LFI Modul: WSL Beitrag zum Schweizer THGI mit Schwerpunkt Kohlenstoffhaushalt des Schweizer Waldes

Data on C stocks and C stock changes in living tree biomass on forest land prepared for the Swiss NIR 2025 (GHGI 1990– 2023)

update of the report for the Swiss NIR 2024 (Didion et al. 2023)

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1 Background and purpose of this update report

Switzerland prepares annually a greenhouse gas inventory for reporting under the climate convention UNFCCC and the Paris Agreement (PA). The Land Use, Land-Use Change and Forestry (LULUCF) sector of the Swiss inventory includes, inter alia, data for the forest sector, encompassing amongst others C stocks and C stock changes (CSC) in above- and belowground living biomass, dead organic matter (DOM) and in the soil.

This report presents an update of the report for the Swiss NIR 2024 (Didion et al. 2023) describing the national mean C stock in above- and belowground tree biomass, and C gains and losses resulting from tree biomass growth and drain (fellings plus natural mortality) in the reporting year 2023. It also includes a recalculation for certain years in the recent past that can be attributed to an error correction in the fifth National Forest Inventory (NFI5) data. On 9 September 2024, the NFI reported a calculation error on its website. The Growing stock in living trees in the NFI5 had to be recalculated due to an error in the formula for importing tree height measurements on tariff sample trees from NFI5. This affected also the growth that is derived based on data from NFI4 and NFI5. On a national scale, the growing stock in the NFI5 was underestimated by approximately 1% and growth by up to 6%. The drain was not affected by the error (source: NFI; <u>https://www.lfi.ch/en/result-query-system/instructions</u> [as of 29 October 2024]).

This update of Didion et al. (2023) has two objectives: To report

- i) recalculated estimates for the NIR2025 on gains and stocks that account for the corrected NFI5 stock data and the resulting changes in growth derived from the change between NFI4 and NFI5. Since C stock estimates for the NIR are annualized based on the net change of gains and losses, their time series is affected from 2014 onward, i.e. after the mid-point of the NFI4 in 2013 (see 2.2 Annualizing C losses and stocks). The time series of C gains is affected from 2018 onward, i.e. the first year of the NFI5 (see 2.2 Annualising C losses and stocks); and
- ii) the estimated C gains, losses and stocks for the additional reporting year 2023.

Compared to the NIR2024, all other data and methods remained unchanged. Thus, the reader is referred to Didion et al. (2023) for additional information on

- Switzerland's efforts adhering to the criteria of transparency, consistency, comparability, completeness and accuracy (section 1.1),
- data and methods for estimating C stocks, C gains and losses (section 2),

- quality assurance and control (section 2.6), and
- time series and verification of these variables since 1990 (section 3).

2 Data and Methods

The Swiss National Forest Inventory (NFI) is the primary source for estimating the C balance of Swiss forests. The estimates of C gains, losses, and stocks since 1990 reported in the NIR are based on biomass growth, drain, and stock data from five NFIs:

- NFI1 (collected in the years 1983 to 1985; EAFV 1988)
- NFI2 (1993 to 1995; Brassel and Brändli 1999)
- NFI3 (2004 to 2006; Brändli 2010)
- NFI4 (2009 to 2017; Brändli et al. 2020)
- NFI5 (2018 to 2026; Abegg et al. 2023)

These inventories provide:

- volume estimates of stemwood and branches estimated using allometries to tree diameter at breast height (dbh) and conversion to biomass using basic wood densities, and
- biomass estimates of foliage and coarse roots estimated using allometries to tree dbh.

Didion et al. (2023) presented revised historic and new, up-to-date NFI5 data that addressed

- minor corrections and updates in the NFI database;
- revised allometry for coarse roots (Zell and Thürig 2013);
- aggregation of spatial strata with the start of the NFI4 (section 2.2.); and
- covered measurements from the first 5 years (2018-2023) of the NFI5.

2.1 Biomass growth, drain, and growing stock

The estimates of biomass growth and drain that are used for reporting C gains and losses in the Swiss NIR are based on sample plots that are common to two consecutive inventories and that are classified as accessible forest but not shrub forest *(gemeinsam zugänglicher Wald ohne Gebüschwald)* following the definition of "productive forest" in Switzerland's GHGI(Combination Category 12, cf. Tab. 6-2 in FOEN 2023). Biomass growing stock for reporting in the NIR is based on all on all sample plots visited in one particular inventory

classified as accessible forest but not shrub forest (*zugänglicher Wald ohne Gebüschwald*), i.e. including sample plots converted to forest since the previous inventory.

