Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

PM (VER 3.2) SLU ID: SLU.dha. 2024.5.2-206

2025-08-19

SLU Artdatabanken
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Assessment of short-term trends in areas of Annex I forest habitat types in Sweden: A basis for reporting under Article 17 of the Habitats Directive (92/43/EEC) in 2025

Contents

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Summary

Assessment of short-term trends in the area of habitat types is an important part of the overall assessment in Article 17 reporting. According to guidelines, this assessment should employ statistically robust methods. In Sweden, the national forest inventory (NFI) has been registering Annex I forest habitat types since 2008 and can therefore serve as a data source for assessing short-term trends.

For the assessment of the short-term trend over a 12-year period, we compared average area estimates and their associated 95% confidence intervals (CI) from two 5-year periods with mid-years 2010 and 2021. An ‘increasing’ or ‘decreasing’ short-term trend was identified if the 95% CI of the difference in area estimates excluded zero. If the 95% CI of the difference included zero, the trend was assessed as ‘stable’. However, for very uncertain estimates, the short-term trends were assessed as ‘uncertain’.

Short-term trends were primarily assessed for wide-ranging forest habitat types, most of which were classified as ‘stable’. Of the 30 forest habitat type–region combinations in Sweden, four were initially assessed as ‘increasing’ (including Western taiga (9010) and Bog woodland (91D0) in the Boreal region). However, in some cases, directional trends, particularly those based on small sample sizes, were re-evaluated as ‘uncertain’ because they were likely influenced by sampling variability during the inventory period. For less common forest habitat types, as well as many habitat types within the Natura 2000 network, short-term trends were assessed as ‘uncertain’ or ‘unknown’ due to insufficient data. Furthermore, because temperate broad-leaved forest habitat types are generally rare, they were analysed collectively, and the resulting short-term trend in area was proposed as a possible solution to improve the reliability of trend estimates for these habitat types.

Background

Task description and general guidelines

As part of the Article-17 reporting, short-term trends in the area of Annex I habitat types should be assessed within the three biogeographical regions (Alpine, Boreal and Continental) in Sweden. The short-term trend should be assessed for the total habitat type areas and the areas within Natura-2000 network. To achieve favourable conservation status, it is required that habitat types' short-term trend in total area (within a region) is either 'stable' or 'increasing' (DG Environment 2023).

Short-term trends in areas cover two reporting cycles, or 12 years, preferably between 2013–2024, or as close to it as possible. The assessment of short-term trends consists of assessing the trend direction, magnitude and the evaluation of the method used (DG Environment 2023).

According to the reporting guidelines (DG Environment 2023), the assessment method should preferably be based on statistically robust sampling. If the sampling and the data are robust and the results are statistically significant, even a trend of small magnitude should be reported as directional, i.e. 'increasing' or 'decreasing'. If the analysis does not yield a statistically significant trend, the trend should be reported as 'stable'. If the sampling is statistically robust, but the data are insufficient to determine trend direction, it can be reported as 'uncertain'. If analysis is not possible due to insufficient sampling or data, the trend should be reported as 'unknown'.

Monitoring of areas of forest habitat types in Sweden

In Sweden, systematic long-term monitoring of areas of forest habitat types is primarily conducted by the national forest inventory (NFI). Monitoring of Annex I habitat types has been ongoing since 2008, following the inventory manual by Gardfjell and Hagner (2019). The NFI is a sample-based inventory using both permanent and temporary sample plots, systematically laid out within tracts across the country. Conducted on a five-year cycle, NFI produces area estimates for five-year periods (e.g. area estimate for 2020 comprises years 2018–2022). The area estimates can be produced for both the total area of individual habitat types, as well as their area within Natura 2000 network (e.g., Skogsdata 2022).

Aim of this PM

The aim of this PM is to document how NFI statistics were used to assess short-term trends in the areas of forest habitat types in Sweden, to support the 2025 Article 17 reporting. We describe the analytical approach and how the instructions from DG Environment (2023) were interpreted.

Method

In this PM, individual habitat types are identified by their codes (e.g. 9010), with their Swedish names in the Tables and the Appendices.

Area estimates from the NFI

A series of area estimates were produced for each habitat type (see Appendix I – Supplementary figures). These estimates covered the period from 2010 to 2021, corresponding to the years with available field inventory data. The area estimates were calculated as 5-year averages for each given year (e.g., 2008–2012 for 2010 and 2019-2023 for 2021), along with the associated relative standard error (RSE).

For most forest habitat types, area estimates were primarily calculated based on sample plots located on forest land, as defined by the Food and Agricultural Organization (FAO). However, in cases of 9040 and 91D0, NFI also identifies these habitat types on both forest land and more sparsely wooded areas. For these habitat types, area estimates were therefore computed for 'all land'. All area estimates were produced by the Swedish National Forest Inventory (NFI; Jonas Dahlgren, pers. comm.).

Furthermore, for 9040, the inventory prior to 2016 was split between NFI and the National Inventory of Landscapes in Sweden (NILS). Consequently, for calculation of short-term trend, the area estimate for 2010 was a 'combined estimate' derived from both inventories (Appendix II, Table S1). This combined estimate was compared to NFI current area estimate from 2021. The combined estimates were provided by NILS (Hans Gardfjell, pers. comm.).

Assessment of short-term trends

Step 1: 'Period'

The NFI statistics on habitat types comprises a 16-year time series (2008–2023). Since data collection follows a five-year cycle, there are three independent five-year area estimates with mid-years 2010, 2015 and 2020 (alternatively 2011, 2016 and 2021) within this period.

To estimate short-term trends, we primarily analysed the difference between the 5-year area estimates from 2010 and 2021. It is important to note that the underlying data for these estimates extend beyond the exact 12-year window (specifically, the 2010 estimate includes data from 2008–2012, and the 2021 estimate includes data from 2019–2023). However, despite encompassing years outside the 12-year period, these are the most representative data points available, given the NFI's sampling design.

Furthermore, we also allowed for some missing data in the time series. Specifically, we calculated the difference in area estimates if the two available estimates were at least 10 years apart within the 12-year period.

Step 2: 'Direction'

Since the NFI statistics contain only three independent area estimates, derived from calculations based on sample plot data, applying regression or trend analysis methods (e.g., the Mann-Kendall test) to determine trend direction is challenging. In NFI, Kempe (2017) developed a method for change estimation between two estimates that uses optimized weights and accounts for the correlation between measurements over time. However, this method has not yet been fully integrated into the NFI workflow and could not be applied to all estimates in this study (Jonas Dahlgren, pers. comm.).

Here, we therefore use a simplified approach by comparing area estimates and their 95% confidence intervals (95% CI) for the first period (mid-year 2010) with those of the last period (with mid-year 2021) (Åsa Ranlund and Wilmer Prentius, SLU, pers. comm.). The difference between the two area estimates, and the associated 95% CI was then calculated as:

$$\text{Difference} = \text{Area}_{2021} - \text{Area}_{2010}$$

$$95\%\,\text{CI} = \pm 1.96 \times \sqrt{\text{Variance}_{2021} + \text{Variance}_{2010}}$$

The variance for each area estimate is calculated by:

$$\text{Variance} = \left(\left(\frac{RSE\ (\%)}{100}\right) \times \text{Area estimate}\right)^2$$

For the assessment of trend direction: If the 95% CI for the difference between the two estimates excludes zero, the change is considered significant, and the trend is classified as 'increasing' or 'decreasing'. If the 95% CI includes zero, the change is considered non-significant, and the trend is classified as 'stable'. However, to avoid classifying highly uncertain estimates as 'stable', we set an RSE threshold of 60%, which roughly corresponds to detecting up to 6% change per year over a 10-year period with 80% power and a 10% error probability (Hedenås et al. 2022). Any trend direction with area estimates with an RSE above this threshold is classified as 'uncertain'.

In cases where NFI area estimates exist only for a shorter period[1] than described in Step 1, or if *no data* was available, the trend was assessed as 'unknown'.

Step 3: 'Trend magnitude'

If a significant change in area estimates was identified, the magnitude of this change was reported as estimated minimum or maximum value (i.e. 95% CI).

Step 4: 'Method used'

The aim is to classify the assessments as method 'a' when they exhibit both high accuracy (representativeness or agreement with the 'true value') and precision (consistency of measurements). However, because the accuracy of NFI habitat-type

[1] In an earlier draft, short-term assessments based on shorter time series (than required in Step 1) were classified as 'uncertain', but were later changed to 'unknown' to ensure compatibility with the reporting system.

area estimates has not been quantified, accuracy cannot be used as a criterion for method classification in this PM [2].

Therefore, method classification is primarily based on precision, specifically the RSE of NFI's area estimates. In general, NFI estimates with a RSE below 25% are considered more reliable, while those exceeding this threshold are considered less certain (Nilsson and Dahlgren 2023). Therefore, a method is classified as 'a) complete survey or a statistically robust estimate', if the area estimates have a RSE of no more than 25%. In cases where the RSE of area estimates exceed this threshold, the method is classified as 'b) based mainly on extrapolation from a limited amount of data'.

