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Pressures on forest habitat types 9010-91F0 under the Habitats Directive (92/43/EEC) in Sweden

This report presents the Swedish Species Information Centre's (SSIC) assessments of pressures and threats impacting forest habitat types listed in Annex 1 of Article 17 under the Habitats Directive (Council Directive 92/43/EEC) across different biogeographical regions in Sweden.

Each assessment is characterized by varying types of information and thus the method used. The focus is on the assessments of two key variables: 'scope' and 'influence', following criteria outlined in a separate report (Berglund & Maňák 2025).

The assessments were made during 2024-2025 on behalf of the Swedish Environmental Protection Agency. Comments are welcome and can be sent to Håkan Berglund (hakan.berglund@slu.se).

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Aim & background

This report aims to assist reviewers in examining and understanding the information used to assess pressures on the forest habitat types in Sweden.

Pressures are anthropogenic factors that have had impacts at biogeographic regional scale during the current reporting period (2019-2024). Threats, on the other hand, are factors expected to induce impacts in the next two reporting periods (2025-2036). A factor can function as both a pressure and a threat if it is currently causing impacts and is likely to continue doing so in the future. In general, the pressures assessed in this report are also expected to act as threats.

The codes and titles of the pressures and threats align with the report format (DG Environment 2022a,b; 2023; 2024). Classification is done with respect to primary sectoral drivers. All pressures are assessed based on information about their adverse effects, following the methodology outlined in Berglund & Maňák (2025). These effects can involve direct or immediate impacts across significant portions of the habitat types at the biogeographical scale (DG Environment 2022b). Adverse effects may include direct area loss, deterioration of habitat conditions, or impeded regeneration or restoration of habitat types (Berglund & Maňák 2025). Information used for the assessments is provided in **Appendices 1** (review of fragmentation), **2** (Tables) and **3** (Figures). **Appendix 4** offers an overview of the assessments.

The assessments of pressures can inform the evaluations of the overall conservation status of structures and functions as well as that of future prospects (DG Environment 2022a; 2023). For a habitat type's structures and functions to be considered in a favourable conservations status, several requirements must be met (DG Environment 2022a,b). The evaluation matrix from DG Environment (2022a), with its explanatory notes in italicized text (2022b), is summarized in this chart:

Favourable ('green')	**Unfavourable – Inadequate ('amber')**	**Unfavourable - Bad ('red')**	***Unknown (insufficient information to make an assessment)***
Structures and functions (including typical species) in good condition and no significant deteriorations / pressures. *Explanatory notes:* *- At least 90 % of the area in good condition.* *- The trend in area in good condition must be stable or increasing* *- The typical species overall should be 'favourable' (not threatened)* *- Fragmentation or other conditions are not impacting significantly on ecological processes*	Any other combination. *Explanatory notes:* *- Less then 25 % of the area is in unfavourable ('not good') condition and; less than 90 % is in 'good' condition; and less than 75 % is in 'unknown' condition.*	More than 25% of the area is unfavourable as regards its specific structures and functions (including typical species)*	No or insufficient reliable information available *Explanatory notes:* *- More than 75 % of habitat area has 'unknown' condition*

* E.g. by discontinuation of former management, or is under pressure from significant adverse influences, e.g. critical loads of pollution exceeded

PA05 (Agriculture)
Abandonment of management/use of grasslands and other agricultural and agroforestry systems (e.g. cessation of grazing, mowing or traditional farming)

DG Environment (2024)'s description: Abandonment of traditional agricultural practices and management in grasslands and other agricultural systems, such as cessation of mowing, abandonment of traditional pastoral systems like itinerant grazing in mountain areas, the abandonment of traditional farming, grazing and other traditional uses of fens, mires, heathland or agroforestry habitats. Also included are situations due to inadequate or lack of conservation management.

The corresponding conservation measure: MA04 Reinstate appropriate agricultural practices to address abandonment, including mowing, grazing, burning or equivalent measures.

The broader code 'PA05' is used for addressing various types of pressures caused by agriculture such as insufficient or inappropriate grazing by livestock or cessation of pollarding and other traditional forest usages. These pressures are expected to primarily affect coniferous Fennoscandian herb-rich forests with *Picea abies* (hereafter referred to as 9050), coniferous forests on, or connected to, glaciofluvial eskers (9060) and oak forests (9160 and 9190).

The focal forest habitat types share a significant ecological history and biodiversity with grassland habitat types. Together with wooded pastures (9070), they form a continuum ranging from forested areas to sparsely wooded habitat types. Many of their conservation values are likely associated with the conditions of landscapes shaped by the historical infield-outland farming system, which prevailed from medieval times until the agrarian revolution in the 18th century (Lindbladh et al. 2007; Eriksson and Cousins 2014). Research indicates that grazing, pollarding and other traditional forest usages including human-induced fires, played a major role in shaping the majority of the area covered by these habitat types throughout their distribution ranges (Bergendorff and Emanuelsson 1996; Lindbladh et al. 2007; 2011; Drobyshev et al. 2021; Westin et al. 2022).

The focal forest habitat types are also facing pressures similar to those impacting grassland habitat types. For wooded meadows (6530) and pastures (9070), code 'PA05' is used to address adverse changes in species composition and structure due to abandonment or inadequate management (Dahlström et al. 2010; Palo et al. 2013; Kindvall et al. 2022; Auffret et al. 2022). The code is similarly applied to the focal forest habitat types.

During the rationalization of agriculture and forestry, up to 90 % of broad-leaved deciduous forests and wooded grassland habitat types were likely lost (Svenningsson 1992; Lindbladh et al. 2011; Eriksson and Cousins 2014). Consequently, the current average forest land area grazed – ca 14 000 hectares, or <0.05% (Swedish Board of Agriculture 2024) – and managed through traditional practices represents only a small fraction of what likely existed before this rationalization. The historic losses increase the risk of time-lagged extinctions and prevent the recovery of specialized species populations (Ranius et al. 2008; Nordén et al. 2014; Auffret et al. 2018). The adverse effects of the pressures outlined under code ‘PA05’ compound those of fragmentation; however, they are addressed separately under the forestry-sector-specific code ‘PB02’ (see the section on ‘PB02’ and references therein).

Fennoscandian herb-rich forests with *Picea abies* (9050)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data

Coniferous forests on, or connected to, glaciofluvial eskers (9060)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data

Oak forests (9160 and 9190)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is considered insignificant in the Alpine region and classified as ‘minority <50%’ in the Boreal and Continental regions.

An unknown proportion of the habitat types’ area holds conservation values shaped by grazing and traditional practices, but also faces the risk of abandonment. However, this ‘scope’ likely varies among the habitat types, being smaller for forest habitat types compared to grassland habitat types. While the habitat conditions of wooded meadows (6530) and pastures (9070) are highly dependent on traditional management, a significant proportion of the focal forest habitat types generally shows less reliance on such practices. Accordingly, the pressure’s ‘scope’ is expected to encompass a minority (0-50%) of the area covered by the focal forest habitat types.

Influence: The ‘influence’ is considered insignificant in the Alpine region but classified as ‘medium’ in the Boreal and Continental regions.

The ‘influence’ is assessed through extrapolation and expert judgement based information about the (1) adverse effects and (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method).

To start, the (1) adverse effects on the focal habitat type’s conditions are known: the absence or prolonged lack of grazing and other traditional practices triggers ecological succession. Species and forest structures adapted to conditions maintained by traditional practices diminish, while tolerant species and structures proliferate (Dahlström et al. 2010; Palo et al. 2013; Auffret et al. 2018).

Regarding (2) long-term trend information at the regional scale, general grassland biodiversity indicators reveal decreasing butterfly and bird species populations (Green et al. 2023; Pettersson & Arnberg 2024). Additionally, a large-scale re-inventory of wooded pastures (9070) suggests ongoing deterioration of habitat conditions, as indicated by increasing cover of bushes and decreasing number of plant indicator species (Glimskär et al. 2024).

Additionally, the number of land holdings with grazing livestock has decreased by ca 50% (from 19 932 to 9 949) since 2003 (Swedish Board of Agriculture 2024). The number of cattle has also decreased by 10% (from 1.6 to 1.4 million) since 2005. Consequently, the number of livestock per landholding have increased by 71% (from 85 to 145) since 2005. These trends suggest that small and medium-sized landholdings outside major agricultural areas are shutting down, while the remaining landholdings are managing larger herds of livestock on average.

These findings suggest that the pressure's 'influence' could be categorized as either 'high' or 'medium', as abandonment and lack of grazing or traditional management are likely the primary causes.

However, other indicators suggest that habitat conditions have remained relatively stable in recent decades. To begin, National Forest Inventory (NFI) statistics (SLU 2024) for a selection of 26 species – expected to correlate positively with habitat conditions in forests shaped by grazing and other traditional practices – indicated no significant changes. Among these species, 13 had decreased (e.g. *Hypochaeris maculata*, *Antennaria dioca*, *Succisa pratensis*), while 8 had increased (e.g. *Luzula multiflora*, *Veronica officinalis*, *Anthoxanthum odoratum*) in occurrence on the national scale since the 1990s on productive forest land outside formally protected areas (sign test, $p = 0.5$). However, the proportion of decreasing species exceeded that of increasing species in all parts of the country. A tendency toward a significantly greater proportion of decreasing species was observed in the southern-hemiboreal 'Svealand' region (sign test, $p = 0.078$).