This ensures that for each inventory the most representative and accurate stocks are used to obtain stock changes for forest and converted to other land categories. Growth, drain, and growing stock estimates comprise the total tree biomass including stemwood of the entire stem over bark, branches over bark, and coarse roots. Growth is calculated as the change in total tree biomass between two consecutive inventories considering the state of a tree as follows:

- A tree is alive and measured in both inventories: difference between the biomass calculated based on the dbh in the first and second inventory.
- A tree is alive and measured in the first inventory and dead (and still present on a sample plot) or harvested (and removed from a sample plot) in the second inventory: difference between the biomass calculated based on the dbh in the first inventory and the modelled dbh (Herold et al. 2019) at the half point of the NFI period as the exact date of tree death or harvest is not known.

For deriving the estimates for the NIR, NFI growth data is assumed to be constant for a particular period in the NIR time series since 1990 (Figure S.1).

Drain correspond to the total biomass of trees that were alive in the first inventory and were dead (considered as natural mortality) or harvested (considered as fellings) in the second inventory. It is estimated based on the modelled dbh (Herold et al. 2019) at the half point of the NFI period. Mean annual values for growth and drain are derived based on the number of vegetation periods calculated separately for each repeatedly visited sample plot (Lanz et al. 2019).

2.2 Annualising C losses and stocks

The data on losses for the NIR are obtained from data on fellings and natural mortality. The time series of drain for the NIR is derived based on annualized fellings and constant natural mortality for a particular NFI period (Figure S.2; section 2.5 in Didion et al. 2023). Fellings are annualised using annual weighting factors derived from the annual volume of harvested trees in Swiss forests that is reported in the Swiss harvest statistics database (Table S.1; FSO 2024).

Growing stock data are annualized based on growing stock in 1985 obtained from the NFI1 and forward calculation using the net change obtained for a NFI period based on growth and annualized drain (eq. 1) where y is number of years since 1985. Since the growth and drain estimates are based on plots common to two inventories and thus do not account for sample plots converted to forest between two inventories, forward calculated stocks cannot match observed

stocks. The calculated stock time series is thus scaled to the observed stocks in subsequent inventories (section 2.5 in Didion et al. 2023) considering the years for which a particular NFI is assumed to be representative, i.e., 1995, 2005, 2013, and 2020 (Figure 1).

$$f_{stock}(y) = stock_{1985} + \sum_{n=1985}^{y-1} (growth_n + drain_n)$$
 (equation 1)

For reporting in the Swiss NIR, it is assumed that

- NFI growth and drain data obtained for a particular NFI period are representative for gains and losses in the time series since 1990 (note that the NFI data report a mean annual value for a period only):
 - NFI1-NFI2 for 1990 to 1995,
 - NFI2-NFI3 for 1996 to 2005,
 - NFI3-NFI4 for 2006 to 2017, and
 - NFI4-NFI5 (currently the common plots from the first 5 years of the NFI4 and the NFI5) for 2018 to 2023.
- NFI growing stock data obtained for a particular NFI are representative for the individual years in the time series since 1990:
 - NFI1 for 1985,
 - NFI2 for 1995,
 - NFI3 for 2005,
 - NFI4 for 2013 (i.e. the mid-point of the 9 annual NFI4 panels 2009 to 2017), and
 - NFI5 for 2020 (i.e. the mid-point of the 5 available annual NFI5 panels 2018 to 2022).



Figure 1. Time series of growing stock. a) growing stock (mean + 2SE) observed in different NFIs and forward calculation based on the stock observed in the NFI1 and growth and drain estimates in subsequent inventories, and b) growing stock (mean + 2SE) observed in different NFIs and scaled time series of stocks to account for plots converted to forest between two inventories.

3 Results and Discussion

3.1 Recalculation of growth data for the period NFI4 to NFI5

As a result of the correction of the NFI5 stock data, the recalculated national annual C gain representative for the period 2018 to 2022, increased by 3.7% from 2.858 ± 0.080 (2SE) t C ha⁻¹ yr⁻¹ (Table 6 in Didion et al. 2023; Table 6-16 in FOEN 2024) to 2.964 ± 0.080 (2SE) t C ha⁻¹ yr⁻¹ (Figure 2a; Table S.2). Compared to period NFI3 to NFI4 (2006-2017) this presents a decline in growth by nearly 5% from 3.108 ± 0.071 (2SE) t C ha⁻¹ yr⁻¹ (Figure 2a) that can be attributed to increased stress from drought and insects, as discussed in Didion et al. (2023) and Allgaier Leuch and Fischer (2023). The standard error shown here corresponds to the NFI random sampling error. Uncertainties related to the temporal aspect, allometric relationships, basic wood density, and C fraction are discussed in the NID (ch. 6.4.3.1 in FOEN 2024).