If area estimates exist only for a shorter period than described in Step 1, or if no area estimates were available, the method was classified as 'd) insufficient or no data available'.

Finally, in cases where data were insufficient and short-term trends were extrapolated from a larger area (e.g., group of habitat types), or where results were re-evaluated and expert opinion was applied, the method is classified as 'c) based mainly on expert opinion with very limited data'.

Guidance from SEPA and SFA

During discussions with the Swedish Environmental Protection Agency (SEPA) and Swedish Forest Agency (SFA) regarding the results, it was requested that, where data are insufficient, short-term trends should be assessed either by increasing the sample size (e.g. grouping habitat types, or extrapolation from larger areas) or by using expert judgement (pers. comm., 20/12/2024). In line with this guidance, we propose appropriate options where applicable.

[2] NFI assigns plots to habitat types largely using an age criterion (Gardfjell and Hagner 2019) that increases as site productivity decreases, reaching ≈150 years on low-productivity sites. Consequently, younger forests that otherwise meet habitat characteristics are likely excluded from NFI estimates for some habitat types. For example, Maňák & Berglund (2022) showed that, in the Alpine region, within Natura 2000 areas classified as Western taiga (9010), NFI plots with stand age <150 years were less likely to be classified as 9010, implying a potential underestimation of area. However, the magnitude of this bias across habitat types and regions remains unquantified.

Results and discussion

Short-term trends in the area of forest habitat types

Total areas

Based on NFI statistics, difference between area estimates of 2010 and 2021 were possible to calculate for the majority of habitat types within the three biogeographical regions (Table 1).

For 13 of the 30 forest habitat type–region combinations found in Sweden, the short-term trends were classified as ‘stable’. For 11 of 30 combinations, the short-term trend was assessed as ‘uncertain’ or ‘unknown’, due uncertainty of the area estimates or due to a lack of data.

A statistically significant increase in area was detected for 91D0, 9010 and 9160 in the Boreal region, and for 9080 in the Continental region.

Areas within N2000 network

For forest habitat types in Natura 2000, the difference in area estimates could be calculated for 15 of the 30 forest habitat type–region combinations (Table 2). The short-term trends for the remaining 14 combinations could not be calculated due to limited data.

The direction of the trend was assessed as ‘stable’ for 8 of the habitat type–region combinations, while the rest was assessed as ‘uncertain’ (Table 2).

Evaluation of short-term trends of forest habitat types

In summary, NFI statistics enabled the assessment of short-term trends mostly in wide-ranging habitat types. For habitat types with small areas, as well as many habitat types within the Natura 2000 network, NFI statistics were lacking or insufficient to determine trends, leading to classifications as either ‘uncertain’ or ‘unknown’.

Regarding the short-term trends with significant results. For 91D0, NFI statistics indicate that tree cover in open mires has increased significantly over the past 35 years, resulting in a net decline in the total area of open mires (Gunnarsson and Nilsson 2024). It is therefore plausible that the trend may have become apparent as the increasing areas for 91D0.

For 9010, NFI’s identification of this habitat type is closely linked to the assessed stand age of inventoried forests (Gardfjell and Hagner 2019). NFI statistics indicate that the area of forests over 140 years old has been increasing since the 1990s (Skogsdata 2023). Since both indicators rely on age criteria, it is likely that the area of 9010 and forests older than 140 years follows similar trends.

Compared to both 9010 and 91D0, area estimates for 9160 in the Boreal region are based on fewer samples and therefore are associated with higher uncertainty. Nevertheless, long-term NFI data has demonstrated that broad-leaved habitat types

as a group has been increasing in the Boreal region since the 1990s (SEPA 2024), which may support the assessed short-term increase in area of 9160.

The increase of 9080 in the Continental region is also associated with relatively high RSEs (57.0% and 24.7%). When compared to other regions, a similar increase was not observed in either the Boreal region as a whole or the adjacent Southern Boreal sub-region, which encompasses most of the southern parts of the country (Figure S7). Furthermore, for swamp forests in general, NFI statistics suggest an overall decreasing trend for whole of Sweden as well as in southern parts of the country (Berglund et al. 2022, Nilsson and Dahlgren 2023). A likely explanation is that the area estimates from the Continental region are based on a relatively small number of sample plots, making them prone to sampling variability. Another possibility is that due to the multiple comparisons, the significant result reflects an increased probability of a Type I error (i.e., a false positive effect), rather than a true effect. Given this context, the short-term trend for 9080 in the Continental region is therefore unlikely to be increasing. As a result, expert opinion was applied, and the short-term trend was deemed ‘uncertain’ (Table 1).

For 91D0 in the Continental region within the Natura 2000 network, NFI data indicated strong decline during the 12-year period (RSEs for the area estimates: 41.4% and 100%, respectively). However, the underlying data showed that for the first period, area estimates included a number of temporary sample plots, while no temporary plots matched Natura 2000 areas in the later period. Furthermore, two permanent sample plots were reclassified to a different habitat type (7110, Åsa Ranlund, SLU, pers. comm.). Thus, the short-term trend of 91D0 in Natura 2000 areas within the Continental region is unlikely to represent a true decrease and can likely be attributed mostly to sampling variability. As a result, we classified this short-term trend as ‘uncertain’ (Table 2).

Finally, for 9030, the NILS Seashore Inventory provides more precise area estimates compared to the NFI, but it currently only includes two cycles, one five-year cycle 2015–2019 and one four-year cycle 2021–2024, making direct comparison and short-trend assessment difficult. Nevertheless, once the second inventory cycle is completed, the area estimates from both cycles are likely to be similar, indicating a stable trend (Hans Gardfjell, pers. comm., see Figure S3). Given the information from both NFI and NILS inventories, the short-term was assessed as ‘stable’.

Extrapolation of short-term trends from a larger sample

According to instructions from SEPA (pers. comm., 20 December 2024), when data are insufficient, short-term trends should be assessed using a larger sample or expert opinion.

Because most broad-leaved forest habitat types in Sweden occupy only small areas and share similar ecological characteristics, it may be more appropriate to analyse them collectively as group. This approach yields more statistically reliable results compared to analysing each habitat type individually.

When considered collectively, broad-leaved forest habitat types were deemed to have a ‘stable’ short-term trend in both the Boreal and Continental regions (Table 3). In Natura 2000 areas, the short-term trend was ‘uncertain’ in the Boreal region and ‘stable’ in the Continental region. It is important to note that these results may be influenced by the most common habitat type among these forests (i.e. 9160). Nevertheless, given the overall scarcity of broad-leaved forest habitat types, a collective analysis likely provides a more reliable assessment of short-term trends.

Other rare habitat types, such as 91E0 and 91F0, are so infrequently represented in the NFI data that even a collective analysis would remain inconclusive. Similarly, 9060 is very rare in the NFI. Although 9060’s short-term trend may be similar to other conifer-dominated forest habitat types, the scarcity of observations warrants classifying their short-term trend as ‘uncertain’.

Conclusions

This PM outlines a method for assessing short-term trends in the area of forest habitat types using NFI statistics. In general, estimates are more reliable for habitat types with larger extents and sample sizes. However, many habitat types are rare and under-represented in the NFI, which limits the precision of area estimates. For habitat types with smaller areas, the results warrant cautious interpretation.

For future reporting periods, the NFI will remain an important source of short- and long-term trends, primarily for the most wide-ranging forest habitat types. For rarer habitat types, newly established inventories, particularly the NILS inventory of deciduous forests and NILS Seashore inventory, are likely to provide more reliable trend statistics in the future.

Tables

Table 1. Assessment of short-term trends for the total area of forest habitat types, based on a comparison of average area estimates from two 5-year periods with mid years 2010 ('year 1') to 2021 ('year 2'), using data from the Swedish National Forest Inventory (NFI) (see Appendix I, Figures S1–S15). NFI area estimates (in hectares) and their corresponding relative standard errors (in percent) were used to calculate the difference in area (± CI95) between the two 5-year periods. Estimated difference with CI 95% not overlapping zero indicate a directional trend in area.