Furthermore, NFI statistics (SLU 2024) reveal no significant change in the area of pasture land, which has remained at ca 500 000 hectares during the 2000s. Likewise, statistics from the Swedish Board of Agriculture (2024) indicate that the total pasture area has stabilized around 450 000 hectares since 2010, with ca 3% (ca 14 000 hectares) consisting of forests managed by grazing.

Based on this information, the pressure's 'influence' may alternatively be categorized as either 'medium' or 'low' (Berglund & Maňák 2025). Overall, a 'medium influence' classification is adopted, as adverse changes in species composition and structure are likely attributable to the specific pressure addressed here (abandonment or inadequate management).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PB02 (Forestry)
Conversion from one type of forestry land use to another

DG Environment (2024)'s description: Conversion of forest habitats into another type of forest habitat, often conversion from extensive forests into production forests (e.g. conversion to monocultures) but also other types of conversion (e.g. conversion from coppice to high forest or changes of tree species composition). Includes deliberate changes. Passive abandonment of traditional forest management should be reported as 'PB04'.

This pressure does not relate only to land use changes that occurred during the reporting period but it refers to instances where continuing the current forestry use of a natural/semi-natural habitat prevent the latter from being restored (e.g. in case of land use conflicts between forestry and nature conservation).

The corresponding conservation measure: MB01 Prevent conversion of (semi-) natural habitats into forests and of (semi-) natural forests into intensive forest plantation.

The broader code 'PB02' addresses various pressures from forestry activities, both historical and from 2019-2024, impacting most forest habitat types. Two key pressures are insufficient connectivity due to fragmentation and, on the other hand, continued loss and impeded regeneration from clear-cutting and intensive management on the other. These pressures are closely linked and require the same conservation measures – forest protection and restoration.

However, their 'scope' differs. To maintain transparency, they are addressed separately under different pressure codes. Information on fragmentation alone is reviewed here under the broader code 'PB02', while information on clear-cutting and intensive management is covered under the specific code 'PB09' ('Clear-cutting, removal of all trees').

Furthermore, the loss of 'high conservation value forests' and forests with long ecological continuity due to clear-cutting also falls under 'PB02'. However, the specific code 'PB14' ('Forest management reducing old growth forests') is used to highlight the significance of these losses, as such forests are critical biodiversity source areas (refer to the sections on 'PB09' and 'PB14' for further details).

The assessments of fragmentation are done collectively for groups of habitat types that share history, ecology and distribution, but also serve as habitat for largely the same species pool. The first group includes western taiga (9010, hereafter referred to as 9010) and other boreal coniferous and deciduous forest habitat types (9030, 9050, 9060, 9080 and 91E0; names listed in **Appendix 2 Table 2.1**), while the second group includes broad-leaved deciduous forest habitat types (9020, 9110, 9130, 9160, 9180, 9190 and 91F0). Both groups occur on mineral soils.

The collective assessments, detailed in **Appendix 1**, apply to each habitat type within its group. As the assessments are identical for each group, they are summarized by region in the following chart:

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' of fragmentation is expected to encompass the 'minority <50% in the Alpine region and the 'majority 50-90%' in the Boreal and Continental regions (see **Appendix 1** and **Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**).

Influence: The 'influence' of fragmentation is considered 'low' in the Alpine region but classified as 'medium' in the Boreal and Continental regions (see **Appendix 1**).

Method used: The method is classified as 'b) based mainly on extrapolation from a limited amount of data' in the Alpine and Boreal regions. In the Continental region, the method is classified and as 'c) based mainly on expert opinion with very limited data' (see **Appendix 1**).

PB09 (Forestry)
Clear-cutting, removal of all trees

DG Environment (2024)'s description: Forest clearance (small to large scale removal of all trees) causing damage to forest habitat or habitats of species targeted by the nature directives, to soil or springs or other physical features.

The corresponding conservation measure: MB01 Prevent conversion of (semi-) natural habitats into forests and of (semi-) natural forests into intensive forest plantation.

The specific code 'PB09' addresses ongoing loss and impeded regeneration due to clear-cutting and intensive management. It is closely linked to 'PB14' ('Forest management reducing old growth forests'), both of which fall under the broader code 'PB02' ('Conversion from one type of forestry land use to another'), which covers the adverse effects of fragmentation alone.

Western taiga (9010)

The 'scope' and 'influence' of clear-cutting and forestry intensification alone:

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	medium	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data

Scope: NFI statistics are used to assess the 'scope' as 'minority <50%' in all regions (**Appendix 2 Table 2.3**). NFI estimates that ca 21%, 52%, and 36% of the area of 9010 in the Alpine, Boreal, and Continental regions occur on productive forest land outside formally protected areas (**Appendix 2 Table 2.3**). An unknown proportion of this area is voluntarily protected from forestry. Less than 50% of the area, a 'minority <50%', in the respective regions are therefore assumed to lack protection and have been exposed to the pressure during 2019-2024.

Influence: The combined effects of both losses and impeded regeneration are taken into account, with their joint 'influence' assessed as 'medium' in the Alpine region and 'high' in the Boreal and Continental regions.

Modern even-aged rotation forestry as a management system dominates and involves a series of measures that influence both the potential for regeneration and the loss of area across the entire distribution range of 9010 and other boreal coniferous and deciduous forest habitat types. For most measures, there are no explicit estimates of their individual impact. However, the area loss due to clear-cutting (final felling) alone can be assessed based on NFI statistics using SSIC's area-unit model (Berglund & Maňák 2025). Furthermore, the adverse effects in terms of impeded regeneration due to intensive management can be assessed based on NFI statistics on the area of forests with potential to develop into the forest habitat types.

Direct losses. – NFI's sample plot data is used to assess the loss rate due to clear-cutting. In the Alpine region, this data suggests that clear-cutting has reduced the area of 9010 on productive forest land outside formally protected areas by ca 0.3-1.0% annually (**Appendix 2 Table 2.4**). In the Boreal region, the annual loss is estimated at 1.1-1.3% per year, with a consistent rate across the three Boreal subregions.

However, the actual clear-cutting loss rates are likely higher than indicated, as an unknown proportion of the non-clear-cut plots are voluntarily protected from forestry. Additionally, since NFI's (SLU 2019) age criterion to classify plots as 9010 increases with decreasing site productivity – reaching ca 150 years in low-productive sites – some clear-cut plots with younger 9010 forests remain undetected, further underestimating the true loss rate.

This estimated loss rate can be compared to an expected threshold for 'medium influence' computed based on the age criterion used by NFI to classify sample plots to 9010: the basal-area-weighed stand age must exceed the lowest recommended final clear-cutting age (LRA) by at least 20-40 years (SLU 2019). Since LRA varies with tree-species composition and site productivity, NFI's age criterion varies accordingly (SLU 2024a).

In Sweden, nearly 75% of the productive forest land outside formally protected areas has a site productivity less than 8 m^3 per hectare and year, with an average of 5.5 m^3 per hectare and year (SLU 2024b). This corresponds to an age criterion of 100-150 years and a threshold for 'medium influence' ranging from ca 0.7% (1/150) to 1% (1/100) across the dominating site type gradient.

In the Boreal region, the current proportion of 9010 on productive forest land outside formally protected areas is estimated at ca 5%, ranging from about 3% to

7% across the three Boreal subregions (**Appendix 2 Table 2.5**). An unknown proportion of the area is voluntarily protected from forestry, implying that the actual unprotected proportion may be slightly lower. To maintain this proportion in the long term across the dominating site productivity gradient, annual clear-cutting can range from approximately 0.6% (calculated as 0.7% × [100-5%]) to 1.0% (calculated as 1.0% × [100-5%]) if the losses are to be fully balanced by regeneration. The estimated average loss of ca 1.1-1.3% exceeds this range, suggesting a 'high influence'.

In the Alpine region, the threshold for 'medium influence' ranges from 0.4-1.2%, based on the same age criterion used for the Boreal region and considering that the current proportion of 9010 within the pressure's 'scope' is less than ca 28% (**Appendix 2 Table 2.5**). While the underestimation of the true loss rate due to NFI's (2019) high age criterion is likely most pronounced in the Alpine region, the estimated rate of clear-cutting is still assumed to have 'medium influence'.

In the Continental region, the estimated loss rate is 3-4%, though this is uncertain due to insufficient permanent sample plot data. Forestry is assumed to have a similar impact as in the neighboring Boreo-nemoral subregion, resulting in a classification of 'high influence'.