3.2 Estimated C gains, losses and stocks for the reporting year 2023

The time series of C stocks, gains and losses as well as their net change (Figure 2) were extended with estimates for the year 2023 for

- gains by assuming that they remained constant at the level of the estimates obtained for the recalculated period 2018 to 2022 based on all sample plots common to the first five years of the inventories NFI4 and NFI5 (Table S.2). These data are corrected for this period since the previous data delivery;
- losses by calculating a weighting factor for 2023 based on the harvest statistics data on harvested volume for 2023 (Table S.1) and the mean of harvested volume in the period 2018-2022 based on all plots common to the first five years of the inventories NFI4 and NFI5 (section 2.5 in Didion et al. 2023);
- stocks by adding gains and losses for 2023 to the stock estimate from 2022 (Table S.3). Since NFI4 stocks are assumed to be representative for the midpoint of period, i.e. 2014 (Figure 1; section 2.5 in Didion et al. 2023), the corrected growth data affected time series of stocks starting in 2014.

For reporting in the NIR the data were separated into 11 regional strata and a national total (section 2.2 in Didion et al. 2023).

3.3 Time series of C gains, losses and stocks in living tree biomass for the Swiss NIR 2025

As a result of the recalculated growth data for the period NFI45, the estimates of gains since 2018 (Figure 2a) changed compared to the NIR submission 2024 (FOEN 2024) and consequently also the net change (Figure 2). Since NFI4 stocks are assumed to be representative for the midpoint of the NFI4 collected between 2009 and 2017, i.e. 2014, the recalculation affected the stocks since 2014 Figure 2d); losses in the years 2018-2022 were not affected (Figure 2b). In the latest reporting year 2023, harvested volume was 4.89 million m³, which corresponds to a decrease by 6% compared to 2022 (Table S.1; FSO 2024) and losses decreased correspondingly from 2.816 ± 0.170 (2SE) t C ha⁻¹ yr⁻¹ to 2.710 ± 0.170 (2SE) t C ha⁻¹ yr⁻¹. For the year 2023, the recalculated estimate of gains (2.964 ± 0.080 (2SE) t C ha⁻¹ yr⁻¹; Table S.2) and the losses, resulted in net change for productive forest in Switzerland of 0.254 ± 0.251 (2SE) t C ha⁻¹ yr⁻¹, i.e., forest land acted as a small sink in 2023 (Figure 2c). The effect of the growth data correction on C gains and stocks prepared for the NIR submission 2025 and those reported in the NIR2024 differed by region (Tables S.2 and S.3). Based on the NFI random sampling error, a statistically significant difference in the means existed for the gains in the national conifer and total strata only. Losses

were not affected by the growth correction and remained the same as in the previous submission (Table S.4)



Figure 2. Estimates of a) gains, b) losses, c) their net change, and d) growing stock reported in the NIR submissions 2023 (FOEN 2023) and 2024(FOEN 2024), and prepared for the NIR2025 based on the correction of the NFI5 estimates of growth and stocks. The data for the NIR 2023 are shown for comparative purposes to indicate the effect of the change in the data for the period NFI45 that were available for the NIR 2024 (section 3.1 in Didion et al. 2023) and that, with the exception of the corrected and new data presented in this report, are also the basis for the NIR 2025. In the NIR 2025 data set, the recalculated C stocks deviate from the previous NIR 2024 from 2014 onwards, the recalculated C gains since 2018. The ribbons indicate 2 standard errors of the mean for the random sampling error estimated for the NFI data. Note that for the net change positive values indicate gains and negative values losses.

