost 5 Mt CO_2/yr during CP 1.

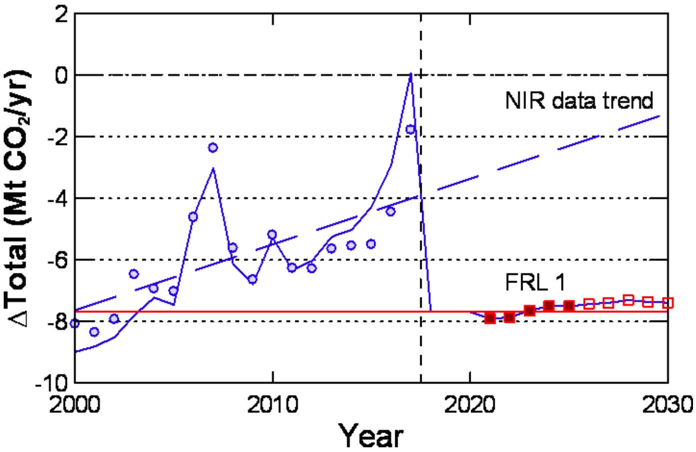

Figure 19: NIR data (symbols) of the components defining emissions and removals for FRL estimation (ΔTotal) and CBM calibration and projection estimates (line). Overlaid are trends for NIR data (dashed line) and FRL 1 level (solid red line).

Although the model fit is not entirely perfect, the key reason for the observed discrepancy is due to the strict methodological constraints imposed by the EU LULUCF Regulation 2018/841.Specifically, the mandatory requirement on maintaining harvest or harvest ratios (i.e., management practices as described) at the levels observed in RP (2000-2009) when estimating FRL, is for the Czech Republic very unfavorable. In contrast, the Czech forestryhas in reality:

i) continued its effort to adapt forests by changing tree species composition (while for FRL it is kept mandatorily constant in projection period);

ii) faced an unprecedented decline of coniferous forest stands due to severe drought accompanied by uncontrolled bark beetle outbreak, resulting in compulsory increased salvage logging (while for FRL it is mandatorily kept at the levels as in reference period).

Theseare the reasons for declining carbon sink strength of the Czech forests as indicated by the NIR trendline in Figure 19. For the nearest years to come, this negative development is expected to significantly intensify due to the record-high harvest levels anticipated – e.g., it is expected that the fellings (basically solely sanitary fellings) will double as compared to the already record-high level of the most recent reported year (2017; see Figure 8). Note also, that the management interventions associated with both i) and ii) are fully in line with the adopted national policies. Firstly, changing species composition is mandated by several legislative acts, such the National Forest Programme (Krejzar 2008) and the Czech Adaptation Strategy (ME 2015, 2017). Secondly, prioritizing and executing sanitary fellings is requested by the Czech Forest Act (289/1995), and hence these interventions are mandatory.

In view of the above, the adopted accounting rules imposed by EU LULUCF Regulation are unfavorable for the country, grossly underrating the actual development of the Czech forestry sector. It is strongly recommended that this issue be specifically addressed by the authorized policymakers.

Finally, it should be understood, that the presented FRL estimates are not optimal – they were prepared under limited time frame given by the late adoption of the LULUCF resolution and the mandatory deadline for FRL submission (by the end of 2018). There are several analytical options aided by the modelling tool (CBM) that could have improved the consistency of the estimates provided there were adequate capacity available (i.e. planned well ahead of time) for this demanding task.

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List of supplementary material

S1 – Species-specific parametrization of biomass Eq. 7 (Boudewyn et al., 2007) for conversion of merchantable volume into above-ground tree biomass

S2 – Species-specific parametrization of historical (net) increment and CAI (gross)

S3 – Disturbance matrices

S4 – Consistency of the time series for ∆LB

S5 - Consistency of the time series for ∆Total

CZECH NATIONAL FOREST ACCOUNTING PLAN - FOREST REFERENCE LEVEL
– **Supplementary material S1**

S1 – Species-specific parametrization of biomass Eq. 7 (Boudewyn et al., 2007) for conversion of merchantable volume into aboveground tree biomass

The species- specific volume to biomass conversion is governed by Eq. 7 as reported in Boudewyn et al. 2007). This equation is a simple exponential function in the form

$$BM_{stem} = a \times V_m{}^b$$

where BM_{stem} is stem biomass over bark for given tree species expressed in t/ha, V_m is merchantable wood volume under bark of given tree species expressed in m^3/ha, *a* a *b* are two parameters to be fitted. Activity data for this procedure were taken from the two campaigns of the sample-based landscape inventory CzechTerra (CZT1 from 2008/2009, CZT2 from 2014/2015; described e.g. in Cienciala et al. 2016). The inventory plots (sized 0.05 ha) qualifying for the fitting procedure were those, where European Beech, English or Sessile oaks, Scots pine and Norway spruce represented the dominant tree species and amount of tree samples for the particular species at the plot was at least five. Tree volume and stem biomass (for details on equations used see Section 3.3.1) were summed per plot and expressed in units per hectare.

The material attached below provides full details on fitting procedure by individual tree species

Results for Species = Spruce

Dependent Variable:M_STEMOB_HA

Sum of Squares and Mean Squares

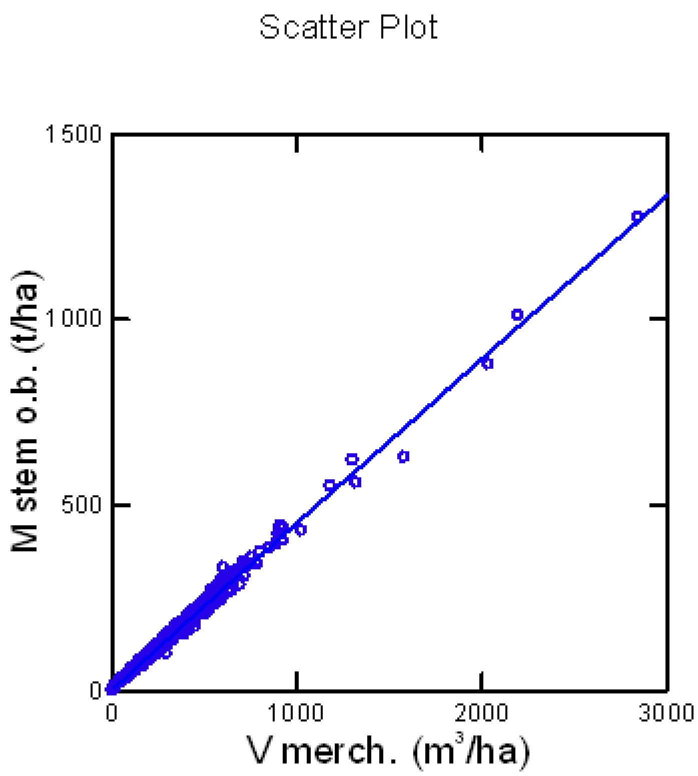
Source	SS	df	Mean Squares
Regression	1.806102E+007	2	9.030512E+006
Residual	55423.453023	500	110.846906
Total	1.811645E+007	502	
Mean corrected	7.473817E+006	501	

R-squares

Raw R-square (1-Residual/Total) : 0.996941
Mean Corrected R-square (1-Residual/Corrected) : 0.992584
R-square(Observed vs. Predicted) : 0.992592

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.494898	0.010626	46.575227	0.474022	0.515775
B	0.986597	0.003248	303.721549	0.980215	0.992979



Results for Species = Beech

Dependent Variable:M_STEMOB_HA

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	4.487700E+006	2	2.243850E+006

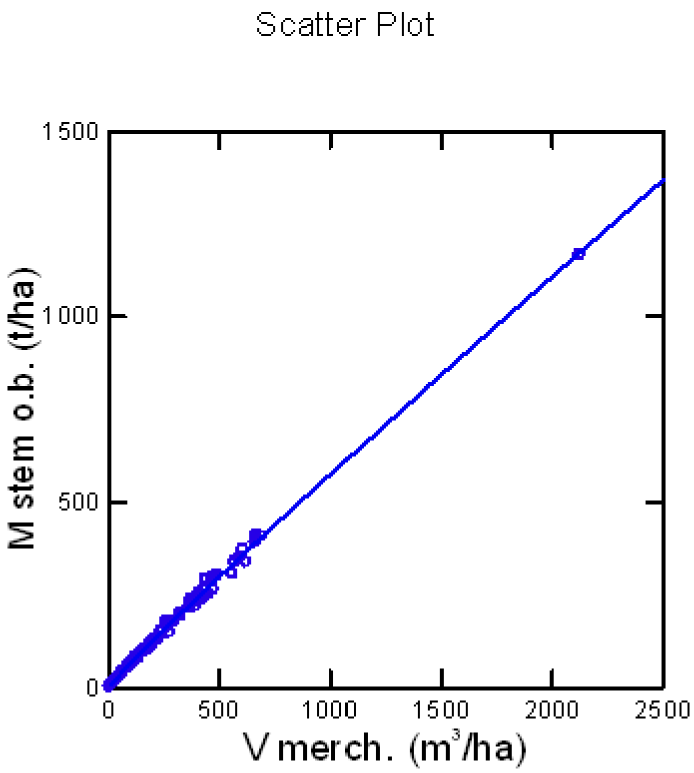
Residual	7022.692214	79	88.894838
Total	4.494723E+006	81	
Mean corrected	2.072938E+006	80	

R-squares

Raw R-square (1-Residual/Total) : 0.998438
Mean Corrected R-square (1-Residual/Corrected) : 0.996612
R-square(Observed vs. Predicted) : 0.996614

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.836967	0.030895	27.090460	0.775471	0.898462
B	0.945760	0.005569	169.840715	0.934677	0.956844



Results for Species = Pine

Dependent Variable:M_STEMOB_HA

Sum of Squares and Mean Squares

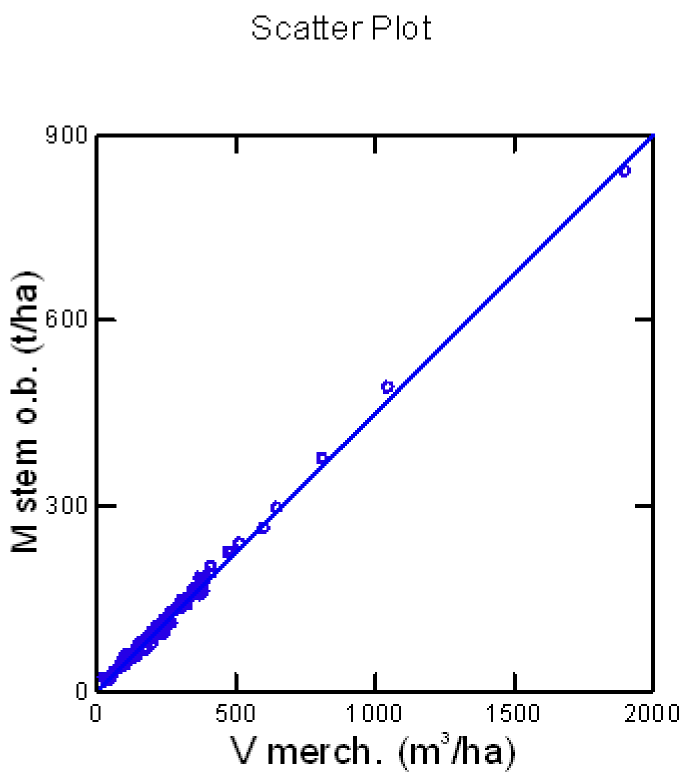
Source	SS	df	Mean Squares
Regression	2.691625E+006	2	1.345812E+006
Residual	4668.195257	116	40.243063
Total	2.696293E+006	118	
Mean corrected	1.098640E+006	117	