The ideal final harvest rate on productive forest land outside protected areas is ca 1% per year under modern forestry, with clear-cut rotations of around 100 years (Berglund & Kuuluvainen 2021). Thus, the observed loss of 9010 – approximately 1.1-1.3% per year in the Boreal region – is at the expected maximum under such management, implying that the proportion of 9010 will gradually decrease to near zero within the pressure's 'scope'. This is supported by future forecasts from the Swedish Forest Agency (Skogsstyrelsen 2022), which reflect trends of forest areas meeting NFI's criteria for forest habitat types like 9010. Projections indicate a long-term decrease, with a predicted 40% reduction on forest land designated for timber production (i.e. the 'scope' of the pressure) across Sweden between 2020 and 2050 (i.e. an annual loss rate ca 1.3%).

Impeded regeneration. – NFI statistics (SLU 2024b) show that forests aged 81-120 years – those with the potential to develop into 9010 – have decreased by approximately 46% (or 3.5% per year) since the 1950s. In the latest inventory period (2016 to 2021), this decrease reached nearly 8% on productive forest land outside formally protected areas. Meanwhile, forests with a stand age of ≤80 years, which have little to no potential to develop into 9010, have expanded by about 29% (or 3.5% per year) overall, with a nearly 1% increase in the last five-year period. These changes have previously been reported for whole Sweden in future forecasts by the Swedish Forest Agency (Skogsstyrelsen 2022) and for north Sweden by Jonsson et al. (2019). The NFI statistics reported are on national scale and include areas voluntarily set aside from forestry, excluding only formally protected areas. Despite these limitations, they remain valid as indicators of the shift towards younger forests and the reduced potential for 9010 regeneration within the pressure's 'scope', particularly in the Boreal region.

Method used: The statistical estimates for assessing the pressure are based on NFI's systematic, stratified sample-plot survey (Fridman et al. 2014). However, the statistical errors of clear-cut area estimates are generally large and do not meet the criteria for high precision. Furthermore, the age criterion used by NFI (SLU 2019) increases with decreasing site productivity and is relatively high (ca 150 years) in low-productive sites. Consequently, 9010-forests of lower stand age are excluded from NFI's estimates, particularly in the Alpine region (Maňák & Berglund 2022). This may lead to an underestimation of losses caused by clear-cutting. Therefore, the method is classified as 'b) based mainly on extrapolation from a limited amount of data' in the Alpine and Boreal regions. In the Continental region, the method is classified and as 'c) based mainly on expert opinion with very limited data'.

Natural forests of primary succession stages of landupheaval coast (9030)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	b) based mainly on extrapolation from a limited amount of data

Scope: NFI statistics are used to estimate the 'scope' as 'majority 50-90%'. NFI classifies forests in sample plots to 9030 based on naturalness criteria (SLU 2019). Given this data, NFI estimates that more than 50% of the area in the Boreal region occur on productive forest land outside formally protected areas (**Appendix 2 Table 2.1-2.3**). An unknown proportion of this area is voluntarily protected from forestry. More than 50% of the area has therefore been exposed to the pressure during 2019-2024.

Influence: The adverse effects of forestry on 9030 are mainly linked to the loss of area due to clear-cutting and other management activities. The 'influence' assessment is therefore based solely on information about losses from clear-cutting. The 'influence' is assessed as 'high'.

9030 is unique since it encompasses primary successional forests developing on the land uplift coast of the Baltic Sea (Svensson & Jeglum 2003). The natural regeneration through primary succession and loss due to transition into other habitat types likely occur at similar rates since both processes are primarily driven by land uplift. However, once impacted by forestry, such as through clear-cutting, a secondary succession starts and the lost area of 9030-forests cannot, by definition, be renewed. Furthermore, NFI uses no age criterion for classifying sample plots to 9030 (SLU 2019), but mainly 9030 of relative high age (at least 100 years) are likely to be clear-cut.

NFI sample plot data indicate that clear-cutting by forestry has reduced the area of 9030 within the 'scope' of the pressure by 0% to 4% per year (**Appendix 2 Table 2.4**). Another estimate is provided by the National Inventory of Landscapes of Sweden (NILS), which indicates that ca 0.1% of 9030's area was lost annually due to clear-cutting (Hans Gardfjell, SLU, personal communication). Both estimates are subject to uncertainties but a 'high influence' is assumed as the area of 9030 of relative high age (at least 100 years) is irreversibly lost (Berglund & Maňák 2025).

Method used: The statistical estimates used for assessing the pressure are based on NFI's stratified sample-plot surveys (Fridman et al. 2014). The statistical error of clear-cut area estimate is generally large and do not meet the criteria for high precision. The accuracy of NFI's methods for classifying plots as 9030 is likely high. For instance, no age criterion is used, meaning that forests of all stages of primary succession is included (SLU 2019). Nonetheless, since the precision is not high, the method is classified as 'b) based mainly on extrapolation from a limited amount of data'.

Fennoscandian herb-rich forests with *Picea abies* (9050)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	b) based mainly on extrapolation from a limited amount of data

Scope: The 'scope' is assessed as 'minority <50%' in the Alpine region and as 'majority 50-90%' in the Boreal region. NFI estimates that ca 47% and 64% of the area in these regions, respectively, occur on productive forest land outside formally protected areas (**Appendix 2 Table 2.1-2.3**). An unknown proportion of this area is voluntarily protected from forestry, implying that the actual share unprotected from forestry and exposed to the pressure during 2019-2024 is smaller than these figures suggest.

Influence: The combined effects of both losses and impeded regeneration are taken into account, with their joint 'influence' assessed as 'low' in the Alpine region and 'high' in the Boreal region.

Direct losses. – NFI sample-plot data suggests no loss in the Alpine region but indicates a 1-2% annual loss of 9050 in the Boreal region on productive forest land outside formally protected areas (**Appendix 2 Table 2.4**). All detected clear-cut plots in the Boreal region were located in the south-eastern subregion. The actual clear-cutting loss rate is likely higher than indicated, as an unknown proportion of the non-clear-cut plots is voluntarily protected from forestry.

To get a threshold for 'medium influence', the average regeneration time of 9050 is first assumed to be 100 years in the Alpine region and 80 years in the Boreal region (regeneration rates 1.25% and 1%, respectively). Thus, the assumed regeneration time is assumed shorten than for 9010, as 9050 develops on site types that are, on average, more nutrient rich and therefore have higher productivity and a lower age criterion according to NFI's method (SLU 2019) compared to those of 9010.

Next, the current proportion of 9050 on productive forest land outside formally protected areas is estimated to be 29% in the Alpine region and 4% in the Boreal region (**Appendix 2 Table 2.5**). An unknown proportion of the area is voluntarily protected from forestry, implying that the actual unprotected proportion may be somewhat smaller. To maintain this proportion in the long term, less than 0.9% in the Alpine region and 1% in the Boreal region can be clear-cut annually if the loss is balanced by regeneration. Hence, the observed loss rate in the Alpine region is considered to have a 'low influence,' whereas in the Boreal region, it is deemed to have a 'high influence.'

Furthermore, as for 9010 (see previous section), the future forecasts from the Swedish Forest Agency (Skogsstyrelsen 2022) provide additional support for the ongoing area loss of forest habitat types such as 9050 within the 'scope' of the pressure.

Impeded regeneration. – The information is identical to that provided for 9010 (refer to the section on 'PB09' for 9010 and references cited therein).

Method used: The information is identical to that provided for 9010 (refer to the section on 'PB09' for 9010 and references cited therein). Therefore, the method is generally classified as 'b) based mainly on extrapolation from a limited amount of data'.

Coniferous forests on, or connected to, glaciofluvial eskers (9060)

Due to lack of data, the assessments determined for 9010 in the Boreal region is also adopted for coniferous forests on, or connected to, glaciofluvial eskers (9060, hereafter referred to as 9060) (refer to the section on 'PB09' for 9010 and references cited therein). However, the method is 'c) based mainly on expert opinion with very limited data'.

Fennoscandian deciduous swamp woods (9080)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' is assessed as 'majority 50-90 %' in both regions. NFI's area estimates for 9080 are <20 000 hectares and therefore subject to uncertainties (**Appendix 2 Table 2.1**). However, estimates suggests that >50% of the area has likely been exposed to the pressure during 2019-2024 (**Appendix 2 Table 2.3**).

Influence: The 'influence' assessment is based solely on information about losses from clear-cutting. It is assessed to be 'low' in all regions.

A single permanent sample plot classified as 9080 was clear-cut in the Continental region during the first re-inventory period (**Appendix 2 Table 2.4**). This suggests a 'low influence' from clear-cutting based on NFI's sample-plot data.

The impact of forestry on the regeneration potential is not assessed. However, NFI statistics show that the area of swamp-forest site types on productive forest land outside formally protected areas has decreased by ca 1% per year since the 1990s (Nilsson & Dahlgren 2023; see assessment for 'PB23 Physical alteration of water bodies for forestry (including dams)').

Method used: Due to the large uncertainties of estimates used, the method is classified as 'c) based mainly on expert opinion with very limited data'.

Deciduous alluvial and riparian forests (91E0 and 91F0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data
Boreal	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘minority <50%’ in the Alpine region and as ‘majority 50-90%’ in the Boreal and Continental regions for both habitat types.