ID	Swedish name	Region	Years	$Area_{Year1}$	$Area_{Year2}$	RSE_{Year1}	RSE_{Year2}	Direction	Difference in area (±CI95%)	Method used
9010	Taiga	ALP	2010-2021	735 630	758 441	8,2	7,9	stable	22 812 (-143 504, 189 128)	a
9010	Taiga	BOR	2010-2021	1 314 669	1 503 973	4,6	4,1	**increasing**	**189 303 (21 123, 357 484)**	a
9010	Taiga	CON	2010-2021	4 405	1 874	49,5	73,0	uncertain	-2 531 (-7 580, 2 519)	b
9020	Nordlig ädellövskog	BOR	2010-2021	6 349	2 059	32,5	49,3	stable	-4 289 (-8 797, 219)	b
9020	Nordlig ädellövskog	CON	2010-2021	464	551	100,0	58,9	uncertain	87 (-1 022, 1 196)	b
9030	Landhöjningsskog	BOR	2010-2021	5 691	6 361	46,1	49,5	stable	671 (-7 366, 8 708)	b
9040*	Fjällbjörkskog	ALP	2010-2021	1 418 540	1 312 826	14,0	6,7	stable	-105 714 (-530 199, 318 770)	a
9050	Näringsrik granskog	ALP	2010-2021	61 123	92 732	19,6	17,1	stable	31 609 (-7 330, 70 549)	a
9050	Näringsrik granskog	BOR	2010-2021	65 779	94 083	17,3	13,0	stable	28 304 (-4 405, 61 013)	a
9060	Åsbarrskog	BOR	2010-2021	4 596	1 652	49,2	100,0	uncertain	-2 943 (-8 435, 2 549)	b
9080	Lövsumpskog	BOR	2010-2021	16 649	15 380	22,1	20,4	stable	-1 270 (-10 736, 8 197)	a
9080	Lövsumpskog	CON	2010-2021	1 617	7 424	57,0	24,7	deemed uncertain	**5 807 (1 784, 9 831)**	c
9110	Näringsfattig bokskog	BOR	2010-2021	2 498	1 826	56,8	73,2	uncertain	-672 (-4 496, 3 151)	b
9110	Näringsfattig bokskog	CON	2010-2021	2 082	1 460	46,2	61,2	uncertain	-621 (-3 195, 1 952)	b
9130	Näringsrik bokskog	BOR	2010-2021	446	218	100,0	100,0	uncertain	-228 (-1 201, 745)	b
9130	Näringsrik bokskog	CON	2010-2021	3 277	2 365	35,0	46,0	stable	-912 (-4 010, 2 186)	b
9160	Näringsrik ekskog	BOR	2010-2021	4 020	12 112	40,6	23,8	**increasing**	**8 092 (1 607, 14 577)**	b
9160	Näringsrik ekskog	CON	2010-2021	2 278	3 612	54,6	48,1	stable	1 333 (-2 855, 5 522)	b
9180	Ädellövskog i branter	BOR	2010-2021	2 079	564	62,3	100,0	uncertain	-1 515 (-4 285, 1 255)	b
9180	Ädellövskog i branter	CON	2010-2016	852	349	100,0	100,0	unknown	-	d
9190	Näringsfattig ekskog	BOR	2010-2021	2 196	3 896	56,4	41,2	stable	1 700 (-2 275, 5 675)	b
9190	Näringsfattig ekskog	CON	2010-2021	552	450	71,3	100,0	uncertain	-102 (-1 273, 1 069)	b
91D0	Skogsbevuxen myr	ALP	2010-2021	166 162	173 306	11,7	11,8	stable	7 144 (-48 122, 62 409)	a
91D0	Skogsbevuxen myr	BOR	2010-2021	1 753 464	2 009 481	3,1	2,8	**increasing**	**256 017 (103 196, 408 837)**	a
91D0	Skogsbevuxen myr	CON	2010-2021	13 764	19 121	21,3	18,8	stable	5 357 (-3 717, 14 430)	a
91E0	Svämlövskog	ALP	---	-	-	-	-	unknown	-	d
91E0	Svämlövskog	BOR	2010-2021	5 251	3 486	46,1	43,3	stable	-1 765 (-7 356, 3 826)	b
91E0	Svämlövskog	CON	2010-2021	398	479	100,0	100,0	uncertain	82 (-1 139, 1 303)	b
91F0	Svämädellövskog	BOR	2013-2017	2 947	1 243	71,8	100,0	unknown	-	d
91F0	Svämädellövskog	CON	---	-	-	-	-	unknown	-	d

* For 9040, the RSE for 2010 refers to combined area estimates from the NFI and NILS for the period 2008–2012. The corresponding RSE for 2021 is derived from NFI data only, as the NFI began including mountain forest inventory in 2016. Both estimates cover all land.

Table 2. Assessment of short-term trends for areas of forest habitat types within Natura 2000 network, based on a comparison of average area estimates from two 5-year periods with mid years 2010 to 2021, using data from the Swedish National Forest Inventory (NFI) (see Appendix I, Figures S1–S15). NFI area estimates (in hectares) and their corresponding relative standard errors (in percent) were used to calculate the difference in area (± CI95) between the two 5-year periods. Estimates of difference with CI 95% not overlapping zero indicate a directional trend in area.

ID	Swedish name	Region	Years	$Area_{Year1}$	$Area_{Year2}$	RSE_{Year1}	RSE_{Year2}	Direction	Difference in area (±CI95%)	Method used
9010	Taiga	ALP	2010-2021	397 940	447 740	11,4	11,1	stable	49 800 (-82 026, 181 626)	a
9010	Taiga	BOR	2010-2021	198 226	235 952	14,4	13,5	stable	37 726 (-46 152, 121 604)	a
9010	Taiga	CON	2016-2020	586	586	100,0	100,0	unknown	-	d
9020	Nordlig ädellövskog	BOR	2019-2021	408	408	100,0	100,0	unknown	-	d
9020	Nordlig ädellövskog	CON	2011-2019	720	399	100,0	100,0	unknown	-	d
9030	Landhöjningsskog	BOR	2011-2021	820	688	100,0	100,0	uncertain	-132 (-2 229, 1 965)	b
9040	Fjällbjörkskog	ALP	2010-2021	131 230	116 323	15,0	16,2	stable	-14 907 (-68 257, 38 443)	b
9050	Näringsrik granskog	ALP	2010-2021	26 022	28 683	33,7	34,3	stable	2 661 (-23 146, 28 467)	b
9050	Näringsrik granskog	BOR	2010-2021	11 179	14 494	51,8	40,9	stable	3 315 (-12 933, 19 563)	b
9060	Åsbarrskog	BOR	---	-	-	-	-	unknown	-	d
9080	Lövsumpskog	BOR	2010-2021	2 042	2 601	51,4	50,6	stable	559 (-2 739, 3 858)	b
9080	Lövsumpskog	CON	2020-2021	2 601	2 601	50,6	50,6	unknown	-	d
9110	Näringsfattig bokskog	BOR	2010-na	980	0	100,0	0,0	unknown	-	d
9110	Näringsfattig bokskog	CON	2010-2021	485	690	100,0	100,0	uncertain	205 (-1 449, 1 858)	b
9130	Näringsrik bokskog	BOR	2014-2018	449	449	100,0	100,0	unknown	-	d
9130	Näringsrik bokskog	CON	2010-2021	446	634	100,0	100,0	uncertain	188 (-1 331, 1 708)	b
9160	Näringsrik ekskog	BOR	2011-2021	1 424	2 139	100,0	74,5	uncertain	715 (-3 472, 4 903)	b
9160	Näringsrik ekskog	CON	2010-2021	1 402	1 993	74,7	74,7	uncertain	591 (-2 975, 4 157)	b
9180	Ädellövskog i branter	BOR	---	-	-	-	-	unknown	-	d
9180	Ädellövskog i branter	CON	2012-2016	349	349	100,0	100,0	unknown	-	d
9190	Näringsfattig ekskog	BOR	2018-2021	450	450	100,0	100,0	unknown	-	d
9190	Näringsfattig ekskog	CON	2011-2021	1 072	450	100,0	100,0	uncertain	-623 (-2 901, 1 656)	b
91D0	Skogsbevuxen myr	ALP	2010-2021	66 179	85 955	21,0	18,6	stable	19 776 (-21 769, 61 320)	a
91D0	Skogsbevuxen myr	BOR	2010-2021	73 140	91 438	14,5	13,6	stable	18 299 (-13 643, 50 241)	a
91D0	Skogsbevuxen myr	CON	2010-2021	3 261	80	41,4	100,0	deemed uncertain	**-3 182 (-5 832, -532)**	c
91E0	Svämlövskog	ALP	---	-	-	-	-	unknown	-	d
91E0	Svämlövskog	BOR	2017-2021	467	849	100,0	71,1	unknown	-	d
91E0	Svämlövskog	CON	---	-	-	-	-	unknown	-	d
91F0	Svämädellövskog	BOR	---	-	-	-	-	unknown	-	d
91F0	Svämädellövskog	CON	---	-	-	-	-	unknown	-	d

* For 9040, the short-term trend is derived from a subset of data below the mountain range and therefore reflects only a portion of the total area of this habitat type.

Table 3. Assessment of short-term trends for areas of broad-leaved forest habitat types as a group (9020, 9110, 9130, 9160, 9180, 9190) for both total areas and areas in Natura 2000 areas. Based on a comparison of average area estimates from two 5-year periods with mid years 2010 to 2021, using data from the Swedish National Forest Inventory (NFI). NFI area estimates (in hectares) and their corresponding relative standard errors (in percent) were used to calculate the difference in area (± CI95) between the two 5-year periods. Estimates of difference with CI 95% not overlapping zero indicate a directional trend in area.