R-squares

Raw R-square (1-Residual/Total) : 0.998269
Mean Corrected R-square (1-Residual/Corrected) : 0.995751
R-square(Observed vs. Predicted) : 0.995777

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.466235	0.013684	34.072523	0.439133	0.493337
B	0.995094	0.004547	218.854223	0.986088	1.004099



Results for Species = Oak

Dependent Variable:M_STEMOB_HA

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	9.756252E+005	2	4.878126E+005
Residual	2275.089294	60	37.918155
Total	9.779003E+005	62	
Mean corrected	3.868197E+005	61	

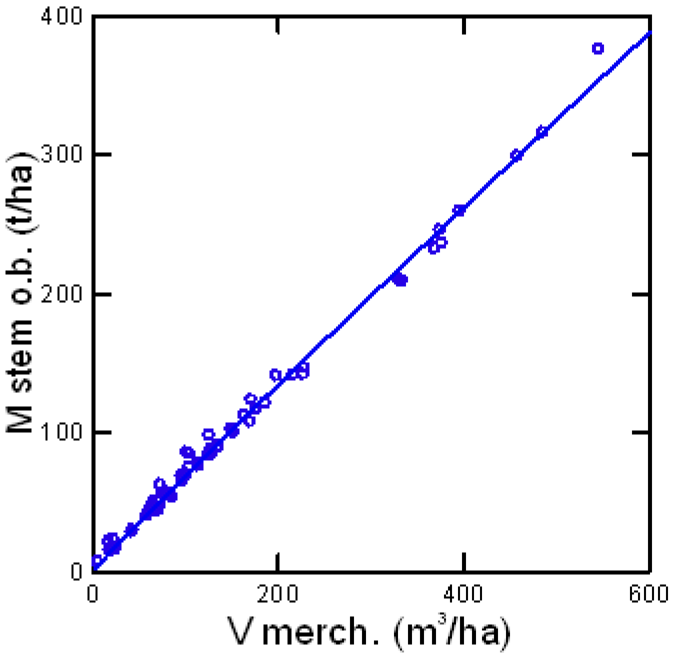
R-squares

Raw R-square (1-Residual/Total) : 0.997673
Mean Corrected R-square (1-Residual/Corrected) : 0.994118
R-square(Observed vs. Predicted) : 0.994236

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.807042	0.049465	16.315497	0.708097	0.905986
B	0.965374	0.010715	90.097646	0.943942	0.986807

Scatter Plot



CZECH NATIONAL FOREST ACCOUNTING PLAN - FOREST REFERENCE LEVEL
– **Supplementary material S2**

S2 – Species-specific parametrization of historical (net) increment and CAI (gross)

The material attached below provides full details on fitting procedure by individual tree species according to Eq. 1 (Section 3.3.1) for both historical (net) increment and CAI (gross).

S2 - HISTORICAL (NET) INCREMENT

Results for Forest category = MAN Species group = BE

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

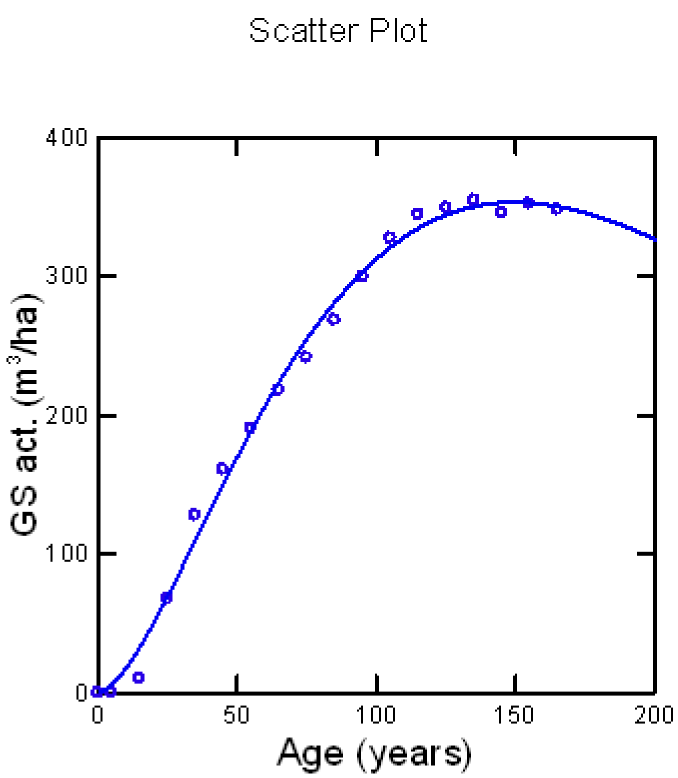
Source	SS	df	Mean Squares
Regression	1 188 585.479	3	396 195.160
Residual	1 597.749	15	106.517
Total	1 190 183.228	18	
Mean corrected	297 615.875	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.995
R-square(Observed vs. Predicted) : 0.995

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.379	0.157	2.413	0.044	0.714
B	1.705	0.117	14.576	1.456	1.955
C	0.989	0.001	826.616	0.986	0.991



Residuals have been saved.

Results for Forest category = MAN Species group = OA

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	905 855.386	3	301 951.795
Residual	1 916.685	15	127.779
Total	907 772.071	18	
Mean corrected	209 735.568	17	

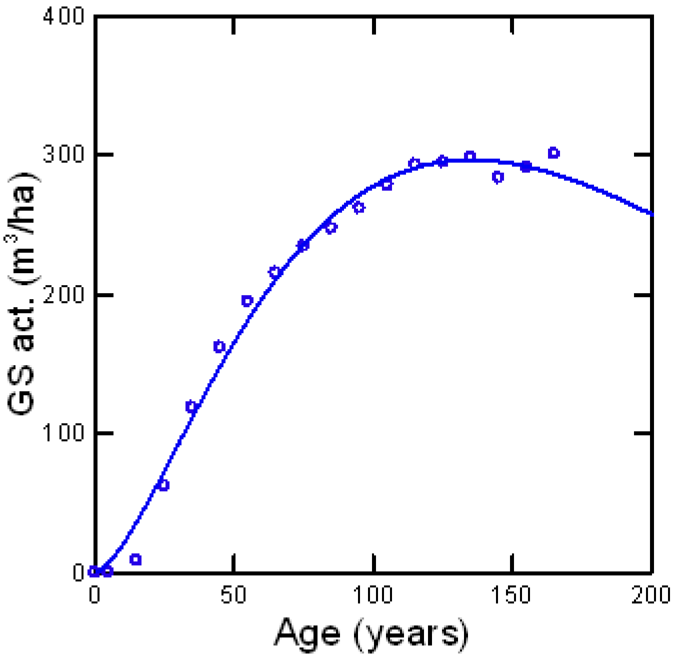
R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.991
R-square(Observed vs. Predicted) : 0.991

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.551	0.254	2.167	0.009	1.093
B	1.610	0.132	12.231	1.329	1.890
C	0.988	0.001	710.362	0.985	0.991

Scatter Plot



Residuals have been saved.

Results for Forest category = MAN Species group = PI

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	1 152 514.996	3	384 171.665
Residual	2 625.194	15	175.013

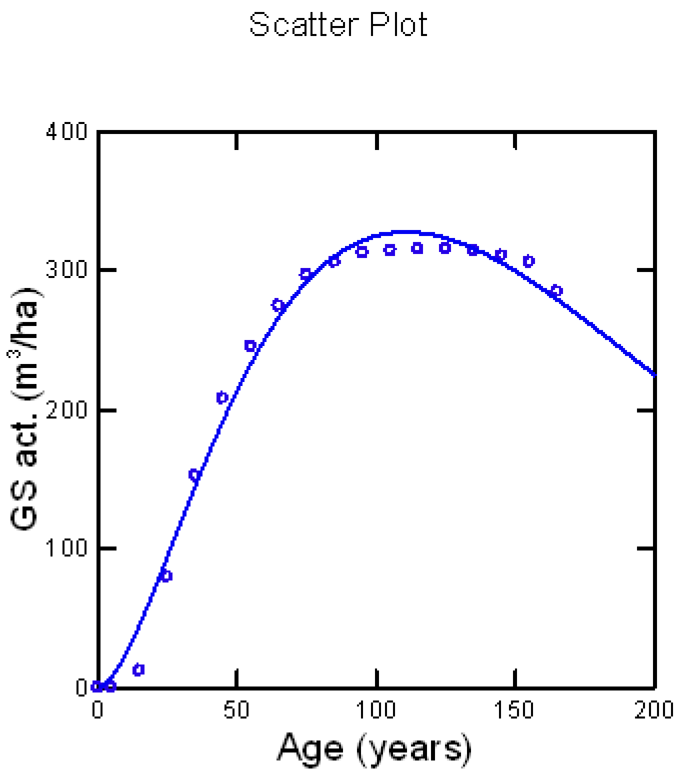
Total	1 155 140.190	18	
Mean corrected	245 047.672	17	

R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.989
R-square(Observed vs. Predicted) : 0.990

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.501	0.223	2.250	0.026	0.976
B	1.749	0.128	13.652	1.476	2.022
C	0.984	0.001	704.618	0.981	0.987



Residuals have been saved.