NFI’s area estimates for 91E0 are small and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**). Very few sample plots meet NFI’s criteria for 91E0 (SLU 2019), with most located outside protected areas in the Boreal region. Consequently, it is estimated that >50% of the area in the Boreal region has likely been exposed to the pressure during 2019-2024 (**Appendix 2 Table 2.3**). In the Alpine and Continental regions, NFI identifies only single or no plots as 91E0, leaving the proportion exposed to forestry unknown. Therefore, the ‘scope’ determined for 9010 and bog woodlands (91D0, hereafter referred to as 91D0) in the Alpine region has been applied to 91E0. In the Continental region, the ‘scope’ is assumed to align with that of the Boreal region.

There is no corresponding data on 91F0. As such, the ‘scope’ determined for 91E0 in the Boreal and Continental regions is also adopted for 91F0.

Influence: The ‘influence’ assessment is based solely on information about losses from clear-cutting. It is assessed to be ‘low’ for both habitat types in all regions.

None of the few permanent sample plots classified as 91E0 were clear-cut during the re-inventory periods made by NFI, indicating a ‘low influence’ at regional scale during 2019-2024 (**Appendix 2 Table 2.4**). The ‘influence’ assessed for 91E0 in the Boreal and Continental regions has been applied to 91F0.

The Forestry Agency’s statistics indicate that no tree retentions is done during clear-cutting along about 30% of the shore line of lakes and streams (Skogsstyrelsen 2025). To what extent it results in loss or impeded regeneration of 91E0 and 91F0 remains unknown.

Method used: Due to the lack of information about the pressure on both 91E0 and 91F0, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

Beech forests (9110 and 9130)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' is assessed as 'majority 50-90%' in the Boreal and as 'minority <50%' in the Continental regions for both 9110 and 9130. Both are confined to the Continental region and the southern, Boreo-nemoral zone of the Boreal region. NFI's area estimates for both habitat types are <5 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**). However, estimates suggests that >50% of the area in the Boreal region and <50% of the area in the Continental region has likely been exposed to the pressure during 2019-2024 (**Appendix 2 Table 2.3**). The estimates for broad-leaved deciduous forest habitat types as a group indicate, however, that >50% of the area in both regions has been exposed to the pressure.

Influence: The combined effects of both losses and impeded regeneration are taken into account, with their joint 'influence' assessed as 'low' for both habitat types in all regions.

Direct losses. – None of the few permanent sample plots classified as 9110 or 9130 has been clear-cut during the period of re-inventories made by NFI (**Appendix 2 Table 2.4**), suggesting a 'low influence'.

Impeded regeneration. – Other indicators available for assessing long-term trends at regional scale suggest that areas (or habitat conditions) have either remained stable or increased since the late 1980s. To start, NFI statistics (SLU 2024b) show that the area of site types dominated by broad-leaved deciduous tree species[1] increased by over 30% on productive forest land outside formally protected areas between the late 1980s and the early 2000s. Since then, the area has remained stable, both within and outside formally protected areas (the current total is ca 245 000 hectares of which ca 205 000 hectares are not protected).

Likewise, NFI statistics (Nilsson & Dahlgren 2023) show that broad-leaved deciduous forests aged 81-120 years – those with highest potential to develop into habitat types – have doubled in area (or increased by ca 3% per year) on productive forest land outside formally protected areas, but the increase has slowed down during the 2000s (the current area is nearly 100 000 hectares). Meanwhile, the area of those with a stand age of ≤80 years, which have lower potential to develop into habitat types, have remained stable since the late 1980s (the current area is ca 90 000 hectares; Nilsson & Dahlgren 2023).

Similarly, the area of those with at least some dead wood (>0 m^3/hectare) irrespective of stand age, have increased with over 60% between the late 1980s and the early 2000s (the current area is ca 100 000 hectares; Nilsson & Dahlgren 2023).

To conclude, the available trend indicators suggest that the potential to regenerate and maintain areas (or habitat conditions) of broad-leaved deciduous forest habitat types has increased or at least remained stable within the 'scope' at the regional scale. Consequently, the 'influence' of the individual pressures is likely to have been no more than 'low' at regional scale during 2019-2024, indicating an 'overall impact' of 'low importance'.

[1] Deciduous tree species comprises ≥65% and broad-leaved deciduous tree species ≥45% of the basal area

Method used: Due to the large uncertainties of estimates used, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

Oak forests (9160 and 9190)

Habitat types for which the assessments below apply					
9160	Sub-Atlantic and medio-European oak or oakhornbeam forests of the Carpinion betuli				
Region	**Timing**	**Scope**	**Influence**	**Overall impact**	**Method used (optional)**
Boreal	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
9190	Sub-Atlantic and medio-European oak or oakhornbeam forests of the Carpinion betuli				
Boreal	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘majority 50-90%’ in both regions for 9160 and as ‘minority <50%’ in both regions for 9190. Both habitat types are confined to the Continental region and the southern, Boreo-nemoral zone of the Boreal region. Most NFI’s area estimates for both habitat types are <5 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**). However, estimates for 9160 suggest that >50% of its area in both regions occur outside formally protected areas and have thereby likely been exposed to the pressure during 2019-2024 (**Appendix 2 Table 2.3**). By contrast, the estimates for 9190 suggest that < 50% in both regions have been exposed to the pressure (**Appendix 2 Table 2.3**). The estimates for broad-leaved deciduous forest habitat types as a group indicate that >50% of the area in both regions has been exposed to the pressure.

Influence: The combined effects of both losses and impeded regeneration are taken into account, with their joint ‘influence’ assessed as ‘low’ for both habitat types in all regions.

Direct losses. – A single permanent sample plot classified as 9160 was clear-cut in the Boreo-nemoral subregion during the first re-inventory period (**Appendix 2 Table 2.4**). This suggests a ‘low influence’ based on NFI’s sample-plot data.

Impeded regeneration. – The information is identical to that provided for beech forests 9110 and 9130 (refer to the section on ‘PB09’ for 9110 and 9130, and references cited therein). The NFI indicators available for assessing long-term trends at regional scale suggest that areas (or habitat conditions) have either remained stable or increased since the late 1980s.

Method used: Due to the large uncertainties of estimates used, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

Mixed broad-leaved forests (9020 and 9180)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘majority 50-90%’ in both regions for both habitat types.

Both habitat types are confined to the Continental region and the southern Boreo-nemoral zone of the Boreal region. NFI’s area estimates for both habitat types are <5 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**). However, estimates for 9020 suggest that >50% of its area in both regions lies outside formally protected areas and has therefore likely been exposed to the pressure during 2019-2024 (**Appendix 2 Table 2.3**). The estimates for broad-leaved deciduous forest habitat types as a group indicate also that >50% of the area in both regions has been exposed to the pressure.

Influence: The combined effects of both losses and impeded regeneration are taken into account, with their joint ‘influence’ assessed as ‘low’ for both habitat types in all regions.

Direct losses. – A single permanent sample plot classified as 9180 and another classified as 9020 were clear-cut in the Boreo-nemoral subregion during the first and second re-inventory period, respectively (**Appendix 2 Table 2.4**). This suggests a ‘low influence’ based on NFI’s sample-plot data.

Impeded regeneration. – The information is identical to that provided for beech forests 9110 and 9130 (refer to the section on ‘PB09’ for 9110 and 9130, and references cited therein). The NFI indicators available for assessing long-term trends at regional scale suggest that areas (or habitat conditions) have either remained stable or increased since the late 1980s.

Method used: Due to the large uncertainties of estimates used, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

Bog woodlands (91D0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	minority <50%	low	low importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	majority 50 – 90%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘minority <50%’ in the Alpine and Boreal regions and as ‘majority 50-90%’ in the Continental region. NFI estimates that ca 3%, 21%, and 56% of the area of 91D0 in the Alpine, Boreal, and Continental regions occur on productive forest land outside formally protected areas (**Appendix 2 Table 2.1-2.3**). An unknown proportion of this area is voluntarily protected from forestry, implying that the actual share unprotected from forestry and exposed to the pressure during 2019-2024 is smaller than these figures suggest.

Influence: The 'influence' assessment is based solely on information about losses from clear-cutting. It is assessed to be 'low' in all regions.

NFI sample-plot data indicates that clear-cutting has reduced the area of 91D0 within the 'scope' of the pressure at clearly lower rates than that of 9010 and 9050 (**Appendix 2 Table 2.4**). NFI uses no age criterion for classifying sample plots to 91D0 (SLU 2019), but mainly 91D0 of relative high age (at least 100 years) are likely to be clear-cut. Hence, it will take a corresponding time (at least ca 100 years) to renew 91D0 of such an age (regeneration rate 1%). Furthermore, the current proportion of 91D0 on productive forest land outside formally protected areas is estimated to be around 20% in all regions (**Appendix 2 Table 2.5**). An unknown proportion of the area is voluntarily protected from forestry, implying that the actual unprotected proportion may be somewhat smaller. To maintain this proportion in the long term, less than ca 0.8% can be clear-cut annually if the loss is balanced by regeneration.