Habitat group	Region	Years	$Area_{Year1}$	$Area_{Year2}$	RSE_{Year1}	RSE_{Year2}	Direction	Difference in area (± CI 95%)	Method used
Total areas									
Broadleaved hab. types	BOR	2010-2021	17 588	20 676	20,0	18,3	stable	3 088 (-7 027, 13 204)	c
Broadleaved hab. types	CON	2010-2021	9 504	8 437	23,8	27,1	stable	-1 067 (-7 374, 5 240)	c
Areas in N2000									
Broadleaved hab. types	BOR	2010-2021	980	3 215	100,0	55,2	uncertain	2 234 (-1 740, 6 209)	c
Broadleaved hab. types	CON	2010-2021	2 333	3 767	52,5	47,7	stable	1 434 (-2 827, 5 695)	c

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Appendix I - Supplementary figures

9010: Western taiga

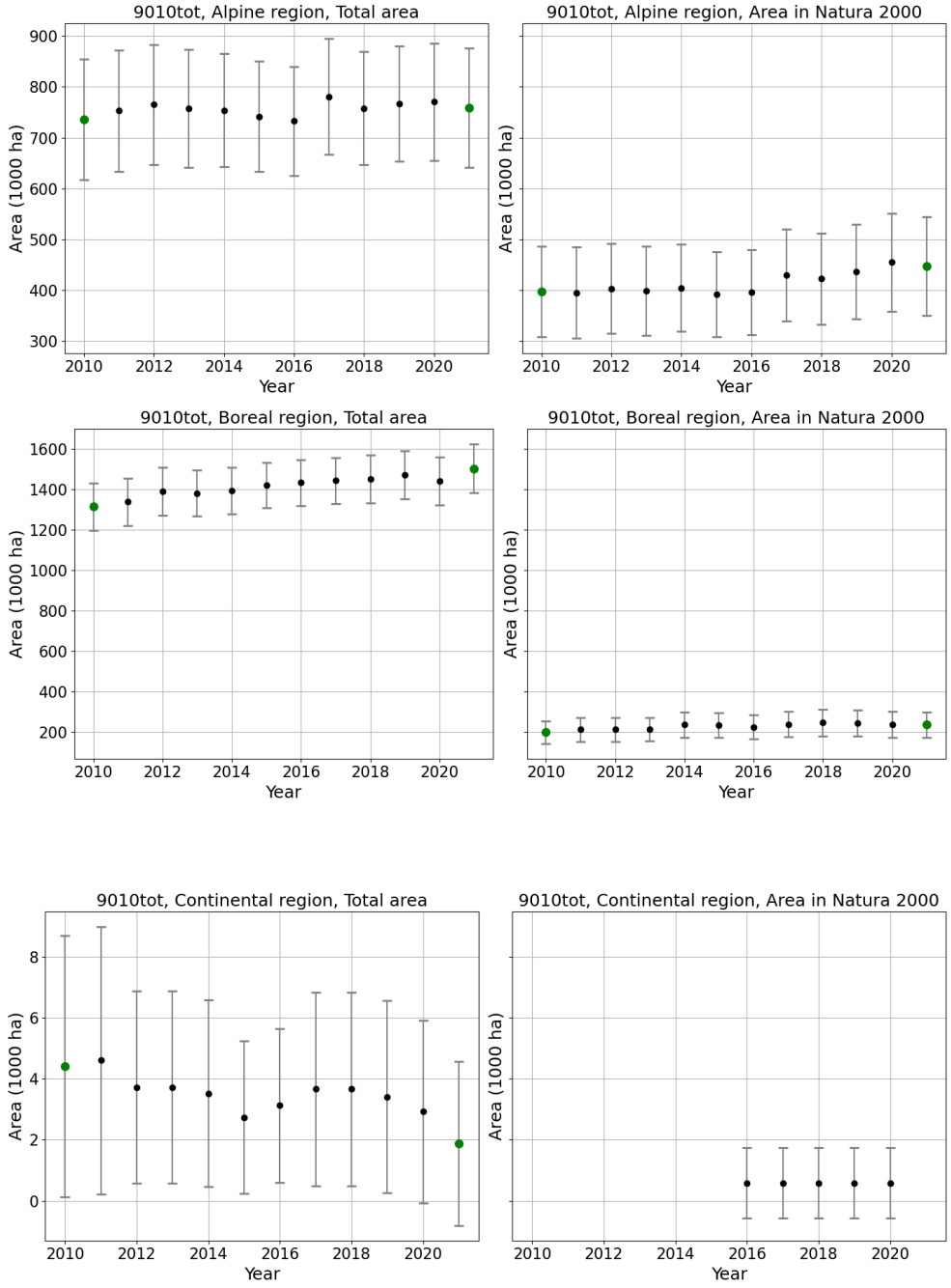


Figure S1. National forest inventory area estimates (in thousand hectares) for habitat type 9010: Western taiga. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Alpine, Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9020: Fennoscandian hemiboreal natural old broad-leaved deciduous (*Quercus*, *Tilia*, *Acer*, *Fraxinus* or *Ulmus*) forests rich in epiphytes

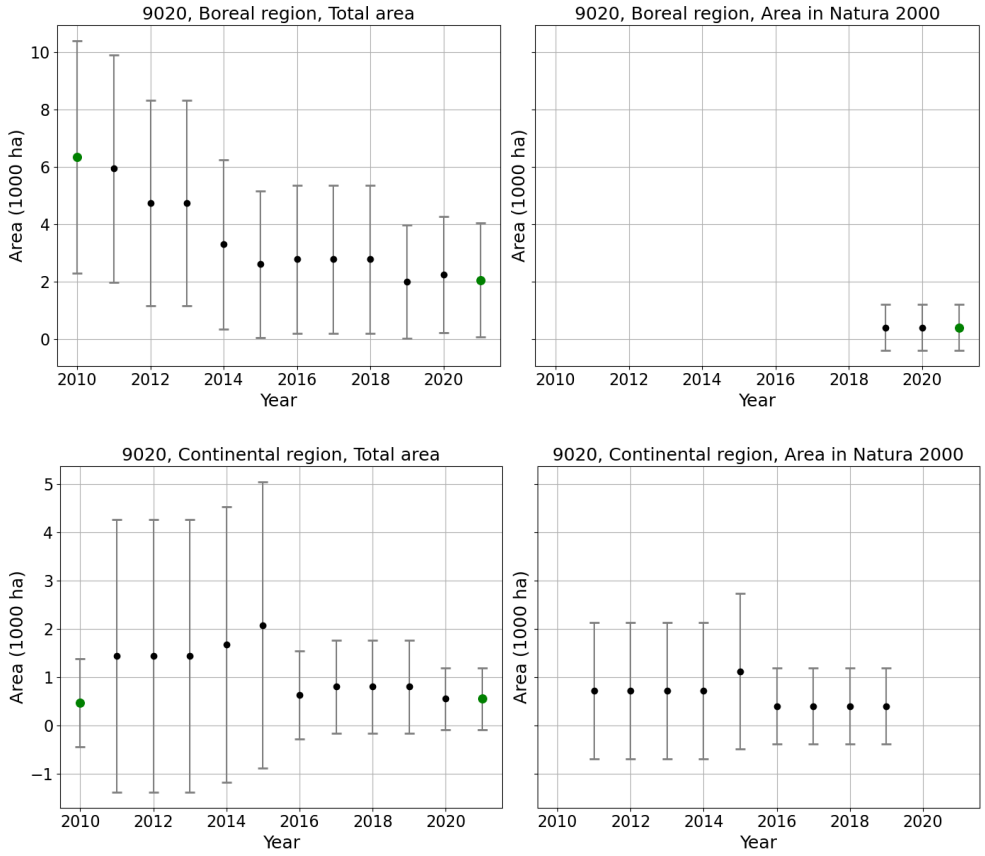
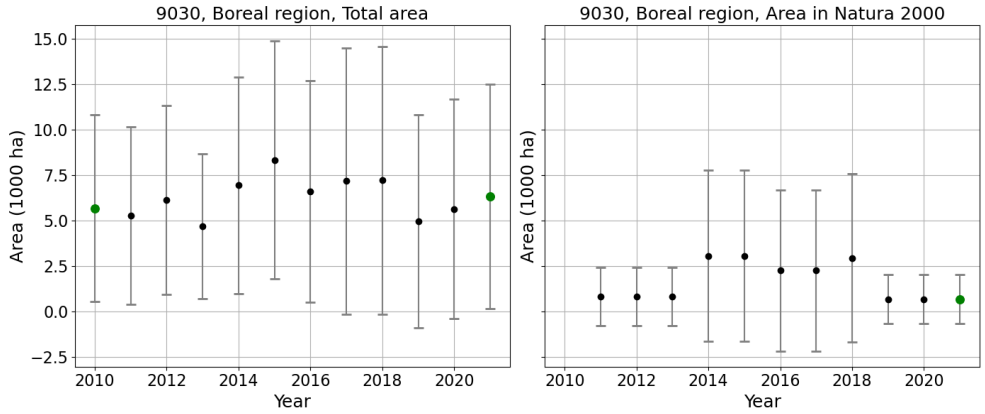