Results for Forest category = MAN Species group = SP

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	2 639 088.713	3	879 696.238
Residual	3 212.499	15	214.167
Total	2 642 301.211	18	
Mean corrected	599 914.312	17	

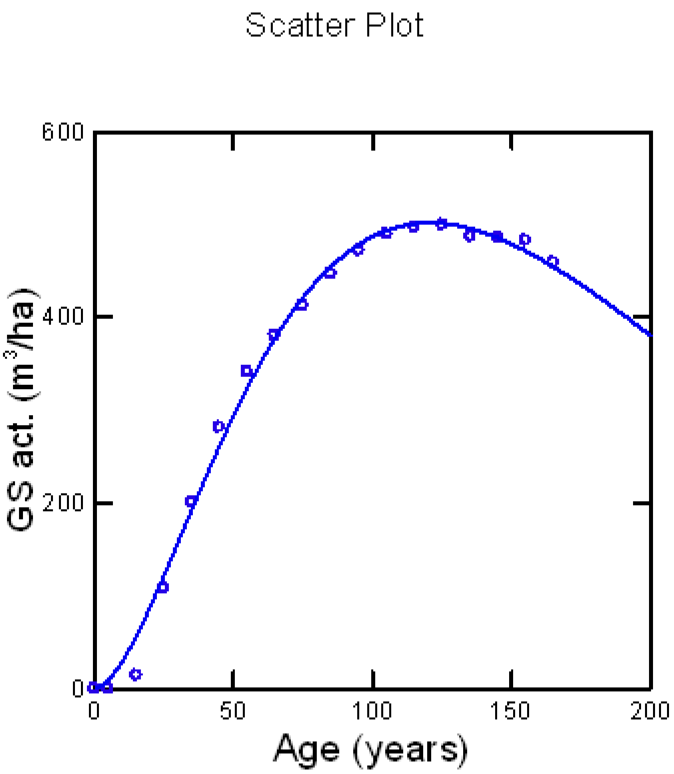
R-squares

Raw R-square (1-Residual/Total) : 0.999

Mean Corrected R-square (1-Residual/Corrected) : 0.995
R-square(Observed vs. Predicted) : 0.995

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.504	0.181	2.790	0.119	0.889
B	1.820	0.102	17.786	1.602	2.038
C	0.985	0.001	910.720	0.983	0.987



Residuals have been saved.

Results for Forest category = PRO Species group = BE

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	689 071.225	3	229 690.408
Residual	3 687.930	15	245.862
Total	692 759.155	18	
Mean corrected	196 872.328	17	

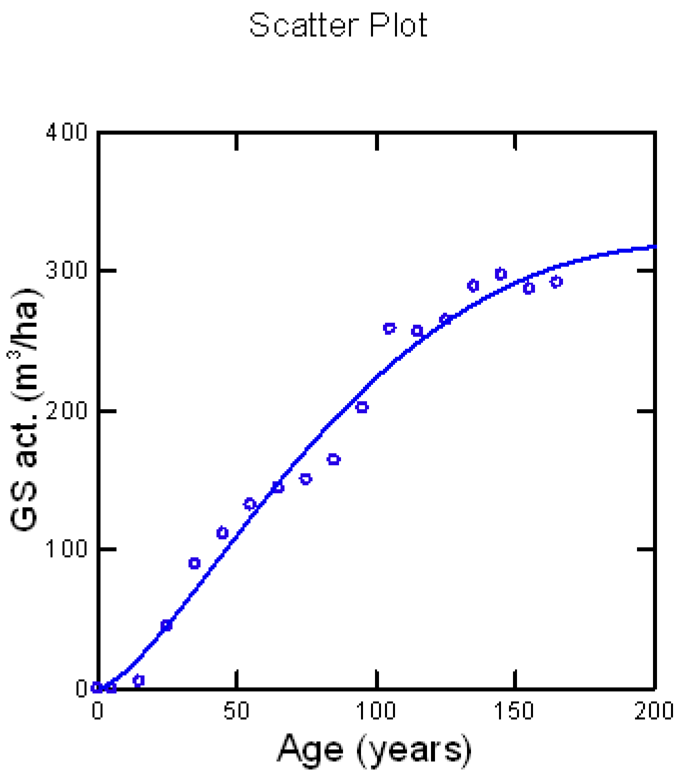
R-squares

Raw R-square (1-Residual/Total) : 0.995
Mean Corrected R-square (1-Residual/Corrected) : 0.981
R-square(Observed vs. Predicted) : 0.981

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper

A	0.386	0.350	1.105	-0.359	1.132
B	1.536	0.253	6.070	0.996	2.075
C	0.993	0.003	394.720	0.988	0.998



Residuals have been saved.

Results for Forest category = PRO Species group = OA

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

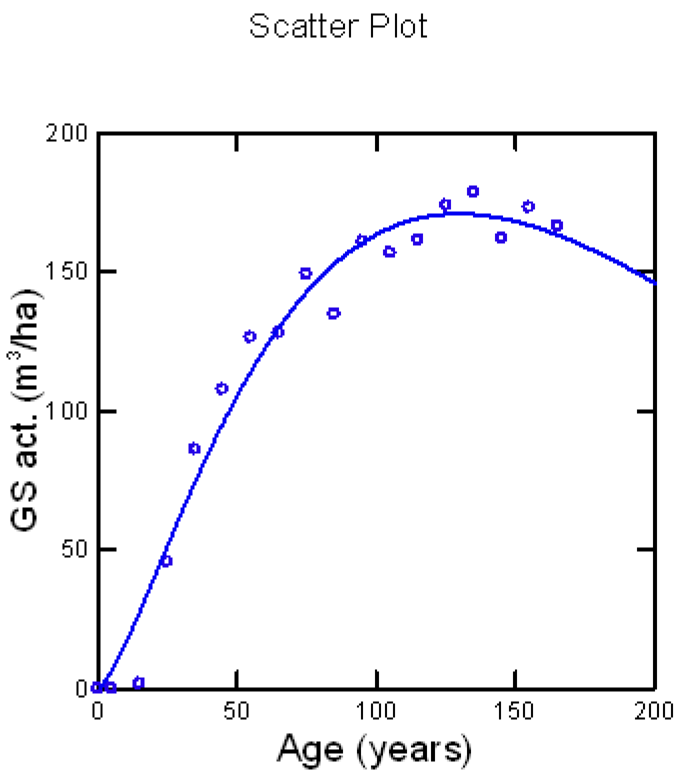
Source	SS	df	Mean Squares
Regression	314 803.109	3	104 934.370
Residual	1 862.324	15	124.155
Total	316 665.433	18	
Mean corrected	68 543.585	17	

R-squares

Raw R-square (1-Residual/Total) : 0.994
Mean Corrected R-square (1-Residual/Corrected) : 0.973
R-square(Observed vs. Predicted) : 0.974

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.664	0.452	1.469	-0.299	1.627
B	1.436	0.196	7.320	1.018	1.854
C	0.989	0.002	461.149	0.984	0.994



Residuals have been saved.

Results for Forest category = PRO Species group = PI

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

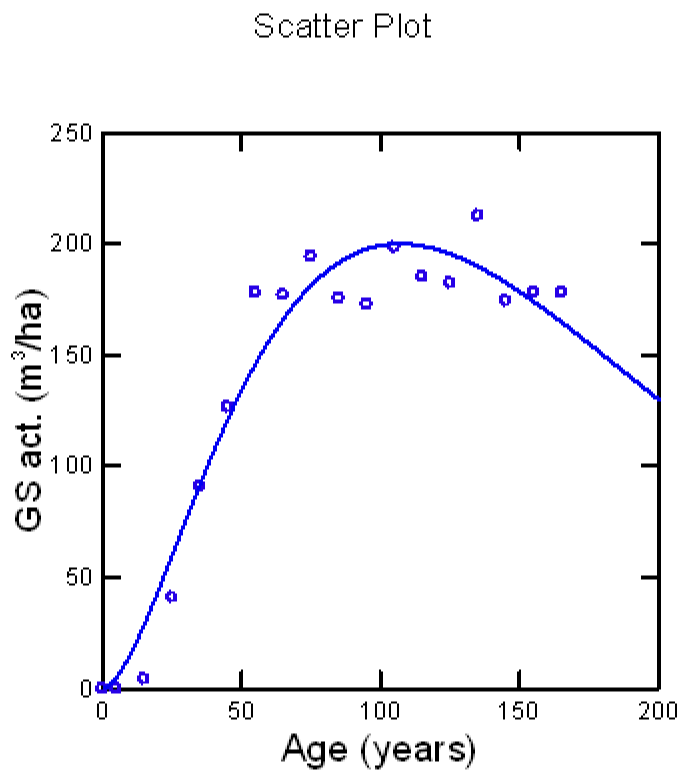
Source	SS	df	Mean Squares
Regression	429 692.616	3	143 230.872
Residual	4 355.682	15	290.379
Total	434 048.299	18	
Mean corrected	94 678.670	17	

R-squares

Raw R-square (1-Residual/Total) : 0.990
Mean Corrected R-square (1-Residual/Corrected) : 0.954
R-square(Observed vs. Predicted) : 0.955

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.307	0.282	1.088	-0.295	0.909
B	1.765	0.266	6.641	1.198	2.331
C	0.984	0.003	336.815	0.977	0.990



Residuals have been saved.

Results for Forest category = PRO Species group = SP

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

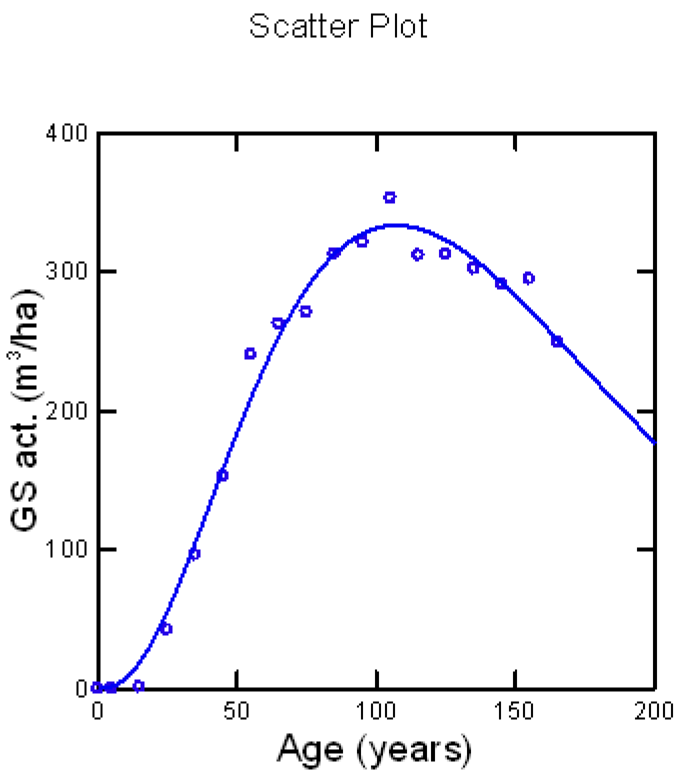
Source	SS	df	Mean Squares
Regression	1 077 407.649	3	359 135.883
Residual	3 425.335	15	228.356
Total	1 080 832.984	18	
Mean corrected	271 550.942	17	

R-squares

Raw R-square (1-Residual/Total) : 0.997
Mean Corrected R-square (1-Residual/Corrected) : 0.987
R-square(Observed vs. Predicted) : 0.988

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.023	0.016	1.446	-0.011	0.058
B	2.604	0.196	13.285	2.186	3.021
C	0.976	0.002	486.014	0.972	0.980



Residuals have been saved.