NFI sample-plot data suggests no loss in the Alpine and the North-western Boreal regions, but indicates around 0.3% loss per year in the South-eastern Boreal and Boreo-nemoral regions on productive forest land outside formally protected areas (**Appendix 2 Table 2.4**). The actual clear-cutting loss rate is likely higher than indicated, as an unknown proportion of the non-clear-cut plots is voluntarily protected from forestry. Nonetheless, the loss is assumed to have a 'low influence' across regions.

Method used: The statistical errors of clear-cut area estimates are generally large and do not meet the criteria for high precision. Therefore, the method is classified as 'b) based mainly on extrapolation from a limited amount of data' in the Alpine and Boreal regions, and as 'c) based mainly on expert opinion with very limited data' in the Continental region.

PB13 (Forestry) Suppression of fire for forestry

DG Environment (2024)'s description: Suppression of fire and decreased use of forest management practices that involve controlled burning.

The corresponding conservation measure: MB13 Burning of forests for nature conservation.

The code 'PB13' addresses the impact of fire suppression, primarily affecting coniferous and deciduous forest habitat types (9010 and 9060).

The adverse effects of the pressures outlined under code 'PB13' compound those of fragmentation; however, they are addressed separately under the forestry-sector-specific code 'PB02' (see the section on 'PB02' and references therein).

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	c) based mainly on expert opinion with very limited data

Coniferous forests on, or connected to, glaciofluvial eskers (9060)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	c) based mainly on expert opinion with very limited data

The assessment outlined below for 9010 in the Boreal region is also applied for 9060, but the method is classified as ‘c) based mainly on expert opinion with very limited data’.

Scope: The ‘scope’ is assessed as ‘minority <50%’ in the Alpine region and as ‘majority 50-90%’ in the Boreal and Continental regions.

Research shows that under a natural disturbance regime, forest fires play a major role in shaping the majority of the area covered by 9010 and other forest habitat types throughout their distribution ranges (Drobyshev et al. 2014, 2021; Berglund & Kuuluvainen 2021). However, the average annual area burning today (ca 0.006%; Ramberg et al. 2017) represents only a fraction of what has historically burned before fire suppression was introduced at large scale (about 2%; Niklasson & Granström 2000).

Accordingly, the majority of the area covered by 9010 in the Boreal region has been exposed to the pressure during 2019-2024. In the Continental region, the southern fringe of the geographical range of 9010 is expected to share much of the fire ecology described for Boreo-nemoral (Hemiboreal) forests, where fire is considered to be a main driver of natural forest dynamics (Niklasson & Drakenberg 2001; Zin et al. 2015; Drobyshev et al. 2021). In contrast, in the Alpine region, the ‘scope’ of fire suppression in the Alpine region is probably more limited, as fire return intervals can be exceptionally long in semi-oceanic mountain climates (Aakala et al. 2009; 2018).

Influence: The ‘influence’ is assessed as ‘high’ in all regions through extrapolation and expert judgement based information about the (1) adverse effects and (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method).

The (1) adverse effects on 9010’s habitat conditions are well understood, and (2) there is long-term information on indicators reflecting changes in habitat conditions at regional scale. Therefore, (3) an assessment can be done through extrapolation and expert judgement based on this information, supported by theoretical reasoning from the sustained-yield models (see Berglund & Maňák 2025).

Regarding (1) adverse effects, today's low fire frequency implies that the regeneration rate of fire-shaped forests at regional scale is at least an order of a magnitude lower than it was before the introduction of large-scale fire suppression (see 'scope'; Drobyshev et al. 2012). The absence of fire is significant even where forestry is prohibited and conservation actions are prioritized (Ramberg et al. 2017). The capacity to burn forest by prescribed fires is approximately 800 hectares per year (Swedish Ministry of the Environment 2021), which corresponds to about 0.06% of the 1.4 million hectares of forest land protected from forestry within Natura-2000 sites (Statistics Sweden 2024).

Furthermore, modern research shows that prolonged absence of fire significantly alters the functional composition of forests. Species and forest structures adapted to recurring fires diminish, while shade-tolerant, fire-sensitive species and structures proliferate (Angelstam & Kuuluvainen 2004). These compositional changes have been demonstrated in unmanaged forests both at the stand (Wardle et al. 1997; Wallenius et al. 2004; Niklasson et al. 2010) and landscape (Pennanen 2002; Hellberg et al. 2004) scales.

Regarding (2) long-term trend information of habitat conditions at regional scale, two types of indicators are used: the area of habitat subtypes and the abundance of species characteristic of or typical to 9010-forests shaped by fire.

To start, research based on NFI data (Sandström et al. 2016) shows that the area of ground lichen-abundant (>50% lichen cover) *Pinus sylvestris* forests has decreased by about 71% (about 1% per year) on productive forest land outside protected areas since the 1950s (ca 70% in total) in the northern part of the Boreal region. It indicates that the regeneration of these forests has been low for decades. A probable reason is the decrease of old, open pine-dominated post-fire successional Boreal forests (Sandström et al. 2016). Likewise, NFI statistics (Nilsson & Dahlberg 2023) show that site types rich or dominated by ground lichens have decreased by about 1% per year since the 1980s.

Even though this is a general trend observed on productive forest land outside protected areas, it has importance as it implies that the potential for regeneration of ground lichen-abundant *P. sylvestris* 9010-forests is also decreasing. With continued absence of fire, these forests are likely to be confined mainly to the most oligotrophic and xeric site types (Angelstam & Kuuluvainen 2004; Niklasson et al. 2010).

The relative short 2010-2021 time series of ground lichen-rich *P. sylvestris* 9010 forests, based on NFI data, reveals no significant change in area of this habitat subtype over the past decade (**Appendix 3 Figure 3.3**). The subtype currently comprises roughly 50% of its potential site-type area in the Alpine region and ca 10% in the Boreal region (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2)**. This suggests that in the Boreal region, it remains below the 20% fragmentation threshold, indicating insufficient connectivity and poor representativeness.

In addition, NFI statistics show that the overall cover of reindeer lichens *Cladonia* spp. has on average decreased by about 30-60% (2-3% per year) on productive forest land outside formally protected area since the 1990s (SLU 2024b). In the field layer, club mosses *Lycopodium* spp., and dwarf shrubs such as *Vaccinium vitis-idaea* and *Empetrum nigrum*, have similar requirements and exhibit decreasing trends. The likely reasons are a growing stock of living trees (denser forests), but also a decrease of disturbed areas and early successional stages (Sandström et al. 2016). However, there are no significant changes in their cover since 2010 within NFI plots classified as 9010 by NFI (statistics not shown).

Furthermore, the area of deciduous forests older than 80 years has steadily decreased on productive forest land outside formally protected areas since the 1980s in the northern part of the Boreal region (SLU 2024b). It indicates that the potential for regeneration of deciduous-rich 9010-forests is also decreasing. Fire suppression is likely one causal factor since fire is known to result in succession dominated by deciduous tree species (Hellberg et al. 2003).

The 2010-2021 time series of deciduous-rich 9010 forests, based on NFI data, shows no significant change in area of this habitat subtype over the past decade (**Appendix 3 Figure 3.3**). The subtype currently comprises roughly 14% of its potential site-type area in the Alpine region and ca 1% in the Boreal region (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2)**. This suggests that in at least the Boreal region, it remains below the 20% fragmentation threshold, indicating insufficient connectivity and poor representativeness.

Given the above information (1 and 2), the (3) impact of the pressure alone, independent of other pressures, is finally assessed. The trends of the habitat subtypes and their species indicate that the potential for regeneration has been impeded for decades. The impact of fire suppression (this pressure code 'PB13') is compounded by other pressures, such as forestry ('PB02' and 'PB09') and high browsing pressure by moose and deer, making its individual effect difficult to evaluate. However, significant long-term compositional changes are known to occur in unmanaged forests due to prolonged absences of fire, both at the stand (Wardle et al. 1997; Wallenius et al. 2004; Niklasson et al. 2010) and landscape (Pennanen 2002; Hellberg et al. 2004) scales. Therefore, it seems unlikely that these habitat subtypes and species would persist or recover within the area of 9010 without fire disturbance, even if other pressures were eliminated.

Consequently, fire suppression is deemed to have a 'high influence' within its 'scope'. This conclusion is considered valid across all regions, as fire is a vital disturbance factor shaping 9010-forests throughout their geographical range.

Method used: The precision of estimates is generally high, as their RSE are smaller than 25%. The accuracy of NFI's data is likely high for the indicators used. However, the statistics used do not explicitly estimate the adverse effects in terms of losses or impeded regeneration of this pressure on the focal forest habitat type at regional scale during 2019-2024. Therefore, the method is classified as 'b) based mainly on extrapolation from a limited amount of data' in the Alpine and Boreal regions, and as 'c) based mainly on expert opinion with very limited data' in the Continental region.

PB14 (Forestry)
Forest management reducing old growth forests

DG Environment (2024)'s description: Shortening of logging rotations or other activities like thinning aimed at earlier logging.