Figure S2. National forest inventory area estimates (in thousand hectares) for habitat type 9020: Fennoscandian hemiboreal natural old broad-leaved deciduous (Quercus, Tilia, Acer, Fraxinus or Ulmus) forests rich in epiphytes. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9030: Natural forests of primary succession stages of landupheaval coast

a) NFI statistics



b) NILS Seashore Inventory statstics

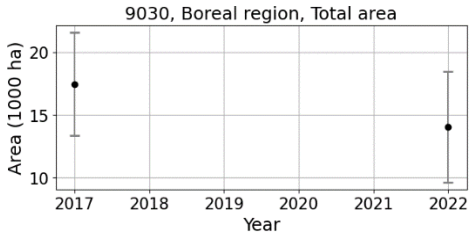
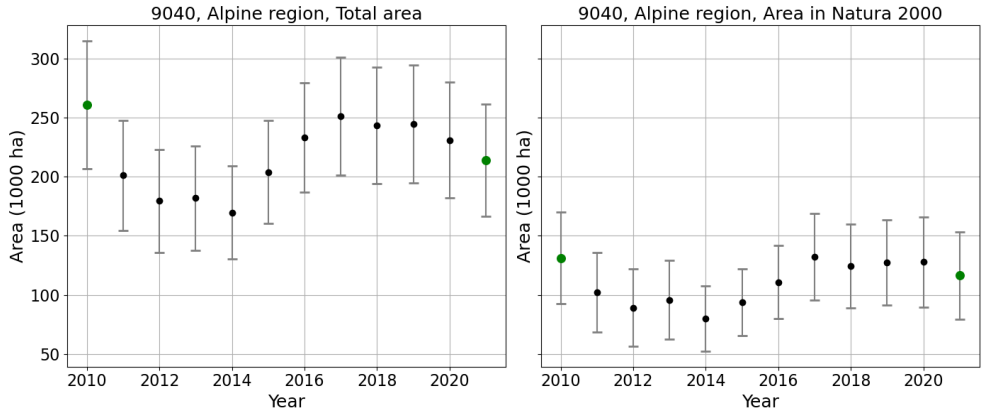


Figure S3. a) National forest inventory area estimates (in thousand hectares) for habitat type 9030: Natural forests of primary succession stages of landupheaval coast. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal region. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

b) NILS Seashore Inventory area estimates for the periods 2015–2019 and 2021–2024. Note that the second area estimate is lower, as the inventory period covers only four years, compared to five years in the first inventory. However, the estimated value for the entire five-year cycle is likely to be comparable between the two inventories (Hans Gardfjell, pers. comm.).

9040: Nordic subalpine/subarctic forests with *Betula pubescens* ssp. *czerepanovii*

a) 9040 below mountain range



b) 9040 including whole mountain range

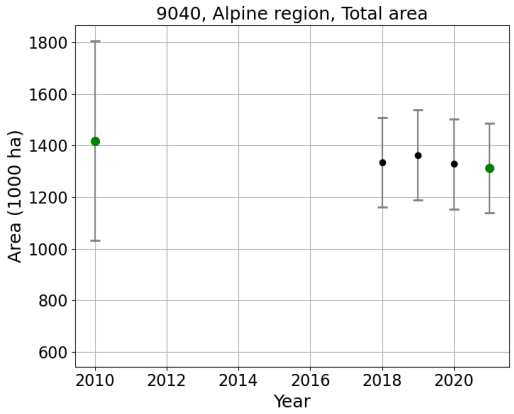


Figure S4. National forest inventory/NILS area estimates (in thousand hectares) for habitat type 9040: Nordic subalpine/subarctic forests with Betula pubescens ssp. czerepanovii. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Alpine region. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

Figure a) displays NFI area estimates for habitat type 9040 located below the mountain range. Figure b) presents combined area estimates from NFI/NILS for 2010 (inventory period 2008–2012; see Appendix II) and NFI area estimates from 2018 onwards, encompassing habitat type 9040 for the entire mountain range. Note that only total area estimates were produced for this dataset.

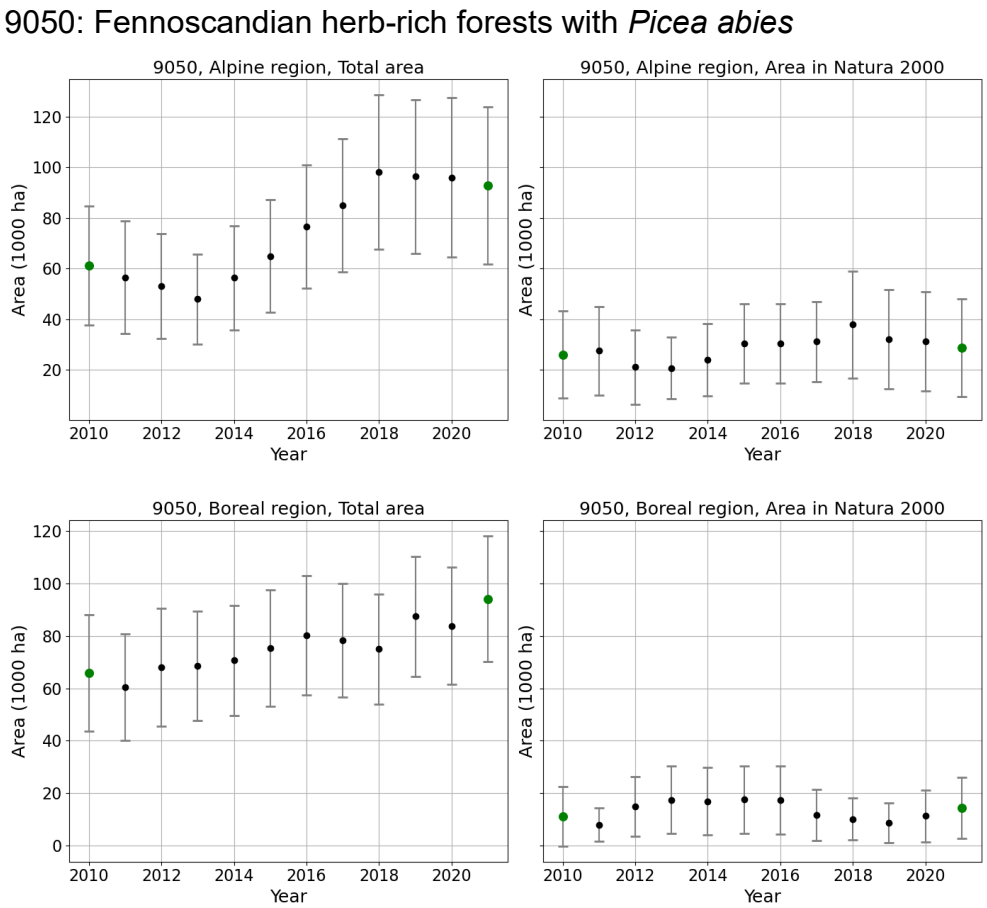


Figure S5. National forest inventory area estimates (in thousand hectares) for habitat type 9050: Fennoscandian herb-rich forests with Picea abies. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Alpine and Boreal regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9060: Coniferous forests on, or connected to, glaciofluvial eskers

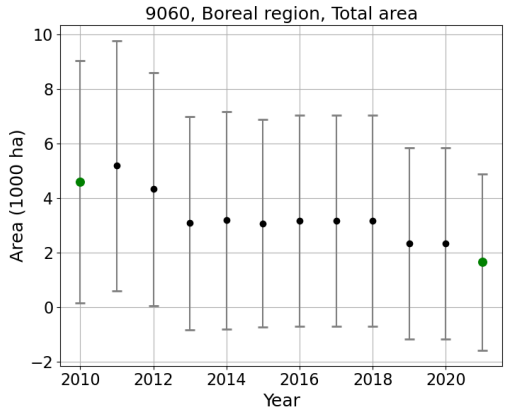


Figure S6. National forest inventory area estimates (in thousand hectares) for habitat type 9060: Coniferous forests on, or connected to, glaciofluvial eskers. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal region. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present). Note that no NFI estimates were available for N2000 areas.