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Supplemental information

Year	NEI warda d	broadleaves		conifers		total	
	NFI period	Harvest [m ³]	factor	Harvest [m ³]	factor	Harvest [m ³]	factor
1986	NFI12	1176795	1.0095388	3451249	0.973562	4628044	0.982464
1987	NFI12	1158445	0.9937969	3411672	0.962397	4570117	0.970167
1988	NFI12	1162122	0.9969513	3332952	0.940191	4495074	0.954237
1989	NFI12	1167474	1.0015426	3374532	0.951921	4542006	0.9642
1990	NFI12	1196011	1.026024	5065667	1.428972	6261678	1.32926
1991	NFI12	1075864	0.922953	3461045	0.976325	4536909	0.963118
1992	NFI12	1172136	1.005542	3274417	0.923679	4446553	0.943937
1993	NFI12	1164931	0.9993611	3172844	0.895027	4337775	0.920845
1994	NFI12	1160618	0.9956611	3449297	0.973011	4609915	0.978616
1995	NFI12	1222362	1.0486295	3456046	0.974915	4678408	0.993156
1996	NFI23	1198861	0.9661648	2796054	0.689283	3994915	0.75414
1997	NFI23	1228819	0.9903081	3154339	0.777607	4383158	0.82743
1998	NFI23	1364530	1.0996779	3480517	0.858016	4845047	0.914623
1999	NFI23	1319610	1.0634767	3408099	0.840164	4727709	0.892473
2000	NFI23	1627567	1.31166	7610407	1.876116	9237974	1.743898
2001	NFI23	1186951	0.9565665	4474629	1.103085	5661580	1.068764
2002	NFI23	1057085	0.8519072	3499532	0.862704	4556617	0.860175
2003	NFI23	1073649	0.8652562	4047322	0.997745	5120971	0.966711
2004	NFI23	1091964	0.8800163	4068558	1.00298	5160522	0.974177
2005	NFI23	1259416	1.0149663	4025234	0.9923	5284650	0.997609
2006	NFI34	1456314	0.9072585	4245213	1.257088	5701527	1.144379
2007	NFI34	1481202	0.9227633	4209356	1.24647	5690558	1.142177
2008	NFI34	1538955	0.9587424	3723244	1.102523	5262199	1.056199
2009	NFI34	1519050	0.9463419	3360646	0.995151	4879696	0.979425
2010	NFI34	1617344	1.007577	3511655	1.039868	5128999	1.029464
2011	NFI34	1663556	1.036367	3411532	1.010219	5075088	1.018643
2012	NFI34	1578854	0.9835988	3079530	0.911907	4658384	0.935005
2013	NFI34	1683797	1.0489765	3094531	0.916349	4778328	0.959079
2014	NFI34	1735880	1.0814233	3177339	0.94087	4913219	0.986154
2015	NFI34	1666104	1.037954	2885793	0.854538	4551897	0.913632
2016	NFI34	1647437	1.0263248	2811554	0.832554	4458991	0.894984
2017	NFI34	1673678	1.0426725	3013864	0.892462	4687542	0.940857
2018	NFI45	1590271	1.02285	3607931	1.060095	5198202	1.048416
2019	NFI45	1484211	0.954633	3129827	0.919617	4614038	0.930597
2020	NFI45	1433876	0.9222579	3368349	0.9897	4802225	0.968552
2021	NFI45	1549832	0.9968399	3448051	1.013118	4997883	1.008014
2022	NFI45	1715536	1.103419	3462863	1.01747	5178399	1.044422
2023	NFI45	1696013	1.0908623	3194147	0.938515	4890160	0.986287

Table S.1. Annual harvested volume in m³ for broadleaves, conifers, and the total based on the Swiss harvest statistics database (FSO 2024) and the derived annual weighting factors per NFI period.

Table S.2. Mean ± 2 SE of estimated C gains of living trees for the periodic NFI45 that were the basis for the reporting years 2018 to 2022 in the NIR 2024 (Didion et al. 2023) and for the reporting years 2018 to 2023 in NIR 2025, respectively. The table gives further the differences between the latest and previous estimates that resulted from the height correction (section 1). Shaded strata indicate cases where the mean values of the corrected and uncorrected data are not within 2 SE (i.e. a statistically significant difference exists). The number of available sample plots in each is given in brackets. This table is based on Table 6 in Didion et al. (2023).