The corresponding conservation measure: MB01 Prevent conversion of (semi-) natural habitats into forests and of (semi-) natural forests into intensive forest plantation.

The specific code 'PB14' addresses loss of 'high conservation value forests' and long-continuity forests due to clear-cutting. It is closely linked to 'PB09' ('Clear-cutting, removal of all trees'), both of which fall under the broader code 'PB02' ('Conversion from one type of forestry land use to another'), which focuses solely on the adverse effects of fragmentation alone. The assessments largely rely on the same reasoning and information as 'PB09' (see the 'PB09' section and cited references). However, 'PB14' specifically highlights the significance of losing 'high conservation value forests' and long-continuity forests, which are vital biodiversity source areas.

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Continental					

Fennoscandian herb-rich forests with *Picea abies* (9050)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	majority 50-90%	high	high importance	b) based mainly on extrapolation from a limited amount of data

The assessments outlined below for 9010 is also applied for 9050.

Scope: The 'scope' is likely similar to that addressed under the broader code 'PB09' (see the 'PB09' section and cited references). The pressure is not expected and assessed in the Continental region.

Influence: The 'influence' is expected to be 'high', as 'high conservation value forests' or 'continuity' and old-growth forests all have exceptionally long regeneration times, meaning that they are effectively irreversible lost, for instance, through clear-cutting.

The assessment is based on information about the loss due to clear-cutting (Svensson et al. 2019; Ahlström et al. 2022; Metria 2023) using SSIC's area-unit model, but also trend indicators (see Berglund & Maňák 2025 for explanation of method).

Ahlström et al. (2022) demonstrate that the annual rate of clear-cutting in potentially uncut unprotected forests with stand ages predating 1880 – another indicator for habitat types like 9010 – is approximately 1.4%. This loss is widespread across Sweden, with higher rate observed in the northern regions. At this rate, all unprotected forests predating 1880 are projected to be clear-cut within decades. These forests represent a continuity dating back to 1880 and it may be questioned whether they can be renewed once they are cut down and afforested by tree planting. However, if the regeneration time is assumed to be at least 140 years (2020-1880 years), less than 0.5% in the Alpine and 0.7% can be clear-cut annually.

Using data from Ahlström et al. (2022), the estimated annual clear-cutting rate in unprotected forests with stand ages predating 1880 is ca 0.8% in the Alpine region, 1.2% in the northwestern Boreal region, 1.7% in the southeastern Boreal region, and 1.1% in the Boreo-nemoral region (Berglund, in prep.). Furthermore, indicators based on these data suggest that the share of forests with stand ages predating 1880 and 1940 has been decreasing on productive forest land outside formally protected areas since 1990s (**Appendix 3 Figure 3.4**). In contrast, the share has tended to remain stable or increase within protected areas and on unproductive forest land set aside from forestry during the 2000s.

Additionally, the indicators suggest that the overall decrease is driven by ongoing losses in the northwestern and southeastern Boreal regions, where these forests still account for ca 10% and 5% of the productive forest land outside formally protected areas (Berglund, in prep.; **Appendix 3 Figure 3.4**). In the Alpine region, the share of forests with stand ages predating 1880 has remained relatively stable. In the Boreo-nemoral region, such forests are exceedingly rare and were already scarce before the 1990s, making it difficult to detect any changes in their occurrence.

In addition to Ahlström et al. (2022), Svensson et al. (2019) and Metria (2023) also provide information on the pressure's 'influence' on 9010 and other boreal coniferous and deciduous forest habitat types as a group.

Method used: Ahlström et al. (2022) estimates for assessing the pressure are based on NFI's systematic, stratified sample-plot survey (Fridman et al. 2014). They provide high-precision estimates of clear-cutting, with a relative 95% confidence interval of less than 5%. However, the extent to which it captures 9010 and 9050 forests has not been quantified. The method is classified as 'b) based mainly on extrapolation from a limited amount of data'.

PB23 (Forestry)
Physical alteration of water bodies for forestry (including dams)

DG Environment (2024)'s description: Activities modifying the physical structure or hydrological functioning of water bodies triggered by forestry production and *exploitation, and activities aimed at drying out the land to facilitate forestry production or exploitation (e.g. altering of flooding regimes, canalisation of rivers, cutting of the oxbow lakes).*

The corresponding conservation measure: MB14 Manage drainage and water abstraction for forestry (inc. restoration of drained or hydrologically altered habitats).

The broader code 'PB23' is intended to address various forestry-related pressures on 'water bodies', including hydrological alterations to both surface and groundwater. Here, 'water bodies' refer to both surface water and groundwater bodies, as defined by the EU Water Framework Directive (Directive 2000/60/EC).

An important observation is that Swedish forests are becoming drier. The rational for using the broader code 'PB23' stems from a complex interplay of potential drivers, including both old and new ditches, hydrological alternations during logging and wood transport, but potentially even intensive management that have increased tree stock and growth.

The pressure addressed under 'PB23' are expected to primarily impact coniferous (9010) or deciduous (9080) swamp forests, as well as bog woodlands (91D0), and, to a lesser extent, alluvial and riparian deciduous forests (91E0 and 91F0).

Western taiga (9010), swamp forests

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	medium	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data

Fennoscandian deciduous swamp woods (9080)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Deciduous alluvial and riparian forests (91E0 and 91F0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Boreal	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Bog woodlands (91D0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	medium	low importance	b) based mainly on extrapolation from a limited amount of data
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘minority <50%’ for 9010 and 91D0 in the Alpine and boreal regions, but as ‘majority 50-90%’ for 9080 in the Boreal and Continental regions, as well as for 91D0 in the Continental region. The assessment made for 9010 and 9080 is assumed applicable also for 91E0 and 91F0.

The reviewed indicators are primarily linked to ditching. Historically, extensive areas of Swedish forests were drained to improve forest production (Jacks 2019). Since the 1990s, the creation of new ditches has significantly decreased due to stricter regulations. Today, forestry primarily focus on maintaining existing old ditches and implementing protective ditching on clear-cuts to prevent waterlogging after cuttings (Jacks 2019).

NFI statistics (Nilsson & Dahlgren 2023) show that ca 10% (or 2.3 million ha) of current productive forest land outside protected areas has a functional ditch within a 25-m radius, corresponding to a ‘scope’ categorized as a ‘minority <50%’. A significantly larger proportion of the total forest land, both inside and outside formally protected areas, is likely impacted by ditches located at greater distances, indicating a larger ‘scope’. Drainage effects likely extend up to 100 meters from ditches (see ‘influence’ below) and the proportion of the area within 100 meters of ditches can be estimated for each habitat type by aligning NFI sample plots with a digital forest ditch map (Laudon et al. 2022; **Appendix 3 Figure 3.5**).

However, the digital map includes both false ditches and fails to detect true ditches, leading to a significant overestimation of the area within 100 meters of ditches in the Alpine region - though to a lesser extent in the Boreal region – and an underestimation in the Continental region, particularly for 91D0. Taking these errors into account, NFI estimates suggest that the proportion of area within 100 meters of ditches is <50% for 9010 and 91D0 in the Alpine and Boreal regions, but >50% for 9080 in the Boreal and Continental regions, as well as for 91D0 in the Continental region (**Appendix 3 Figure 3.5**).

The widespread decreases in the area of wet to moist site types, as well as the cover of *Sphagnum* mosses, observed in NFI statistics (Nilsson & Dahlberg 2023; SLU 2024b), suggest drivers with a large ‘scope’. However, the ‘scope’ of individual forestry-related pressures other than ditching remains unquantified. Hydrological alternations during logging and wood transport may be expected to have smaller ‘scope’ than that of the ditch network. Potentially lower soil water levels due to increased evapotranspiration – driven at least partly by intensive forest management, which has doubled the stock of growing trees since the 1920s and increased tree growth by nearly 50% since the 1950s (SLU 2024b) – may be expected to have a relatively large ‘scope’.

Influence: The ‘influence’ is generally assessed as ‘medium’ through extrapolation and expert judgement based information about the (1) adverse effects and (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method).

The (1) adverse effects are known. Hydrological alternations trigger ecological succession and shift the functional composition of forests. Species and structures adapted to natural hydrological conditions and high soil water levels diminish, while others proliferate. For instance, tree growth and volume increases, while *Sphagnum* cover decreases as it is replaced by feather mosses near ditches (Ågren et al. 2024).

The reviewed (2) long-term trend indicators show both decreasing and stable trends. As previously mentioned, NFI statistics indicate that Swedish forests are becoming drier. The area of swamp forest – wet to moist site types with *Sphagnum* and other wetland mosses in the ground layer – has decreased on productive forest land outside formally protected areas since the 1990s, likely reducing the regeneration potential of the focal forest habitat types. This decrease is observed nationwide, amounting to ca 25% (or 1% per year) at the national scale (Nilsson & Dahlberg 2023). The reduction in *Sphagnum* cover is less pronounced, reaching only about 7% (or <0.5% per year). Based on this information, the pressure’s ‘influence’ may be categorized as either ‘medium’ or ‘high’ within its ‘scope’ during 2019-2024 (Berglund & Maňák 2025).