9080: Fennoscandian deciduous swamp woods

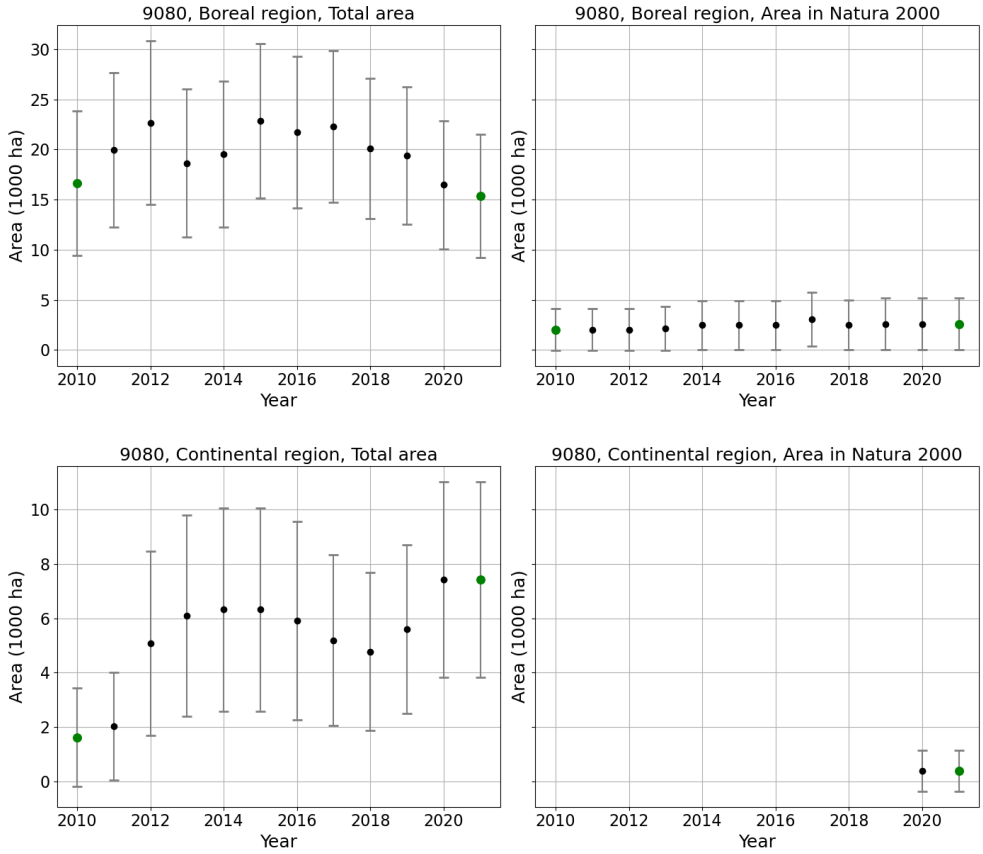


Figure S7. National forest inventory area estimates (in thousand hectares) for habitat type 9080: Fennoscandian deciduous swamp woods. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9110: *Luzulo-Fagetum* beech forests

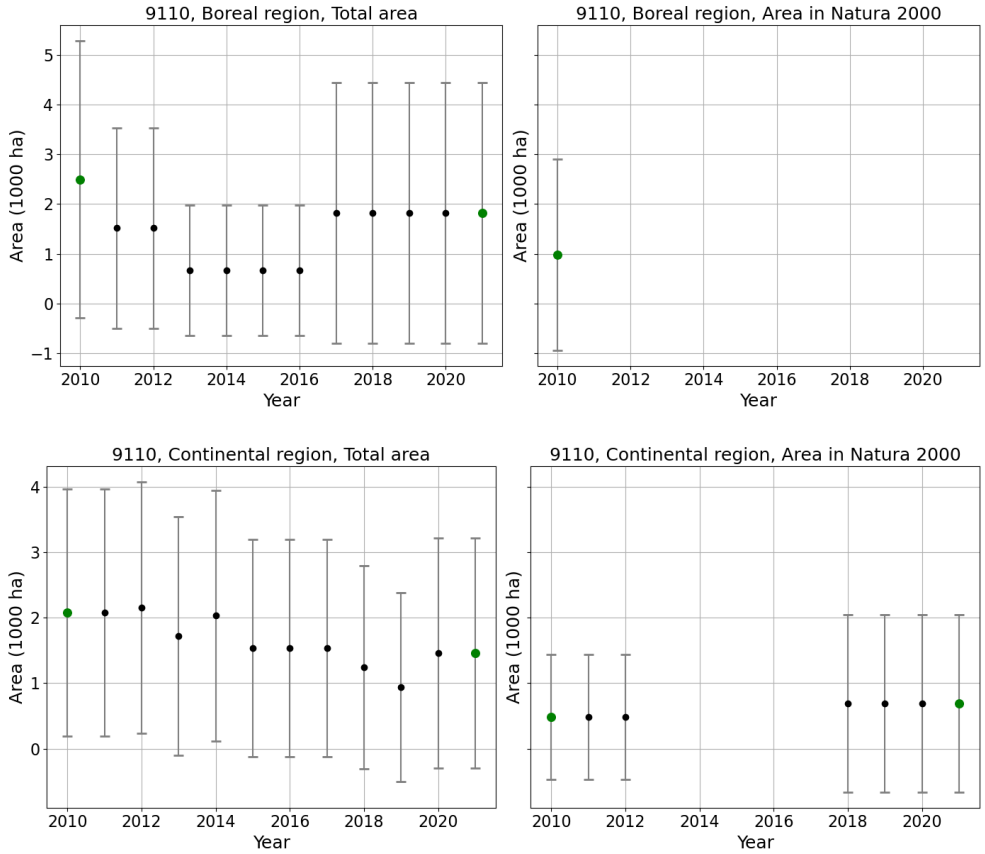


Figure S8. National forest inventory area estimates (in thousand hectares) for habitat type 9110: Luzulo-Fagetum beech forests. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9130: *Asperulo-Fagetum* beech forests

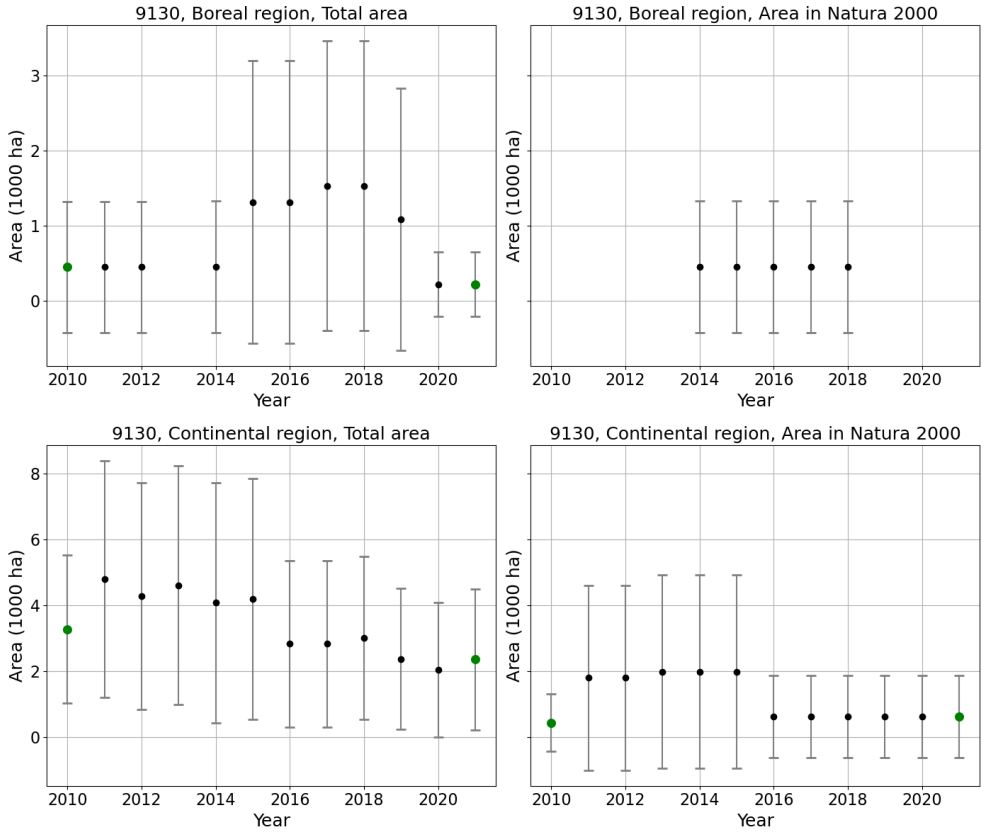


Figure S9. National forest inventory area estimates (in thousand hectares) for habitat type 9130: Asperulo-Fagetum beech forests. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9160: Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*