Results for Forest category = SPE Species group = BE

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

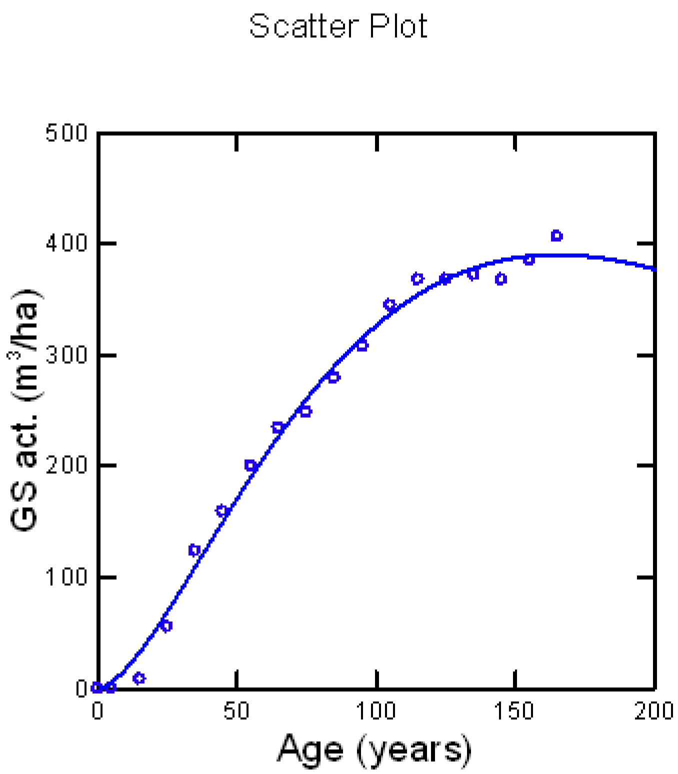
Source	SS	df	Mean Squares
Regression	1 349 169.359	3	449 723.120
Residual	2 405.040	15	160.336
Total	1 351 574.399	18	
Mean corrected	356 839.961	17	

R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.993
R-square(Observed vs. Predicted) : 0.994

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.410	0.203	2.015	-0.024	0.843
B	1.671	0.140	11.978	1.374	1.968
C	0.990	0.001	702.273	0.987	0.993



Residuals have been saved.

Results for Forest category = SPE Species group = OA

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

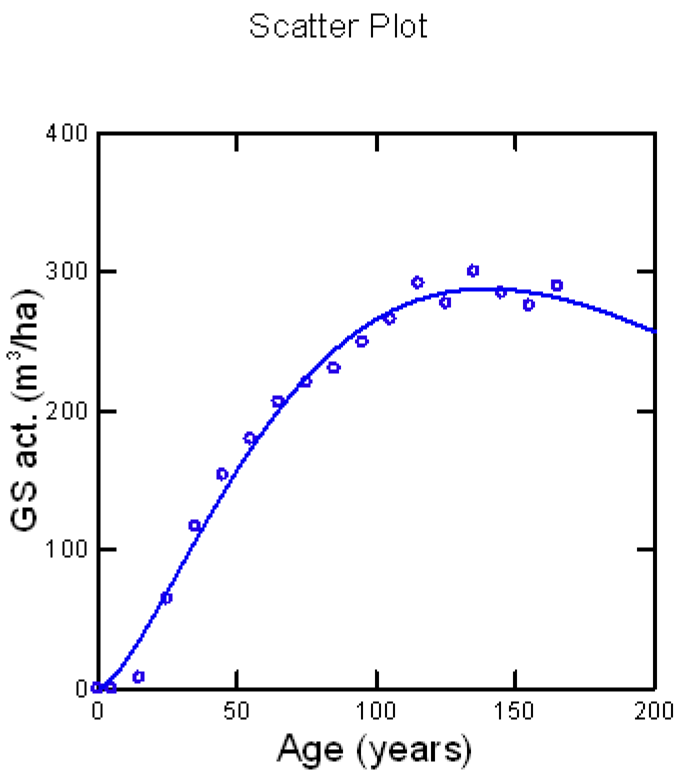
Source	SS	df	Mean Squares
Regression	842 271.727	3	280 757.242
Residual	2 069.359	15	137.957
Total	844 341.086	18	
Mean corrected	196 406.685	17	

R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.989
R-square(Observed vs. Predicted) : 0.990

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.581	0.290	2.006	-0.036	1.199
B	1.575	0.142	11.082	1.272	1.878
C	0.989	0.001	659.801	0.986	0.992



Residuals have been saved.

Results for Forest category = SPE Species group = PI

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

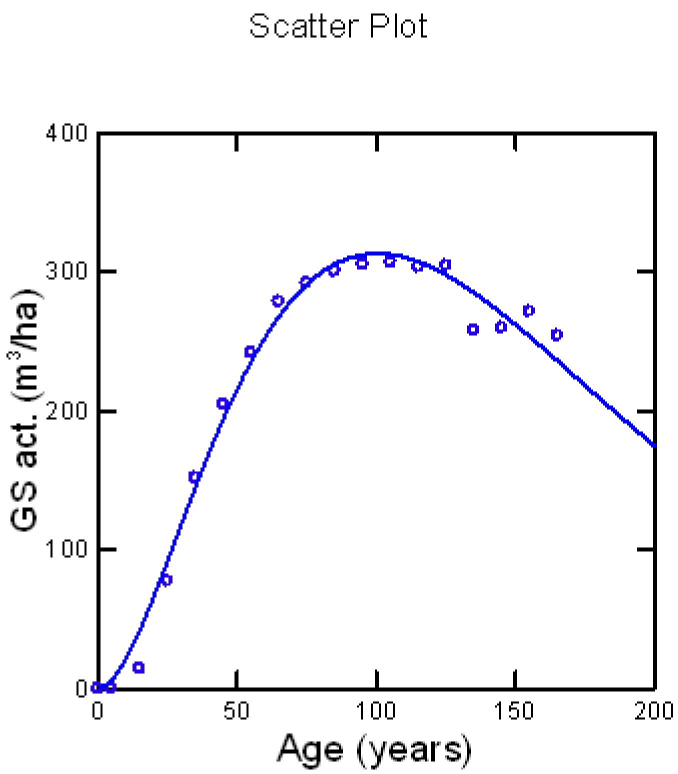
Source	SS	df	Mean Squares
Regression	1 024 805.525	3	341 601.842
Residual	2 987.344	15	199.156
Total	1 027 792.869	18	
Mean corrected	214 673.065	17	

R-squares

Raw R-square (1-Residual/Total) : 0.997
Mean Corrected R-square (1-Residual/Corrected) : 0.986
R-square(Observed vs. Predicted) : 0.987

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.301	0.150	2.002	-0.019	0.621
B	1.925	0.145	13.311	1.617	2.234
C	0.981	0.002	614.426	0.978	0.984



Residuals have been saved.

Results for Forest category = SPE Species group = SP

Dependent Variable:HYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

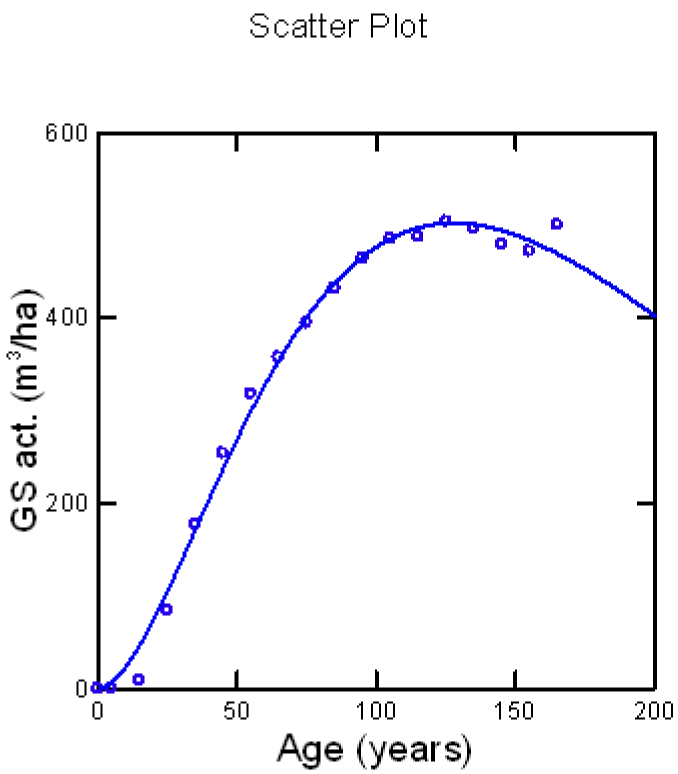
Source	SS	df	Mean Squares
Regression	2 567 713.933	3	855 904.644
Residual	4 021.435	15	268.096
Total	2 571 735.367	18	
Mean corrected	623 353.939	17	

R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.994
R-square(Observed vs. Predicted) : 0.994

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.336	0.148	2.272	0.021	0.652
B	1.898	0.125	15.215	1.632	2.164
C	0.985	0.001	764.508	0.983	0.988



Residuals have been saved.

S2 - CAI (gross)

Results for Forest category = MAN Species group = BE

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

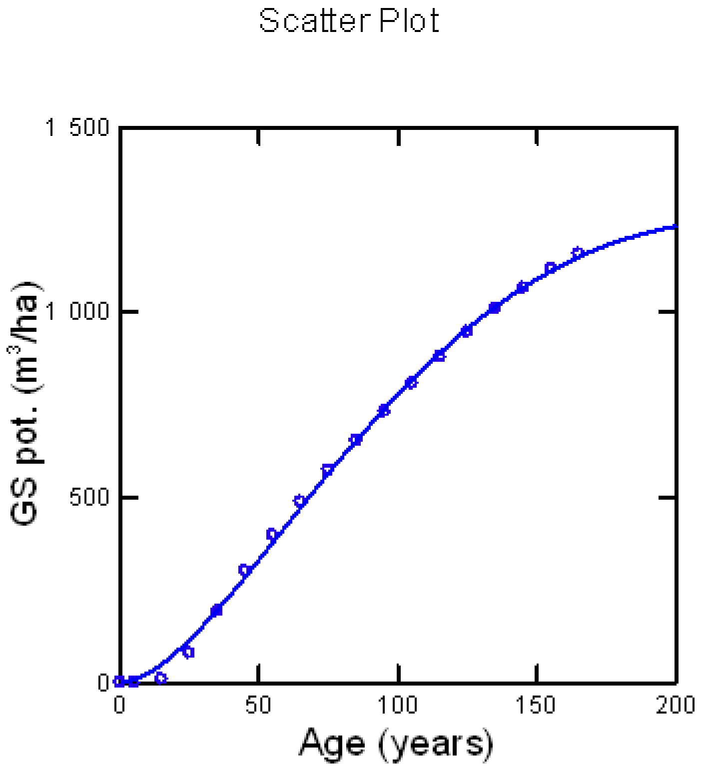
Source	SS	df	Mean Squares
Regression	8 895 641.190	3	2 965 213.730
Residual	4 464.288	15	297.619
Total	8 900 105.479	18	
Mean corrected	2 867 442.988	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.999

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.416	0.142	2.940	0.115	0.718
B	1.809	0.094	19.289	1.609	2.008
C	0.992	0.001	1 115.033	0.990	0.994



Residuals have been saved.