Spatial stratum	Species	Data NIR 2024		Data NIR 2025		Difference
opular stratam	Openies	t C ha ⁻¹ a ⁻¹	2 SE	t C ha ⁻¹ a ⁻¹	2 SE	t C ha ⁻¹ a ⁻¹
Jura <=600m (N=144)	conifers	0.98	0.26	1.00	0.26	0.03
	broadleaves	1.79	0.30	1.86	0.31	0.07
	Total	2.77	0.34	2.86	0.34	0.10
Jura >600m-1200m	conifers	1.57	0.19	1.64	0.20	0.06
(N=336)	broadleaves	1.31	0.16	1.38	0.16	0.07
	Total	2.88	0.22	3.01	0.22	0.13
Jura >1200m (N=68)	conifers	1.42	0.32	1.48	0.32	0.07
	broadleaves	0.47	0.18	0.49	0.18	0.02
	Total	1.89	0.39	1.97	0.39	0.08
Plateau <=600m (N=372)	conifers	1.68	0.21	1.72	0.21	0.04
	broadleaves	2.34	0.24	2.39	0.24	0.06
	Total	4.01	0.25	4.11	0.25	0.10
Plateau >600m (N=283)	conifers	2.35	0.27	2.41	0.28	0.06
	broadleaves	2.19	0.34	2.25	0.34	0.06
	Total	4.53	0.38	4.66	0.38	0.13
Pre-Alps <=1200m	conifers	2.36	0.23	2.44	0.24	0.08
(N=391)	broadleaves	1.50	0.23	1.55	0.23	0.05
	Total	3.86	0.28	3.99	0.28	0.14
Pre-Alps >1200m	conifers	1.96	0.27	2.06	0.27	0.10
(N=218)	broadleaves	0.24	0.11	0.26	0.11	0.02
	Total	2.21	0.28	2.32	0.28	0.11
Alps <=1200m (N=323)	conifers	1.25	0.18	1.31	0.18	0.05
	broadleaves	1.24	0.20	1.27	0.20	0.04
	Total	2.49	0.23	2.58	0.23	0.09
Alps >1200m (N=776)	conifers	1.93	0.14	2.02	0.14	0.09
	broadleaves	0.17	0.05	0.17	0.05	0.00
	Total	2.10	0.14	2.19	0.14	0.10
Southern Alps <=1200m	conifers	0.24	0.17	0.26	0.18	0.02
(N=204)	broadleaves	1.89	0.29	1.94	0.29	0.06
	Total	2.13	0.31	2.21	0.32	0.08
Southern Alps >1200m	conifers	1.48	0.21	1.54	0.22	0.06
(N=222)	broadleaves	0.52	0.18	0.53	0.18	0.01
	Total	2.00	0.24	2.07	0.24	0.07
Switzerland (N=3337)	conifers	1.70	0.07	1.77	0.07	0.07
	broadleaves	1.16	0.06	1.20	0.06	0.04
	Total	2.86	0.08	2.96	0.08	0.11

Table S.3. Mean ± 2 SE of estimated C growing stock of living trees for the periodic NFI45 data that were the basis for the reporting years 2018 to 2022 in NIR 2024 (Didion et al. 2023) and for the reporting years 2018 to 2023 in NIR 2025, respectively. The table gives further the differences between the latest and previous estimates that resulted from the height correction (section 1). The number of available sample plots in each is given in brackets. This table is based on Table 8 in Didion et al. (2023).

Snatial stratum	Species	Data NIR 2024		Data NIR 2025		Difference
opatial stratam	opeoles	t C ha ⁻¹	2 SE	t C ha ⁻¹	2 SE	t C ha ⁻¹
Jura <=600m (N=146)	conifers	32.50	8.61	32.75	8.69	0.25
	broadleaves	77.80	10.90	78.44	10.97	0.64
	Total	110.30	12.24	111.19	12.32	0.89
Jura >600m-1200m	conifers	64.20	6.57	64.78	6.64	0.58
(N=341)	broadleaves	64.25	6.09	64.86	6.14	0.60
	Total	128.45	7.20	129.64	7.27	1.18
Jura >1200m (N=68)	conifers	72.40	12.58	72.99	12.69	0.60
	broadleaves	20.79	7.83	20.94	7.88	0.15
	Total	93.20	13.28	93.93	13.38	0.75
Plateau <=600m (N=375)	conifers	46.65	6.14	47.03	6.19	0.38
	broadleaves	75.55	8.34	76.07	8.40	0.52
	Total	122.20	8.40	123.11	8.46	0.90
Plateau >600m (N=286)	conifers	70.65	8.58	71.23	8.66	0.57
	broadleaves	74.25	10.82	74.82	10.90	0.57
	Total	144.90	11.75	146.05	11.85	1.14
Pre-Alps <=1200m	conifers	87.30	7.87	88.04	7.94	0.75
(N=393)	broadleaves	62.10	7.62	62.57	7.67	0.48
	Total	149.40	8.97	150.61	9.04	1.23
Pre-Alps >1200m	conifers	111.85	10.99	112.72	11.07	0.86
(N=227)	broadleaves	15.52	5.16	15.66	5.23	0.14
	Total	127.40	11.49	128.38	11.58	0.99
Alps <=1200m (N=337)	conifers	58.00	7.27	58.47	7.32	0.47
	broadleaves	51.15	6.86	51.51	6.91	0.35
	Total	109.15	8.58	109.97	8.64	0.82
Alps >1200m (N=818)	conifers	95.85	5.08	96.65	5.13	0.77
	broadleaves	6.05	1.45	6.09	1.46	0.04
	Total	101.90	5.05	102.73	5.09	0.81
Southern Alps <=1200m	conifers	15.30	9.46	15.51	9.67	0.21
(N=211)	broadleaves	87.90	9.30	88.42	9.35	0.50
	Total	103.20	13.02	103.93	13.20	0.72
Southern Alps >1200m	conifers	73.40	8.76	73.97	8.83	0.55
(N=233)	broadleaves	17.03	4.89	17.10	4.92	0.08
	Total	90.45	8.30	91.07	8.37	0.63
Switzerland (N=3453)	conifers	72.00	2.36	72.58	2.38	0.59
	broadleaves	45.66	2.05	45.99	2.06	0.34
	Total	117.65	2.55	118.58	2.57	0.93