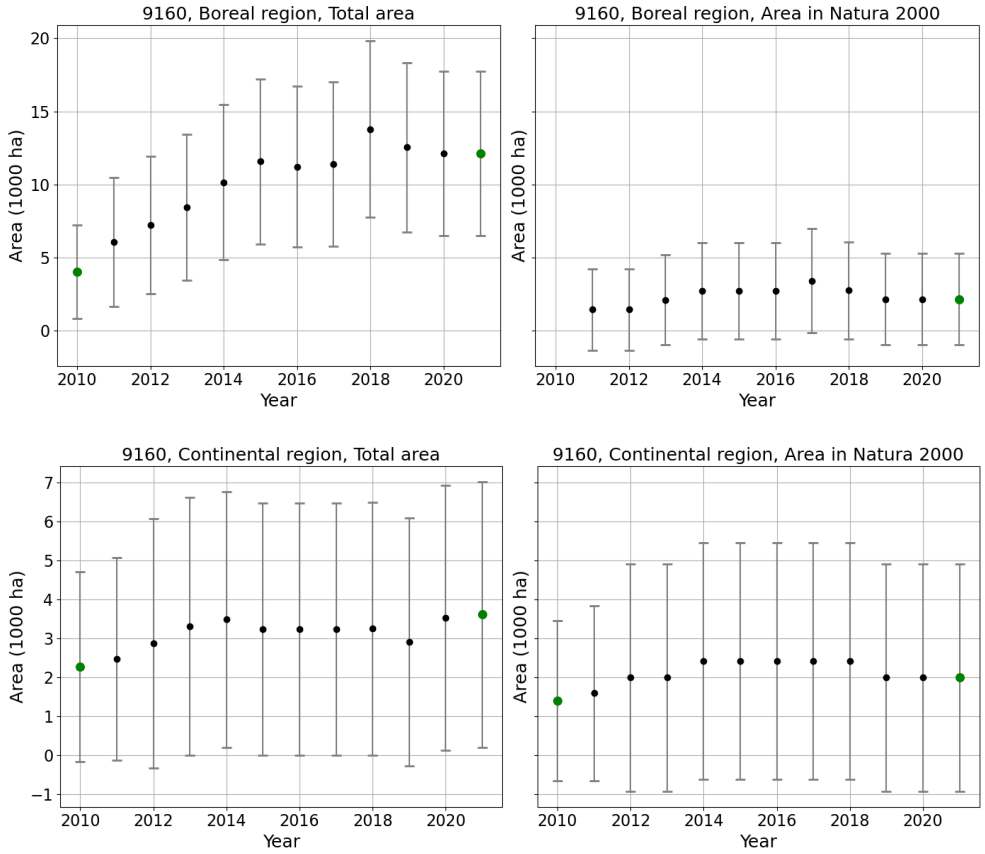


Figure S10. National forest inventory area estimates (in thousand hectares) for habitat type 9160: Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

9180: *Tilio-Acerion* forests of slopes, screes and ravines

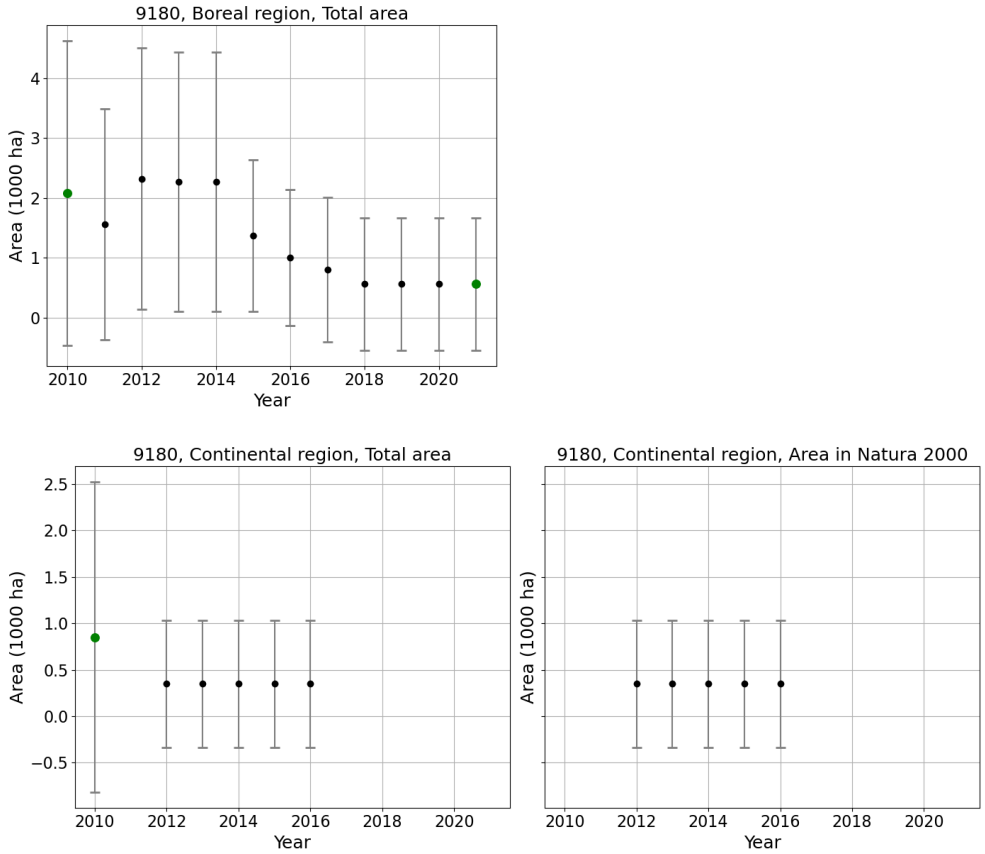


Figure S11. National forest inventory area estimates (in thousand hectares) for habitat type 9180: Tilio-Acerion forests of slopes, screes and ravines. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present). Note that no NFI estimates were available for N2000 areas in the Boreal region.

9190: Old acidophilous oak woods with *Quercus robur* on sandy plains

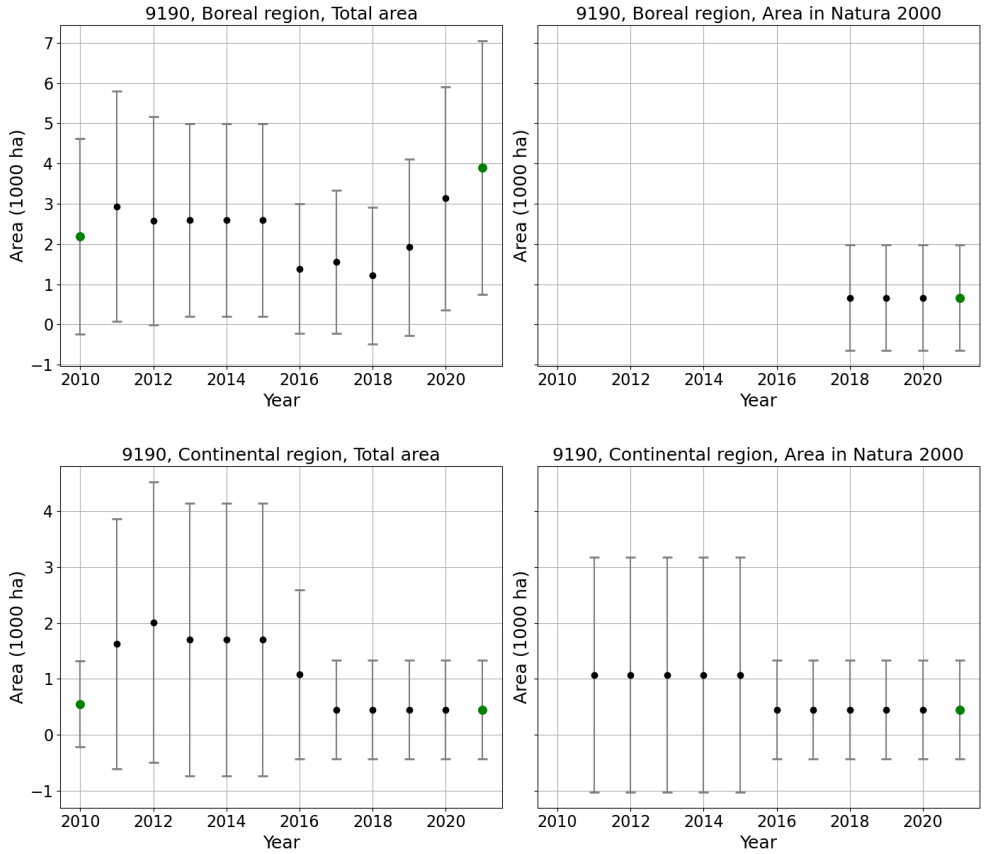


Figure S12. National forest inventory area estimates (in thousand hectares) for habitat type 9190: Old acidophilous oak woods with Quercus robur on sandy plains. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