Results for Forest category = MAN Species group = OA

Dependent Variable:CYT2004

Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

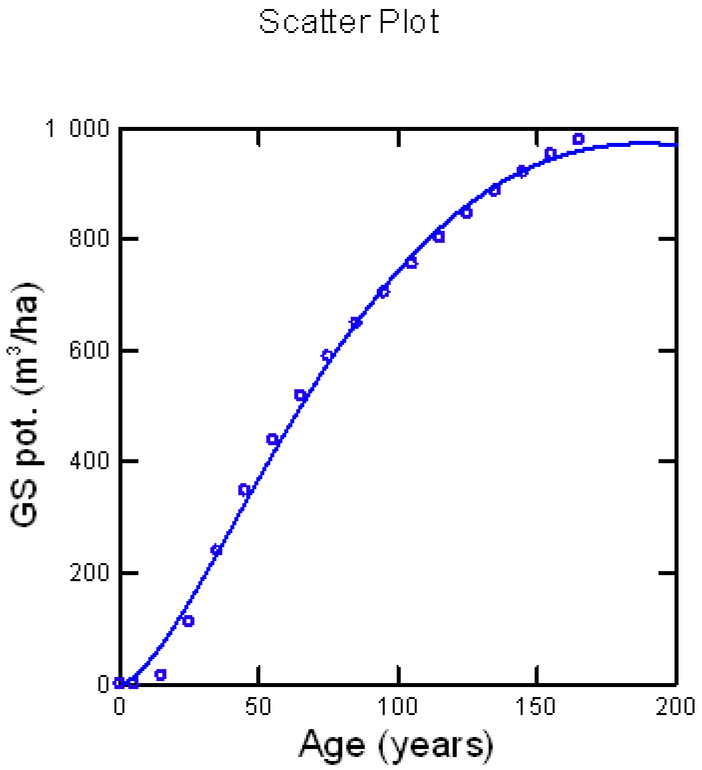
Source	SS	df	Mean Squares
Regression	7 348 982.318	3	2 449 660.773
Residual	7 802.098	15	520.140
Total	7 356 784.416	18	
Mean corrected	2 059 619.110	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.996
R-square(Observed vs. Predicted) : 0.997

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.965	0.389	2.482	0.136	1.794
B	1.631	0.113	14.468	1.391	1.871
C	0.991	0.001	883.011	0.989	0.994



Residuals have been saved.

Results for Forest category = MAN Species group = PI

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

Source	SS	df	Mean Squares
Regression	7 738 764.172	3	2 579 588.057

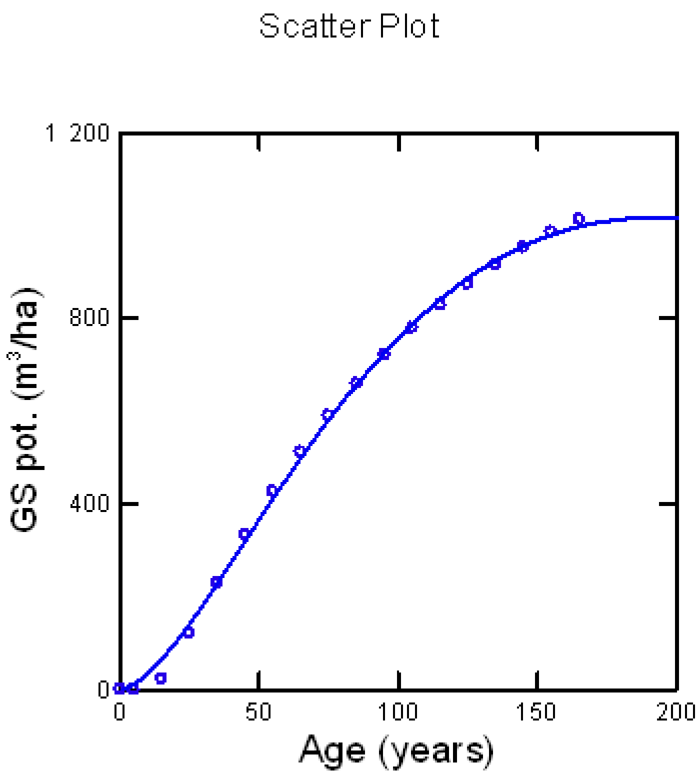
Residual	3 881.772	15	258.785
Total	7 742 645.944	18	
Mean corrected	2 216 061.409	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.783	0.227	3.456	0.300	1.266
B	1.682	0.081	20.846	1.510	1.854
C	0.991	0.001	1 246.524	0.990	0.993



Residuals have been saved.

Results for Forest category = MAN Species group = SP

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

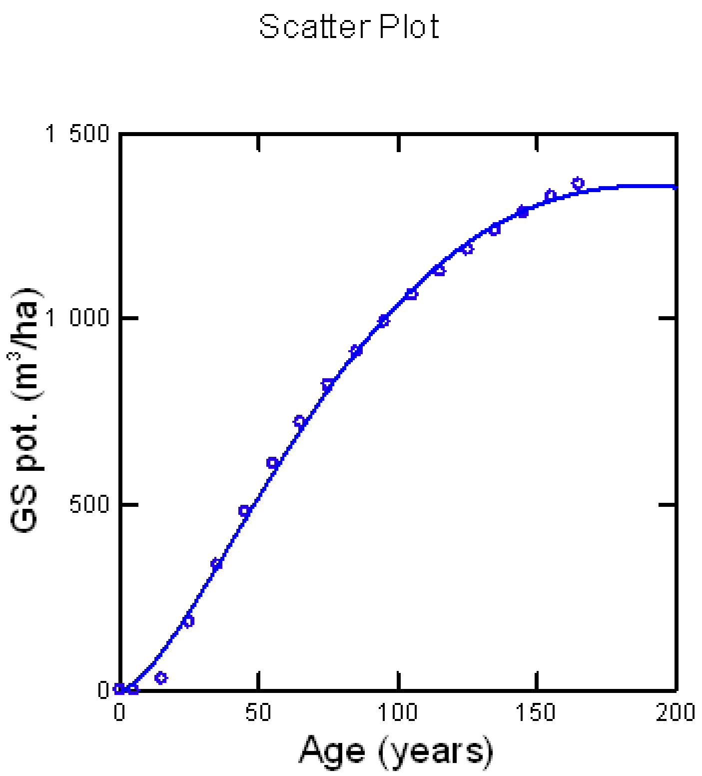
Source	SS	df	Mean Squares
Regression	14 389 436.076	3	4 796 478.692
Residual	9 800.104	15	653.340
Total	14 399 236.180	18	
Mean corrected	3 984 483.317	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	1.447	0.462	3.131	0.462	2.432
B	1.614	0.089	18.049	1.423	1.805
C	0.991	0.001	1 110.616	0.990	0.993



Residuals have been saved.

Results for Forest category = PRO Species group = BE

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

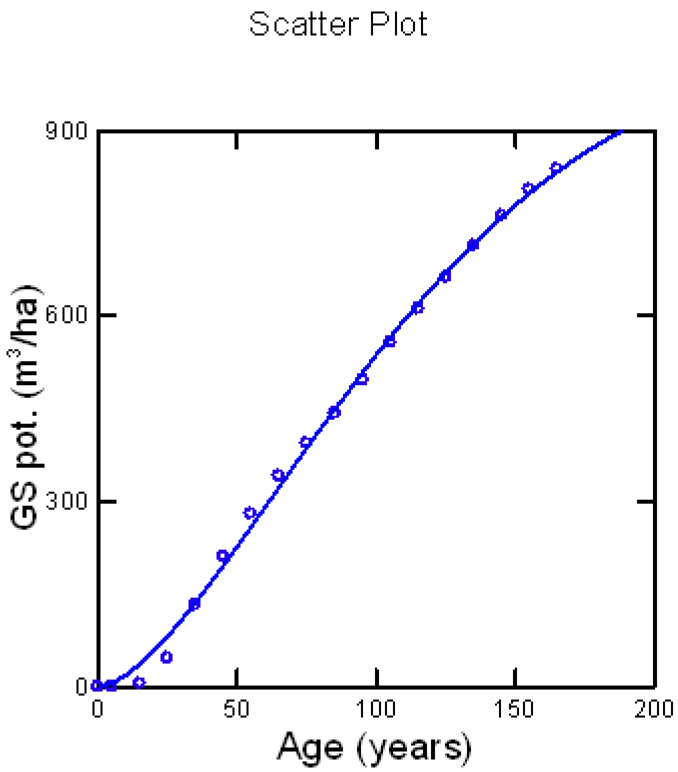
Source	SS	df	Mean Squares
Regression	4 421 878.977	3	1 473 959.659
Residual	3 873.270	15	258.218
Total	4 425 752.247	18	
Mean corrected	1 462 043.875	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.997
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.387	0.175	2.213	0.014	0.760
B	1.711	0.124	13.747	1.446	1.976
C	0.994	0.001	843.114	0.991	0.996



Residuals have been saved.

Results for Forest category = PRO Species group = OA

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

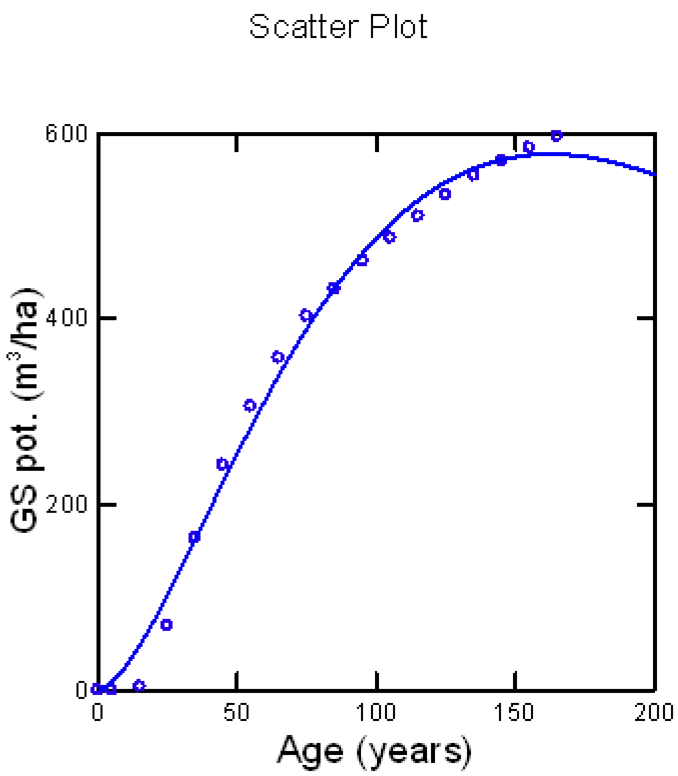
Source	SS	df	Mean Squares
Regression	2 984 179.571	3	994 726.524
Residual	5 852.899	15	390.193
Total	2 990 032.471	18	
Mean corrected	799 024.902	17	

R-squares

Raw R-square (1-Residual/Total) : 0.998
Mean Corrected R-square (1-Residual/Corrected) : 0.993
R-square(Observed vs. Predicted) : 0.993

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.573	0.299	1.916	-0.064	1.210
B	1.691	0.147	11.523	1.378	2.004
C	0.990	0.001	667.654	0.986	0.993



Residuals have been saved.