In contrast, NFI statistics (Nilsson & Dahlgren 2023) show no increase in the area of productive forest land with a functional ditch within a 25-m radius since the 1990s. Additionally, the Forest Agency’s statistics (Skogsstyrelsen 2025) indicate that the annual rate of protective ditching has remained relatively stable and limited, ranging from 300 to 1 900 hectares per year since 2005. Furthermore, available indicators suggest that population trends for selected forest and wetland bird species – some of which inhabit swamp forests and wetlands – vary (Green et al. 2023). In recent decades, equal numbers of species have shown increasing, decreasing, or relatively stable trends. Based on this information, the pressure’s ‘influence’ can be categorized as either ‘medium’ or ‘low’ (Berglund & Maňák 2025).

Method used: The assessments rely on indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as ‘b) based mainly on extrapolation from a limited amount of data’ in the Alpine and Boreal regions for the most wide-ranging habitat types, and as ‘c) based mainly on expert opinion with very limited data’ in all other cases.

PC01 (Extraction of resources) Extraction of minerals (e.g. rock, metal ores, gravel, sand, shell)

DG Environment (2024)'s description: Extraction of rocks, gravel, sand, metal ores, loam, clay and shells from quarries, inland water bodies (lakes, river beds) and sea.

The corresponding conservation measure: MC01 Adapt/manage extraction of non-energy resources.

This pressure is expected to primarily affect 9010 and is linked to area losses caused by mining industry. It warrants individual assessment under the sector-specific code 'PC01' as its adverse effects compound those of pressures on 9010 classified as 'medium importance' but driven by a different sector – specifically, those addressed under 'PB02', 'PB09' and 'PB14 (see their respective sections and references therein).

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental					

Scope: National mining industry statistics are used to assess the 'scope' as 'minority <50%' in the Boreal region. The bulk (ca 70%) of Swedish mining areas are located in Norrbotten, the northernmost county, covering some 12 000 hectares. Since 2010, this area has been expanded by nearly 3% per year (SCB 2025). Existing old mines, such as those in Aitik (ca 8 000 hectares), Mertainen (ca 300 hectares) and Kaunisvaara (ca 800 hectares), are being expanded. Plans and exploitation concessions for new mines, such as the one in Nunasvaara, have been approved, while proposals for others, such as those in Kallak and Nautanen, are still in progress. These developments will result in the local exploitation and loss of forests with high conservation value and long ecological continuity, such as 9010 (as indicated by species observations in impacted areas on Artportalen.se). However, the forests impacted by the mining industry during 2019-2024 represent only a small proportion of the total 9010 area at the biogeographic regional scale.

Influence: The pressure's individual 'influence' is assessed as 'medium' in the Boreal region. The area losses of 9010 due to the mining industry are relatively small compared to the expected threshold for 'medium influence' and the loss rate from clear-cutting by forestry (see the section on 'PB09' and references therein). However, these losses are irreversible where they occur and intensify the adverse effects of fragmentation and clear-cutting driven by forestry (see the sections on 'PB02', 'PB09' and 'PB14' for further details).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

PD01 (Energy production) Wind, wave and tidal power (including infrastructure)

DG Environment (2024)'s description: Renewable energy (wind, wave and tidal power) generation including development and use of associated infrastructure (e.g. building wind turbines or tidal barrages, collision of birds with wind turbines, damage to coastal habitats or disturbance of marine mammals due to operation of tidal or wave barrages).

The corresponding conservation measure: MC03 Adapt/manage renewable energy installation, facilities and operation (excl. hydropower and abstraction activities).

This pressure is expected to primarily affect 9010 and is linked to direct area loss from land exploitation during wind farm construction. It warrants individual assessment under the sector-specific code ‘PD01’ as its adverse effects compound those of pressures classified as ‘medium importance’ but driven by a different sector – specifically, those addressed under ‘PB02’, ‘PB09’ and ‘PB14 (see their respective sections and references therein).

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental					

Scope: Information about expanding wind energy projects in Norrbotten, the northernmost county, is used to assess the ‘scope’ as ‘minority <50%’ in the Boreal region. Large-scale projects, such as Markbygden (ca 50 000 hectares) in Piteå – one of Europe’s largest – have already been completed (Markbygden Vind AB 2008), while others, like Storlandet in Gällivare (Vattenfall 2025), are underway. These projects are usually established in high-altitude, windy areas that generally have been less impacted by modern forestry and are therefore likely to contain forests with high conservation value and long ecological continuity, such as 9010. For example, hundreds of hectares of old-growth forest with high conservation value were left unprotected, and some were lost during the construction of the Uljabuouda wind energy project in Arjeplog. However, the forests impacted by the wind energy industry during 2019-2024 represent only a small proportion of the total 9010 area at the biogeographic regional scale.

Influence: The pressure’s individual ‘influence’ is assessed as ‘medium’ in the Boreal region.

Wind power development can result in area loss and fragmentation of habitat types but can also influence species through many mechanisms (see Tolvanen et al. 2023 and references therein). The area losses of 9010 are relatively small compared to the expected threshold for 'medium influence' and the loss rate from clear-cutting by forestry (see the section on 'PB09' and references therein). However, these losses are irreversible where they occur and intensify the adverse effects of fragmentation and clear-cutting driven by forestry (see the sections on 'PB02', 'PB09' and 'PB14 for further details).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PD02 (Energy production)
Hydropower (dams, weirs, run-off-the-river and respective infrastructure)

DG Environment (2024)'s description: Hydropower generation including development and use of associated infrastructure (e.g. building dams or weirs, changes of hydrological functioning rivers or chemical and thermal properties of water due to operation of dams and weirs).

The corresponding conservation measure: MC04 Reduce impact of hydropower operation and infrastructure (incl. the restoration of freshwater habitats).

The code 'PD02' is intended to be used for addressing various types of pressures caused by hydropower activities, such as damming and river flow regulation (altered hydrological functioning). These pressures impact primarily alluvial and riparian deciduous forests (91E0 and 91F0) and is mainly associated with deteriorations of conditions within the area classified as habitat types. The pressure has remained constant, as most dams were built during the 20th centuries.

Assessments of Fennoscandian natural rivers (3210) and water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation (3260) serve as references.

Deciduous alluvial and riparian forests (91E0 and 91F0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' is assessed as 'minority <50%' based on data from the Swedish Water Information system (WISS).

The pressure is wide ranging while the majority of rivers have been altered by dams, flow regulation and channel fragmentation (Nilsson et al. 2005). There are approximately 1,800 hydropower plants across the country generating 45% of Sweden's energy.

In Sweden, there are about 4 100 Natura-2000 sites, and around 10% of them are estimated to be affected by hydropower structures (HaV 2024). Furthermore, quality variables registered for the hydrology of rivers in WISS indicate that approximately 3%, 11%, and 12% of watercourses in the Alpine, Boreal, and Continental regions, respectively, are being impacted by hydropower structures. In addition, the connectivity has been altered by dams, barriers, etc. in ca 13%, 24% and 28% of the assessed watercourses. However, according to the database, some of these aspects have been assessed for only a minority of watercourses in the Alpine, Boreal, and Continental regions. Therefore, the results should be interpreted with caution.

This information suggest that although almost all rivers in Sweden have been regulated to some extent (Arheimer & Lindström 2014), the ‘scope’ may be classified as a ‘minority <50%’ for the focal habitat types and regions.

Influence: The ‘influence’ is generally assessed as ‘high’ through extrapolation and expert judgement based information about the adverse effects.

Deciduous alluvial and riparian forests (91E0 and 91F0) are highly dynamic habitat types found on floodplains, depending on natural streamflow regimes for their persistence. Their tree species rely on periodic flooding and sediment deposition for regeneration and dominance (Hughes 2003).

River regulation for hydropower has been identified as the most significant factor contributing to hydrological changes in Swedish rivers (Arheimer et al. 2017). In general, hydropower regulation changes water flows, with spring flows being the most reduced, while winter flows increase (Bergström 1999; Arheimer & Lindström 2014; Arheimer et al. 2017)

Research shows that hydropower structures (dams, weirs, run-off-the-river systems, and related infrastructure) alter natural flow regimes – impacting flow timing, frequency, duration, magnitude, and predictability – which regulate riparian vegetation dynamics (Nilsson & Svedmark 2002; Renöfält et al. 2010; Malm Renöfält & Ahonen 2013; Näslund et al. 2013). The habitat types most impacted are primarily deciduous alluvial and riparian forests (91E0 and 91F0), which are particularly sensitive to changes in water flow and lateral connectivity (von Wachenfeldt & Bjelke 2017).

The absence or prolonged reduction of flooding and fluvial processes accelerates ecological succession, leading to decrease of species and forest structures adapted to natural flow regimes, while more tolerant species and structures proliferate. For instance, studies of the regulated river Nedre Dalälven suggest that preserving deciduous alluvial and riparian forests (91E0 and 91F0) requires flooding periods of 25 to 150 days (Zinke 2013). Additionally, establishment and survival of competing small Norway spruces (*Picea abies*, < 50 cm in height) are hindered by flooding for lasting 25-30 days at least every two or three years (Eriksson et al. 2016).