91D0: Bog woodland

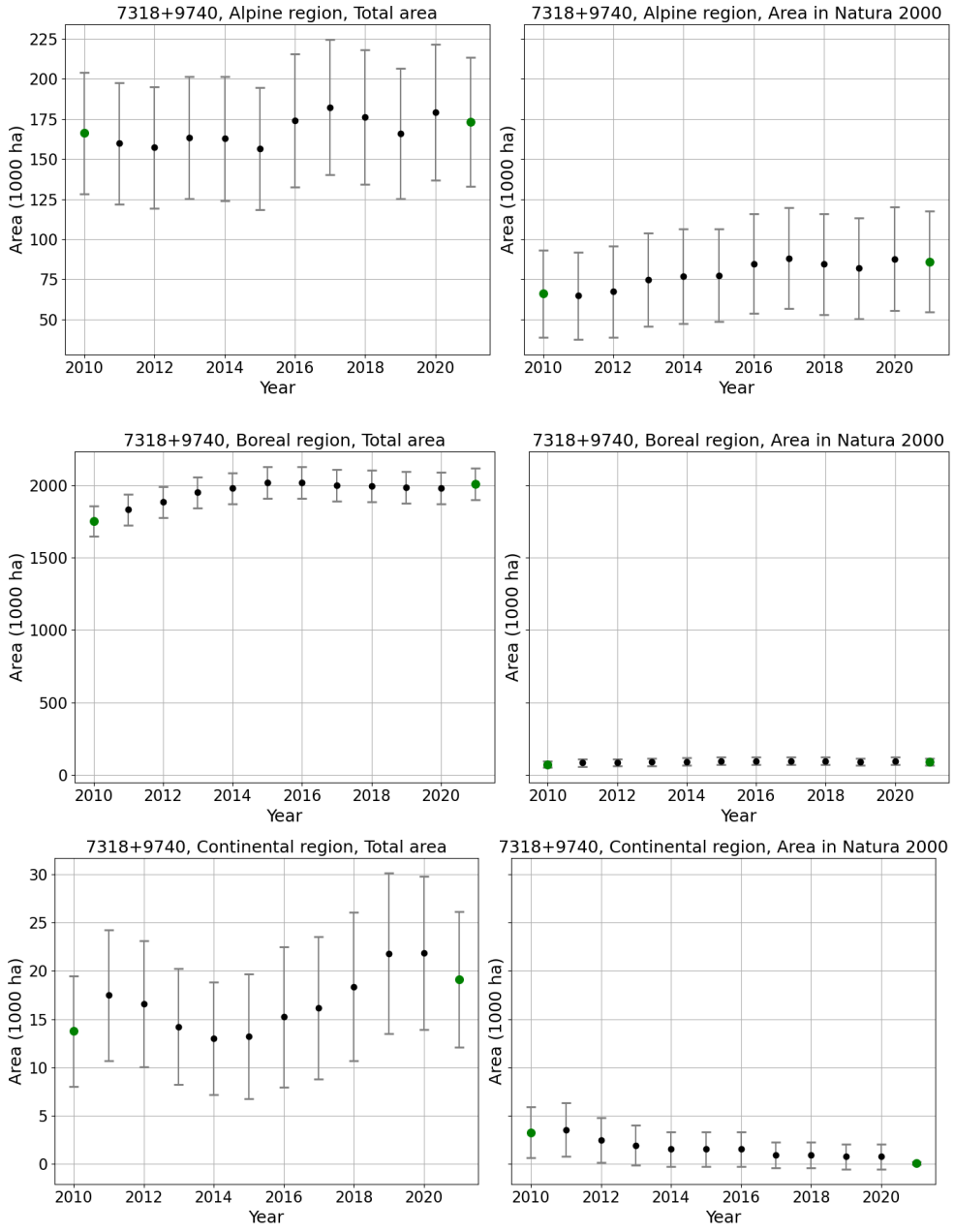


Figure S13. National forest inventory area estimates (in thousand hectares) for habitat type 91D0: Bog woodland. 5-year moving averages with 95% confidence intervals for the period 2010-2021. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Alpine, Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present).

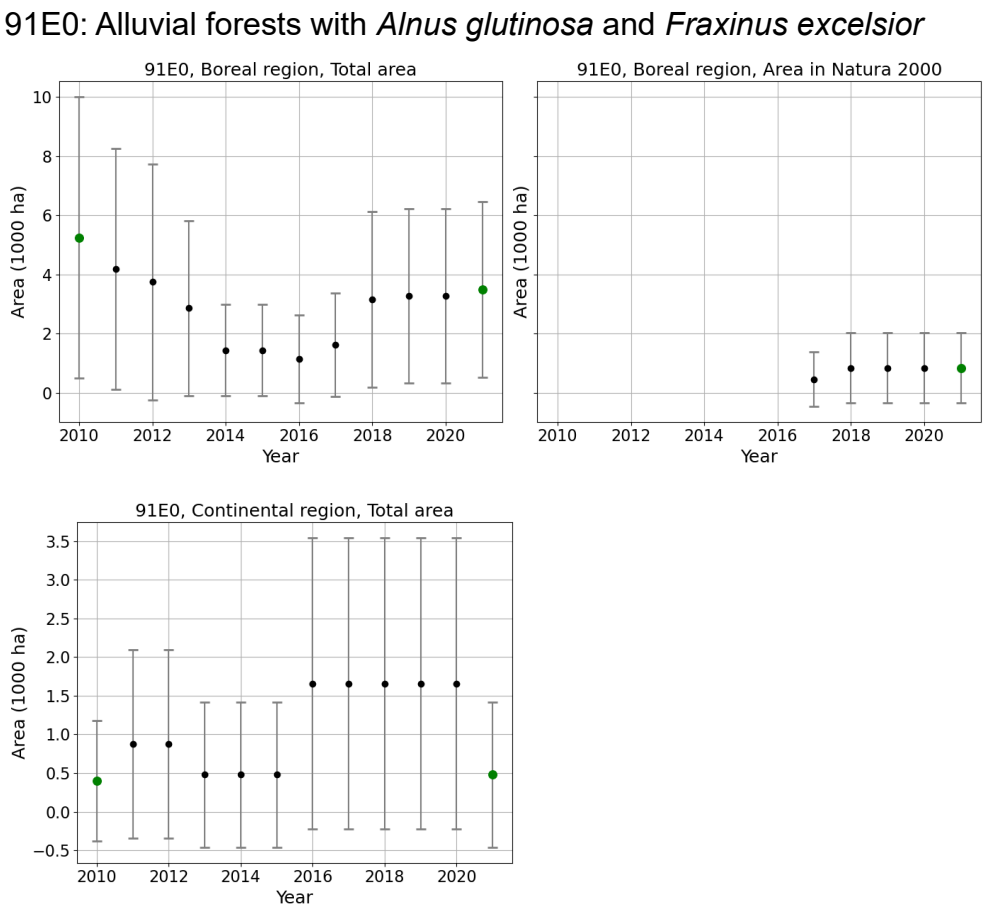


Figure S 14. National forest inventory area estimates (in thousand hectares) for habitat type 91E0: Alluvial forests with Alnus glutinosa and Fraxinus excelsior. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Total area (left) and area within N2000 (right) in the Boreal and Continental regions. The short-term trend is assessed by comparing the mean and 95% confidence intervals of the first and last years in the time series (highlighted in green circles when present). Note that no NFI estimates were available for the Alpine region and N2000 areas in the Continental region.

91F0: Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers

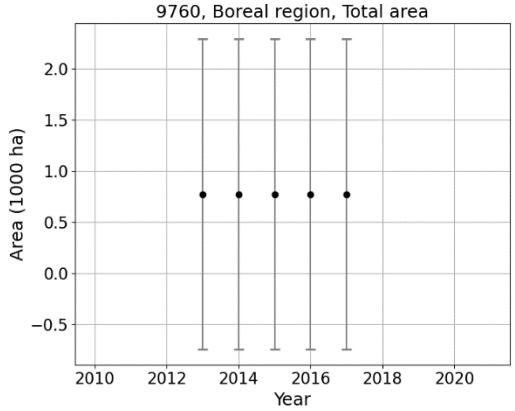


Figure S15. National forest inventory area estimates (in thousand hectares) for habitat type 91F0: Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers. 5-year moving averages with 95% confidence intervals for the period 2010-2021. Note that no NFI estimates were available for the Continental region and N2000 areas in the Boreal region.

Appendix II

Table S1. Area estimates for habitat type Nordic subalpine/subarctic forests with Betula pubescens ssp. czerepanovii (9040) for the periods 2008–2012 and 2014–2017 (both are four-year averages). The areas are calculated as combined estimates based on data from the Swedish National Forest Inventory (NFI) and the National Inventory of Landscapes in Sweden (NILS). Data provided from the NILS database (Hans Gardfjell, pers. comm.). Note that while some areas of this habitat type are also detected in the Boreal region, the Article 17 reporting uses national area estimates.

Habitat	Habitatnamn	Region	Period	Areal	Var	SE	CV	Antal1	Antal2	Metod	Inv
9040	Fjällbjörkskog	Alpine	2008-2012	13105.2	3705810.0	1925.0	0.15	267	196	B	Nils/RT
9040	Fjällbjörkskog	Alpine	2014-2017	14535.7	3493196.5	1869.0	0.13	211	460	B	Nils/RT
9040	Fjällbjörkskog	Boreal	2008-2012	1080.1	211874.5	460.3	0.43	23	23	B	Nils/RT
9040	Fjällbjörkskog	Boreal	2014-2017	492.5	24535.6	156.6	0.32	9	28	B	Nils/RT
9040	Fjällbjörkskog	Sweden	2008-2012	14185.4	3917684.4	1979.3	0.14	290	219	B	Nils/RT
9040	Fjällbjörkskog	Sweden	2014-2017	15028.2	3517732.0	1875.6	0.12	220	488	B	Nils/RT