Results for Forest category = PRO Species group = PI

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

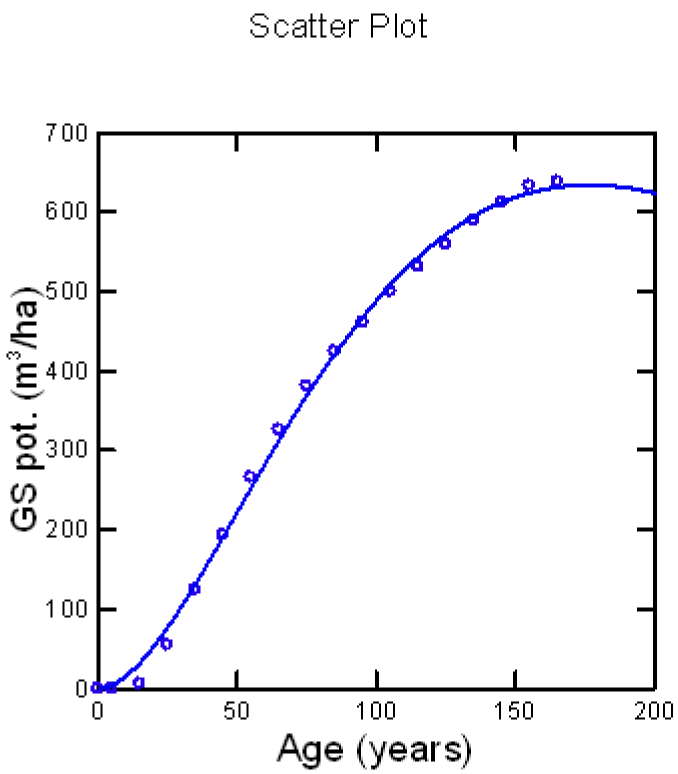
Source	SS	df	Mean Squares
Regression	3 150 355.133	3	1 050 118.378
Residual	2 307.518	15	153.835
Total	3 152 662.650	18	
Mean corrected	942 087.130	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.199	0.076	2.608	0.036	0.362
B	1.932	0.106	18.167	1.706	2.159
C	0.989	0.001	962.502	0.987	0.991



Residuals have been saved.

Results for Forest category = PRO Species group = SP

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

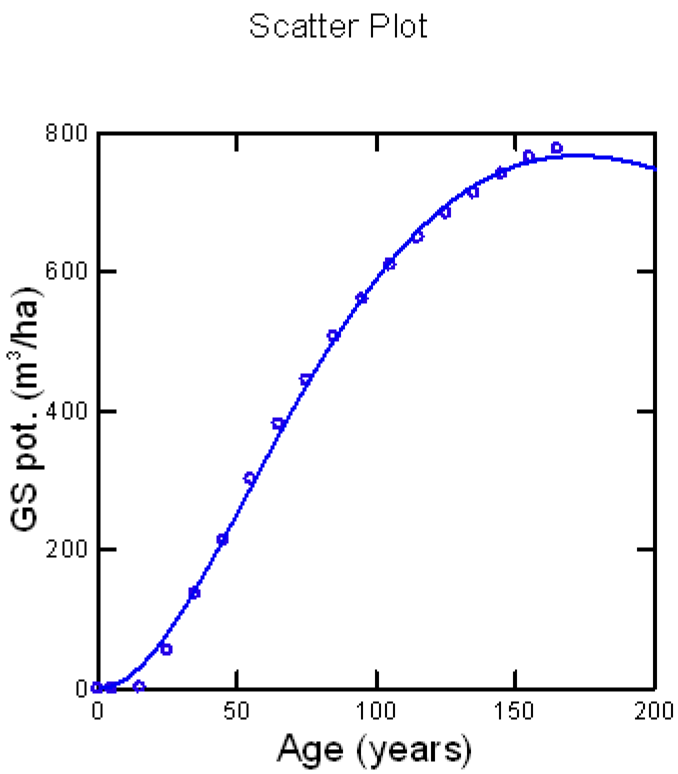
Source	SS	df	Mean Squares
Regression	4 580 917.149	3	1 526 972.383
Residual	2 482.063	15	165.471
Total	4 583 399.212	18	
Mean corrected	1 421 899.083	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.118	0.042	2.809	0.028	0.207
B	2.116	0.098	21.524	1.907	2.326
C	0.988	0.001	1 057.607	0.986	0.990



Residuals have been saved.

Results for Forest category = SPE Species group = BE

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

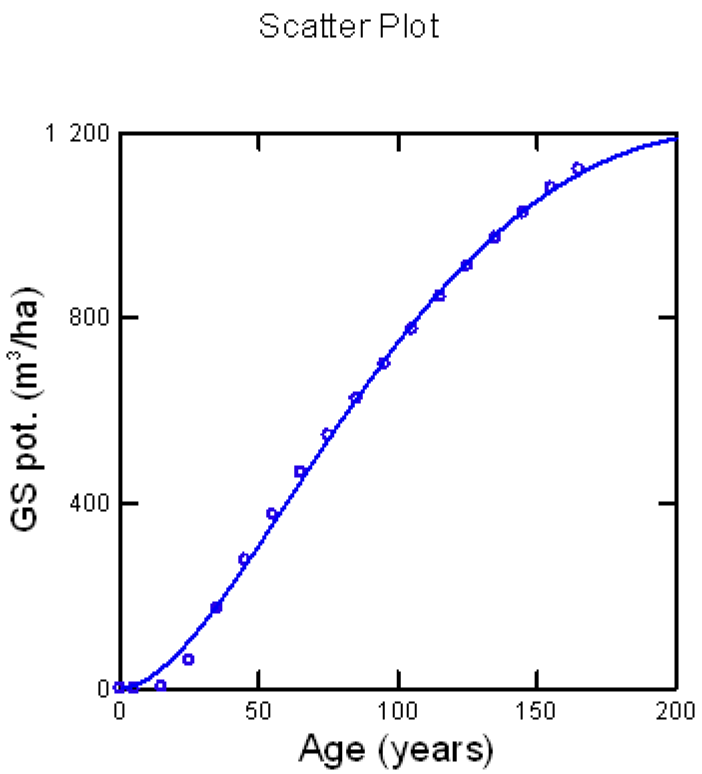
Source	SS	df	Mean Squares
Regression	8 234 172.172	3	2 744 724.057
Residual	5 013.560	15	334.237
Total	8 239 185.732	18	
Mean corrected	2 709 804.829	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.293	0.114	2.570	0.050	0.536
B	1.887	0.107	17.633	1.659	2.115
C	0.992	0.001	984.373	0.989	0.994



Residuals have been saved.

Results for Forest category = SPE Species group = OA

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

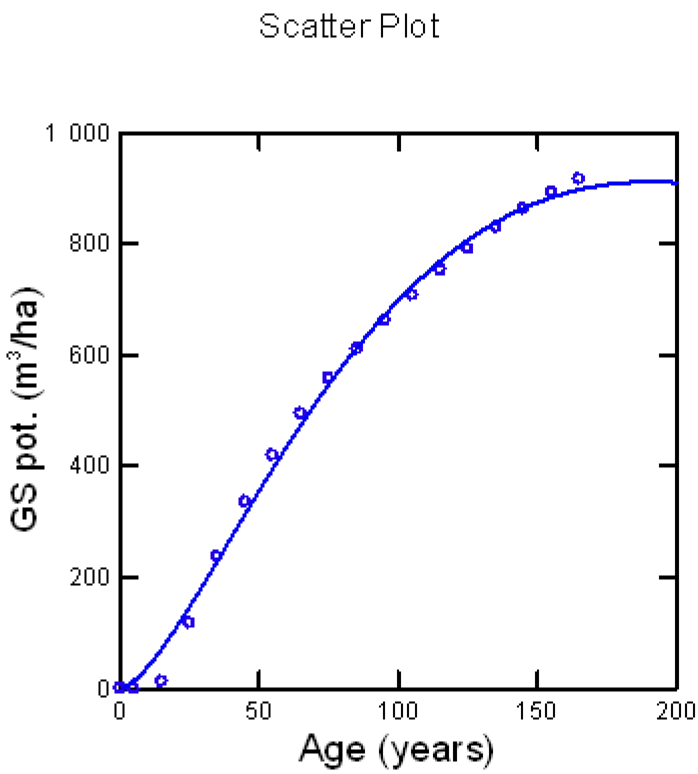
Source	SS	df	Mean Squares
Regression	6 489 576.163	3	2 163 192.054
Residual	7 509.042	15	500.603
Total	6 497 085.205	18	
Mean corrected	1 786 993.693	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.996
R-square(Observed vs. Predicted) : 0.996

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	1.149	0.468	2.458	0.153	2.146
B	1.571	0.114	13.770	1.328	1.814
C	0.992	0.001	866.237	0.989	0.994



Residuals have been saved.

Results for Forest category = SPE Species group = PI

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

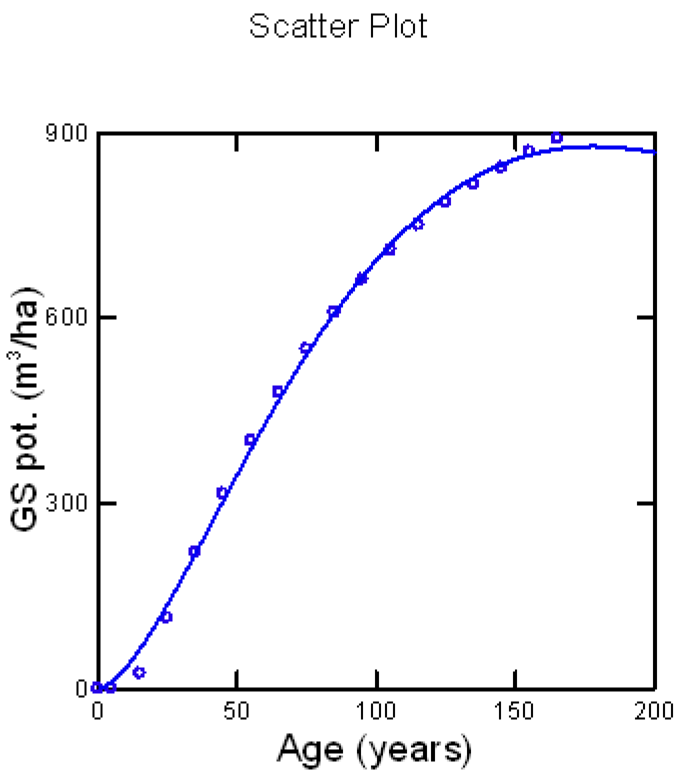
Source	SS	df	Mean Squares
Regression	6 284 159.102	3	2 094 719.701
Residual	3 414.865	15	227.658
Total	6 287 573.967	18	
Mean corrected	1 736 142.848	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.744	0.216	3.447	0.284	1.203
B	1.691	0.081	20.828	1.518	1.864
C	0.991	0.001	1 226.117	0.989	0.992



Residuals have been saved.