Table S.4. Mean ± 2 SE of estimated C losses due to drain including fellings and natural mortality for the periodic NFI45 that were the basis for the reporting years 2018 to 2022 in the NIR 2024 (Didion et al. 2023) and for the reporting years 2018 to 2023 in NIR 2025, respectively. Since losses were not affected by the the height correction (section 1), the values for both submissions are the same. The number of available sample plots in each is given in brackets. This table is based on Table 7 in Didion et al. (2023).

		Data NIR 2025 and 2024		
Spatial stratum	Species	t C ha ⁻¹ a ⁻¹	2 SE	
Jura <=600m (N=144)	conifers	1.56	0.61	
	broadleaves	2.39	0.68	
	Total	3.95	0.85	
Jura >600m-1200m	conifers	1.91	0.52	
(N=336)	broadleaves	1.59	0.43	
	Total	3.51	0.68	
Jura >1200m (N=68)	conifers	1.28	0.50	
	broadleaves	0.58	0.48	
	Total	1.86	0.75	
Plateau <=600m (N=372)	conifers	2.41	0.49	
	broadleaves	2.27	0.50	
	Total	4.67	0.68	
Plateau >600m (N=283)	conifers	2.81	0.63	
	broadleaves	1.98	0.52	
	Total	4.79	0.83	
Pre-Alps <=1200m	conifers	2.68	0.60	
(N=391)	broadleaves	1.43	0.44	
	Total	4.11	0.77	
Pre-Alps >1200m (N=218)	conifers	1.46	0.51	
	broadleaves	0.08	0.06	
	Total	1.54	0.52	
Alps <=1200m (N=323)	conifers	1.34	0.43	
	broadleaves	0.98	0.34	
	Total	2.32	0.56	
Alps >1200m (N=776)	conifers	1.05	0.22	
	broadleaves	0.12	0.05	
	Total	1.17	0.23	
Southern Alps <=1200m	conifers	0.17	0.19	
(N=204)	broadleaves	1.15	0.26	
	Total	1.31	0.33	
Southern Alps >1200m	conifers	1.06	0.50	
(N=222)	broadleaves	0.18	0.15	
	Total	1.24	0.52	
Switzerland (N=3337)	conifers	1.65	0.15	
	broadleaves	1.07	0.11	
	Total	2.72	0.18	



Figure S.1. Time series of gains based on the observed state change between two National Forest Inventories (NFI12: 1986-1995; NFI23: 1996-2005; NFI34: 2006-2017; NFI45: 2018-2023). The dashed vertical lines indicate the starting years of individual NFI periods. Note that the values for the NFI45 are based on the height correction (section 1).



Figure S.2. Time series of losses. Losses comprise observed natural mortality and fellings that are initially derived as constants between two National Forest Inventories (NFI12: 1986-1995; NFI23: 1996-2005; NFI34: 2006-2017; NFI45: 2018-2023). The time series of losses is annualised by scaling fellings using annual weighting factors derived from the Swiss harvest statistics database (Table S.3). The dashed vertical lines indicate the starting years of individual NFI periods.