Results for Forest category = SPE Species group = SP

Dependent Variable:CYT2004
Zero weights, missing data or estimates reduced degrees of freedom

Sum of Squares and Mean Squares

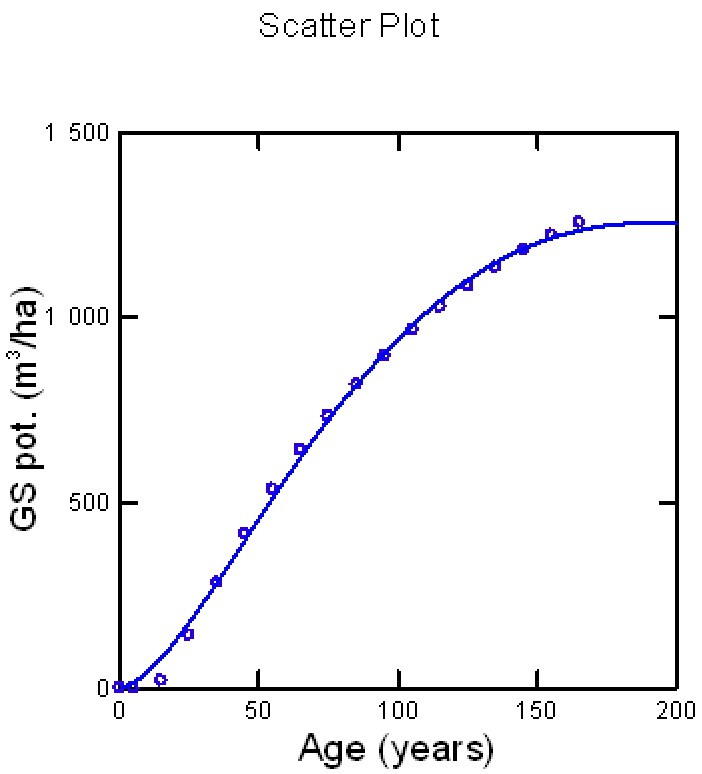
Source	SS	df	Mean Squares
Regression	11 927 071.684	3	3 975 690.561
Residual	7 937.973	15	529.198
Total	11 935 009.657	18	
Mean corrected	3 420 093.800	17	

R-squares

Raw R-square (1-Residual/Total) : 0.999
Mean Corrected R-square (1-Residual/Corrected) : 0.998
R-square(Observed vs. Predicted) : 0.998

Parameter Estimates

Parameter	Estimate	ASE	Parameter/ASE	Wald 95% Confidence Interval	
				Lower	Upper
A	0.934	0.311	2.998	0.270	1.597
B	1.696	0.093	18.225	1.497	1.894
C	0.991	0.001	1 080.947	0.989	0.993



Residuals have been saved.

CZECH NATIONAL FOREST ACCOUNTING PLAN - FOREST REFERENCE LEVEL:
– **Supplementary material S3**

S3 – Disturbance matrices

The attached material provides complete details of carbon pools changes as used in the CBM simulations.

The flow of carbon among various carbon pools caused by a disturbance or management event represented in CBM is described by so called disturbance matrices. Composing the CBM simulations, default disturbance matrices were calibrated to domestic conditions and prevailing management procedures according to the available information and expert judgement.

The specific adjustments are explained in form of matrices, where rows define originating pools and columns represent target pools.

The following disturbance matrices were used in CBM when projecting the Czech FRL:

- DIST. 1 Forest fire
- DIST. 2 Thinning
- DIST. 3 & 3a Salvaging with clear-cut
- DIST. 3b Salvaging (soft) without clear-cut and species change
- DIST. 4 Final harvest
- DIST. 5 Clear-cut with slash-burn

DISTID1 Forest fire

	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable	0,75																0,15			0,1										
Softwood foliage													0,02													0,88	0,01	0,09		
Softwood others																					0,73					0,25	0	0,02		
Softwood sub-merch				1																										
Softwood coarse roots															0,5	0,5														
Softwood fine roots													0,29	0,5												0,19	0	0,02		
Hardwood merchantable							0,75										0,15					0,1								
Hardwood foliage													0													0,9	0,01	0,09		
Hardwood others																							0,79			0,19	0	0,02		
Hardwood sub-merch										1																				
Hardwood coarse roots															0,5	0,5														
Hardwood fine roots													0,29	0,5												0,19	0	0,02		
Above Ground Very Fast soil C													0													0,9	0,01	0,09		
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															0,25											0,67	0,01	0,07		
Below Ground Fast soil C																1														
Medium soil C																	0,8									0,18	0	0,02		
Above Ground Slow soil C																		0,57								0,38	0	0,04		
Below Ground Slow soil C																			1											
Softwood Stem Snag																	0,25			0,25						0,5				
Softwood Branch Snag															1															
Hardwood Stem Snag																	0,25					0,25				0,5				
Hardwood Branch Snag															1															
Black C																								1						
Peat																								1						

DISTID2 Thinning	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable	0,9																													0,1
Softwood foliage		0,9											0,1																	
Softwood others			0,9																		0,1									
Softwood sub-merch				0,9																	0,1									
Softwood coarse roots					0,9										0,05	0,05														
Softwood fine roots						0,9							0,05	0,05																
Hardwood merchantable							0,9																							0,1
Hardwood foliage								0,9					0,1																	
Hardwood others									0,9														0,1							
Hardwood sub-merch										0,9													0,1							
Hardwood coarse roots											0,9				0,05	0,05														
Hardwood fine roots												0,9	0,05	0,05																
Above Ground Very Fast soil C													1																	
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															1															
Below Ground Fast soil C																1														
Medium soil C																	1													
Above Ground Slow soil C																		1												
Below Ground Slow soil C																			1											
Softwood Stem Snag																				1										
Softwood Branch Snag																					1									
Hardwood Stem Snag																						1								
Hardwood Branch Snag																							1							
Black C																								1						
Peat																									1					

DISTID3 Salvaging with clearcut	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable																	0,15									0,05				0,8
Softwood foliage		0,05											0,95																	
Softwood others			0,05												0		0,65				0,2					0,1				
Softwood sub-merch				1																										
Softwood coarse roots					0,05										0,48	0,48														
Softwood fine roots						0,05							0,48	0,48																
Hardwood merchantable																	0,03									0,05				0,92
Hardwood foliage								0,05					0,95																	
Hardwood others									0,05								0,65						0,2			0,1				
Hardwood sub-merch										1																				
Hardwood coarse roots											0,05				0,48	0,48														
Hardwood fine roots												0,05	0,48	0,48																
Above Ground Very Fast soil C													1																	
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															1															
Below Ground Fast soil C																1														
Medium soil C																	1													
Above Ground Slow soil C																		1												
Below Ground Slow soil C																			1											
Softwood Stem Snag																	0,1									0,1				0,8
Softwood Branch Snag																					1									
Hardwood Stem Snag																	0,1									0,1				0,8
Hardwood Branch Snag																							1							
Black C																								1						
Peat																									1					

DISTID3b Salvaging without clearcut	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable	0,8																													0,2
Softwood foliage		0,8											0,2																	
Softwood others			0,8																		0,2									
Softwood sub-merch				1																										
Softwood coarse roots					0,8										0,1	0,1														
Softwood fine roots						0,8							0,1	0,1																
Hardwood merchantable							0,8																							0,2
Hardwood foliage								0,8					0,2																	
Hardwood others									0,8														0,2							
Hardwood sub-merch										1																				
Hardwood coarse roots											0,8				0,1	0,1														
Hardwood fine roots												0,8	0,1	0,1																
Above Ground Very Fast soil C													1																	
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															1															
Below Ground Fast soil C																1														
Medium soil C																	1													
Above Ground Slow soil C																		1												
Below Ground Slow soil C																			1											
Softwood Stem Snag																				1										
Softwood Branch Snag																					1									
Hardwood Stem Snag																						1								
Hardwood Branch Snag																							1							
Black C																								1						
Peat																									1					

DISTID4 Final cut	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable	0,08																0,05									0,05				0,82
Softwood foliage													1																	
Softwood others															0,6											0,2				0,2
Softwood sub-merch				1																										
Softwood coarse roots															0,5	0,5														
Softwood fine roots													0,5	0,5																
Hardwood merchantable							0,05										0,03									0,04				0,88
Hardwood foliage													1																	
Hardwood others															0,6											0,2				0,2
Hardwood sub-merch										1																				
Hardwood coarse roots															0,5	0,5														
Hardwood fine roots													0,5	0,5																
Above Ground Very Fast soil C													1																	
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															1															
Below Ground Fast soil C																1														
Medium soil C																	1													
Above Ground Slow soil C																		1												
Below Ground Slow soil C																			1											
Softwood Stem Snag																	0,85									0,1				0,05
Softwood Branch Snag															1															
Hardwood Stem Snag																	0,85									0,1				0,05
Hardwood Branch Snag															1															
Black C																								1						
Peat																									1					

DISTID5 Slash and burn	Softwood merch.	Softwood foliage	Softwoodothers	Softwoodsub-merch	Softwood coarse roots	Softwood fine roots	Hardwood merch.	Hardwood foliage	Hardwood others	Hardwood sub-merch	Hardwood coarse roots	Hardwood fine roots	Above Ground Very Fast soil C	Below Ground Very Fast soil C	Above Ground Fast soil C	Below Ground Fast soil C	Medium soil C	Above Ground Slow soil C	Below Ground Slow soil C	Softwood Stem Snag	Softwood Branch Snag	Hardwood Stem Snag	Hardwood Branch Snag	Black C	Peat	CO2	CH4	CO	NO2	products
Softwood merchantable	0,05																													0,95
Softwood foliage		0,05											0,95																	
Softwood others			0,05												0,3						0,65					0				
Softwood sub-merch				0,05											0,95															
Softwood coarse roots					0,05										0,48	0,48														
Softwood fine roots						0,05							0,48	0,48																
Hardwood merchantable							0,05																							0,95
Hardwood foliage								0,05					0,95																	
Hardwood others									0,05						0,3								0,65			0				
Hardwood sub-merch										0,05					0,95															
Hardwood coarse roots											0,05				0,48	0,48														
Hardwood fine roots												0,05	0,48	0,48																
Above Ground Very Fast soil C													1																	
Below Ground Very Fast soil C														1																
Above Ground Fast soil C															1															
Below Ground Fast soil C																1														
Medium soil C																	1													
Above Ground Slow soil C																		1												
Below Ground Slow soil C																			1											
Softwood Stem Snag																	0,1									0,7				0,2
Softwood Branch Snag																					1									
Hardwood Stem Snag																	0,1									0,7				0,2
Hardwood Branch Snag																							1							
Black C																								1						
Peat																									1					

CZECH NATIONAL FOREST ACCOUNTING PLAN - FOREST REFERENCE LEVEL:
– **Supplementary material S4**

4 – Consistency of the time series for ΔLB

The attached material provides the details on the iterative steps when testing the consistency of the time series (historical/calibration for 2000 until 2017 and projected from 2018-2030) for the change in carbon pools in living biomass (ΔLB). This was prepared according to the recommendations of Forsell et al. (2018), p. 74.

The attached print of the MS Excell spreadsheet shows the following:

- Initial state of ΔLB (in Mt C) and its TEST (meeting the condition of Average ± 2*SD) – labelling two outliers by 0 to define 1st iteration results
- ΔLB data matching TEST above
- New dataset of ΔLB rate of change (ΔΔLB)
- TEST of ΔΔLB – comparing the last qualifying historical and the first qualifying projected estimate – PASSED (in green)

CONSISTENCY OF THE TIME SERIES														
	Initial state				**Result of 1st**			**Iter. 1**		**Result of 1st**				**D_Iter1**
YEAR	**ΔLB**	SD	0.615	TEST	**ΔLB**	SD	0.427	TEST		**ΔLB**	**ΔΔLB**	SD	0.231	TEST
2000	2.314	AVG	1.469	1	2.314	AVG	1.587	1		2.314		AVG	-0.046	
2001	2.360	AVG+2SD	2.699	1	2.360	AVG+2SD	2.442	1		2.360	0.020	AVG+2SD	0.417	1
2002	2.223	AVG-2SD	0.239	1	2.223	AVG-2SD	0.732	1		2.223	-0.058	AVG-2SD	-0.508	1
2003	1.708			1	1.708			1		1.708	-0.232			1
2004	1.723			1	1.723			1		1.723	0.009			1
2005	1.797			1	1.797			1		1.797	0.043			1
2006	0.638			1	0.638			1		0.638	-0.645			0
2007	-0.148			0										1
2008	1.055			1	1.055			1		1.055				1
2009	1.575			1	1.575			1		1.575	0.493			0
2010	1.006			1	1.006			1		1.006	-0.361			1
2011	1.464			1	1.464			1		1.464	0.455			0
2012	1.484			1	1.484			1		1.484	0.014			1
2013	1.420			1	1.420			1		1.420	-0.043			1
2014	1.337			1	1.337			1		1.337	-0.058			1
2015	0.980			1	0.980			1		0.980	-0.267			1
2016	0.485			1	0.485			1		0.485	**-0.505**			**1**
2017	-0.325			0										1
2018	1.773			1	1.773			1		1.773				1
2019	1.753			1	1.753			1		1.753	**-0.011**			**1**
2020	1.763			1	1.763			1		1.763	0.005			1
2021	1.821			1	1.821			1		1.821	0.033			1
2022	1.811			1	1.811			1		1.811	-0.005			1
2023	1.744			1	1.744			1		1.744	-0.037			1
2024	1.712			1	1.712			1		1.712	-0.018			1
2025	1.708			1	1.708			1		1.708	-0.002			1
2026	1.684			1	1.684			1		1.684	-0.014			1
2027	1.678			1	1.678			1		1.678	-0.003			1
2028	1.654			1	1.654			1		1.654	-0.015			1
2029	1.666			1	1.666			1		1.666	0.007			1
2030	1.673			1	1.673			1		1.673	0.004			1

CZECH NATIONAL FOREST ACCOUNTING PLAN - FOREST REFERENCE LEVEL:

– **Supplementary material S5**

5 – Consistency of the time series for ∆Total (LB+DW+HWP)

The attached material provides the details on the iterative steps when testing the consistency of the time series (historical/calibration for 2000 until 2017 and projected from 2018-2030) for the change in all carbon pools (∆Total) jointly (including living biomass, deadwood and HWP contribution). This was prepared according to the recommendations of Forsell et al. (2018), p. 74.

The attached print of the MS Excell spreadsheet shows the following:

- Initial state of ∆LB (in Mt C) and its TEST (meeting the condition of Average ± 2*SD) – labelling two outliers by 0 to define 1st iteration results
- ∆Total data matching TEST above
- New dataset of ∆Total rate of change (∆∆Toral)
- TEST of ∆∆Total – comparing the last qualifying historical and the first qualifying projected estimate – PASSED (in green)

CONSISTENCY OF THE TIME SERIES																								
	Initial state				**1st**				**2nd**				**3rd**				**4th**				**5th**			
YEAR	**ΔTotal**	SD	0.536	TEST	**ΔTotal**	SD	0.426	TEST	**ΔTotal**	SD	0.333	TEST	**ΔTotal**	SD	0.276	TEST	**ΔTotal**	SD	0.253	TEST	**ΔTotal**	SD	0.197	TEST
2000	2.450	AVG	1.784	1	2.450	AVG	1.844	1	2.450	AVG	1.918	1	2.450	AVG	1.972	1	2.450	AVG	1.996	1	2.450	AVG	2.045	
2001	2.402	AVG+2SD	2.856	1	2.402	AVG+2SD	2.697	1	2.402	AVG+2SD	2.583	1	2.402	AVG+2SD	2.524	1	2.402	AVG+2SD	2.501	1	2.402	AVG+2SD	2.438	1
2002	2.320	AVG-2SD	0.711	1	2.320	AVG-2SD	0.991	1	2.320	AVG-2SD	1.252	1	2.320	AVG-2SD	1.420	1	2.320	AVG-2SD	1.491	1	2.320	AVG-2SD	1.651	1
2003	2.126			1	2.126			1	2.126			1	2.126			1	2.126			1	2.126			1
2004	1.970			1	1.970			1	1.970			1	1.970			1	1.970			1	1.970			1
2005	2.034			1	2.034			1	2.034			1	2.034			1	2.034			1	2.034			1
2006	1.249			1	1.249			1	1.249															
2007	0.824			1	0.824																			
2008	1.678			1	1.678			1	1.678			1	1.678			1	1.678			1	1.678			1
2009	1.852			1	1.852			1	1.852			1	1.852			1	1.852			1	1.852			1
2010	1.443			1	1.443			1	1.443			1	1.443			1	1.443							
2011	1.726			1	1.726			1	1.726			1	1.726			1	1.726			1	1.726			1
2012	1.644			1	1.644			1	1.644			1	1.644			1	1.644			1	1.644			
2013	1.431			1	1.431			1	1.431			1	1.431			1	1.431							
2014	1.371			1	1.371			1	1.371			1	1.371											
2015	1.168			1	1.168			1	1.168															
2016	0.801			1	0.801																			
2017	-0.018																							
2018	2.098			1	2.098			1	2.098			1	2.098			1	2.098			1	2.098			1
2019	2.093			1	2.093			1	2.093			1	2.093			1	2.093			1	2.093			1
2020	2.098			1	2.098			1	2.098			1	2.098			1	2.098			1	2.098			1
2021	2.157			1	2.157			1	2.157			1	2.157			1	2.157			1	2.157			1
2022	2.144			1	2.144			1	2.144			1	2.144			1	2.144			1	2.144			1
2023	2.085			1	2.085			1	2.085			1	2.085			1	2.085			1	2.085			1
2024	2.046			1	2.046			1	2.046			1	2.046			1	2.046			1	2.046			1
2025	2.047			1	2.047			1	2.047			1	2.047			1	2.047			1	2.047			1
2026	2.028			1	2.028			1	2.028			1	2.028			1	2.028			1	2.028			1
2027	2.016			1	2.016			1	2.016			1	2.016			1	2.016			1	2.016			1
2028	1.993			1	1.993			1	1.993			1	1.993			1	1.993			1	1.993			1
2029	2.007			1	2.007			1	2.007			1	2.007			1	2.007			1	2.007			1
2030	2.014			1	2.014			1	2.014			1	2.014			1	2.014			1	2.014			1

CONSISTENCY OF THE TIME SERIES																			
6th				**7th**				**8th**				**Final**				**Final**			
ΔTotal	SD	0.162	TEST	**ΔTotal**	SD	0.121	TEST	**ΔTotal**	SD	0.074	TEST	**ΔTotal**	SD	0.056	TEST	**Δ_ΔTotal**	SD	0.025	TEST
	AVG	2.044			AVG	2.045			AVG	2.048			AVG	2.060			AVG	-0.006	1
2.402	AVG+2SD	2.369			AVG+2SD	2.288			AVG+2SD	2.195			AVG+2SD	2.172			AVG+2SD	0.044	1
2.320	AVG-2SD	1.720	1	2.320	AVG-2SD	1.802			AVG-2SD	1.900			AVG-2SD	1.948			AVG-2SD	-0.056	1
2.126			1	2.126			1	2.126			1	2.126			1				1
1.970			1	1.970			1	1.970			1	1.970			1	-0.073			
2.034			1	2.034			1	2.034			1	2.034			1	0.033			1
																			1
																			1
1.678																			1
1.852			1	1.852			1	1.852											1
																			1
1.726			1	1.726															1
																			1
																			1
																			1
																			1
																			1
																			1
2.098			1	2.098			1	2.098			1	2.098			1				1
2.093			1	2.093			1	2.093			1	2.093			1	-0.002			1
2.098			1	2.098			1	2.098			1	2.098			1	0.002			1
2.157			1	2.157			1	2.157			1	2.157			1	0.028			1
2.144			1	2.144			1	2.144			1	2.144			1	-0.006			1
2.085			1	2.085			1	2.085			1	2.085			1	-0.027			1
2.046			1	2.046			1	2.046			1	2.046			1	-0.019			1
2.047			1	2.047			1	2.047			1	2.047			1	0.000			1
2.028			1	2.028			1	2.028			1	2.028			1	-0.009			1
2.016			1	2.016			1	2.016			1	2.016			1	-0.006			1
1.993			1	1.993			1	1.993			1	1.993			1	-0.011			1
2.007			1	2.007			1	2.007			1	2.007			1	0.007			1
2.014			1	2.014			1	2.014			1	2.014			1	0.003			1