Most hydropower structures were built during the 20th century, yet their dams and associated river continue to have direct adverse effects. These impacts contribute to a gradual decrease in the area of good habitat condition, either through loss or impeded regeneration (Eriksson et al. 2016), potentially leading to a 'high influence' (see Berglund & Maňák 2025 for explanation of assessment method).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PD06 (Energy production) Transmission of electricity and communications (cables)

DG Environment (2024)'s description: Construction, operation and maintenance of power lines and communication infrastructure (e.g. collisions or electrocution of wildlife with phone and power lines), including constructions and cables above and below ground.

The corresponding conservation measure: MC06 Reduce impact of service corridors and networks.

This pressure is expected to primarily affect 9010 and is linked to direct area loss from land exploitation during power-line construction. It warrants individual assessment under the sector-specific code 'PD06' as its adverse effects compound those of pressures classified as 'medium importance' but driven by a different sector – specifically, those addressed under 'PB02', 'PB09' and 'PB14 (see their respective sections and references therein).

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental					

Scope: Information from Svenska kraftnät (2025) is used to assess the 'scope' as 'minority <50%' in the Boreal region. Large power line construction projects are planned or underway in Norrbotten, Sweden's northernmost county. These new power lines aim to facilitate electricity export and import with Finland, strengthen the existing grid, and ensure reliable power supply for expanding industries both inland and along the coast. These developments will likely have adverse effects on forests such as 9010 (as indicated by submitted environmental impact assessments; Svenska kraftnät 2024). However, the forests impacted during 2019-2024 represent only a small proportion of the total 9010 area at the biogeographic regional scale.

Influence: The pressure's individual 'influence' is assessed as 'medium' in the Boreal region, as the potential losses remain relatively small (see, e.g., Svenska kraftnät 2024) compared to the expected threshold for 'medium influence' and the loss rate from forestry-driven activities (see the section on 'PB09' and references therein). However, these losses are irreparable where they occur and contribute to the cumulative adverse effects of fragmentation and clear-cutting caused by forestry (see the sections on 'PB02', 'PB09' and 'PB14 for further details).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PF15 (Commercial, industrial and recreational infrastructure and areas)
Modification of coastline, estuary and coastal conditions for built-up areas

DG Environment (2024)'s description: Activities modifying coastline or estuary and coastal conditions triggered by urban development such as development and protection of residential, commercial, industrial and recreational infrastructure and areas (also entailing the expansion of single dwellings). Includes activities like building sea defenses and coastal protection infrastructure or maintenance of existing coastal structures (e.g. repairs to existing sea defenses, harbor walls).

The corresponding conservation measure: MF08 Manage changes in hydrological and coastal systems and regimes for construction and development (incl. restoration of habitats).

This pressure is expected to primarily affect 9030 and is linked to loss, deterioration or impeded regeneration due to exploitation from construction and other human activities along the coast. It warrants individual assessment under the sector-specific code 'PF15' as its adverse effects also compound those of other pressures classified as 'medium or high importance' but driven by a different sector – specifically, those addressed under 'PB02' and 'PB09' (see their respective sections and references therein).

Natural forests of primary succession stages of landupheaval coast (9030)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' is assessed as 'minority <50%'. This assessment is based on national statistics on coastline exploitation (Nilsson 2023; SCB 2025) within 9030 distribution range, spanning from the northernmost Boreal region to Uppland in the south. These statistics indicate that the exploited area proportion accounts for ca

35% within 30 meters and nearly 40% within 100 meters of the coastline. The proportions vary geographically, ranging from roughly 20% to nearly 40% along the coast down to Uppland, but increasing to around 40-60% in the Stockholm area (Nilsson 2023).

Influence: The 'influence' is assessed as 'high'. The 9030 forests are unique since they encompasses primary successional forests in different stages of development – from young to old – on the land uplift coast of the Baltic Sea (Svensson & Jeglum 2003). By definition, they cannot be renewed once lost (see the section on 'PB09' for details).

Coastline exploitation can cause direct loss or deterioration of 9030 but also impede natural regeneration by destroying land uplift areas where this habitat type would otherwise form through primary succession. These irreversible adverse effects have 'high influence' (Berglund & Maňák 2025).

National statistics (Nilsson 2023) indicate that the area of exploited coastline increased by nearly 3% (ca 0.3% per year) within both 30 meters and 100 meters of the coastline between 2010 and 2020. The increase varies geographically, ranging from roughly 1% to 5% (0.2-0.5% per year) along the coast down to Uppland, and from 2% to 10% (0.2-1.1%) in the Stockholm area (Nilsson 2023).

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PI04 (Alien and problematic species) Plant and animal diseases, pathogens and pests

DG Environment (2024)'s description: Problems related to plant and animal diseases, pathogens and pests (including insect and nematode pests) like plague affecting rodents or diseases such as those caused by Clostridium botulinum (avian botulism) and Trichomonas gallinae (trichomoniasis).

The corresponding conservation measure: MI06 Controlling and eradicating plant and animal diseases, pathogens and pests.

Forests with ash or elm present in most of the area (9020, 9180 and 91F0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	majority 50 – 90%	high	high importance	b) based mainly on extrapolation from a limited amount of data

Forests with ash or elm present in less than half of the area (9080, 91E0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data
Continental	ongoing and likely to be in the future	minority <50%	high	medium importance	b) based mainly on extrapolation from a limited amount of data

Scope: The 'scope' is assessed as 'majority 50-90%' for the former group of habitat types and 'minority <50%' for the latter.

Both Dutch elm disease (DED), caused by the invasive fungal pathogen *Ophiostoma novo-ulmi* (introduced in the 1970s; CABI 2021), and ash dieback, caused by the fungal pathogen *Hymenoscyphus fraxineus* (introduced around 2000; Thomsen et al. 2007), have become established throughout the entire geographical ranges of ash (*Fraxinus excelsior*) and native elm species (*Ulmus glabra*, *U. minor* and *U. laevis*) in Sweden. The affected forest habitat types are those where ash and elm are characteristic species. Ash is characteristic of mixed broad-leaved forests (9020 and 9180), 9080 and deciduous alluvial and riparian forests (91E0 and 91F0). Elm is characteristic for the same habitat types, except for 9080.

Since the pathogens are highly contiguous and have severe adverse effects (see 'influence') across the entire geographical range of ash and elm, the 'scope' is determined by the extent of overlap between the pathogens' geographical ranges and those of the affected habitat types. In general, the pathogens' geographical ranges fully coincide with those of the habitat types. As a result, the whole (>90%) area of the habitat types concerned were exposed to the pressure during 2019-2024. However, most of the areas (50-90%) of habitat types 9080 and 91E0 have likely been exposed, as these types also occur in parts of the Boreal region that fall outside the pathogens' (and the affected tree species') ranges. Furthermore, in all these habitat types, the tree layers may include deciduous tree species other than ash and elm. It is therefore assumed that ash or elm are present in most of the area of 9020, 9180 and 91F0, but in less than half of the area of 9080 and 91E0.

Influence: The 'influence' is assessed as 'high' where the pathogens occur.

There is information on the adverse effects caused by the pressure at both local and regional scales. The adverse effects are direct and severe, as the pathogens weaken and kill mature trees at high rates. Elm trees, in particular, are unable to mature and grow large due to DED, effectively halting their regeneration. These pathogens are leading to the deterioration of habitat conditions, affecting many species associated with ash and elm.

Information regarding ash dieback: An inventory done in 2009-2010 in Götaland (the Boreo-nemoral and Continental regions) revealed that nearly 50% of the ash trees had suffered more than 25% canopy loss, and approximately 23% had died from ash dieback (Wulff & Hansson 2011). Similarly, Brunet et al. (2023) revisited stands inventoried prior to the pathogen's arrival, showing that ash-dominated stands had lost around half of its original cover in the upper canopy, with a noticeable loss in the lower canopy as well. In Västra Götaland County (part of the Boreo-nemoral region), a study in 2020 estimated that 90% of the surveyed trees exhibited symptoms of ash dieback, compared to 62% in 2009. The annual mortality rate of non-pollarded old-growth trees was estimated at 1.6%, highlighting significant mortality rates due to the pathogen (Bengtsson et al. 2021).

Information regarding DED: The pathogen typically affects large trees (diameter at breast high >10 cm), while understory trees tend to persist. However, recent reports indicate that smaller, young trees are increasingly being attacked as well (Brunet et al. 2014; CABI 2021; SLU 2024c). Although exact elm mortality rates have not been quantified, it is estimated that around 50% of the large elm trees in Sweden have died from DED since the pathogen's introduction (SLU 2024c). Brunet et al. (2023) found that in previously elm-dominated stands, nearly all (100%) elm trees in the upper canopy had died, with significant losses also occurring in the lower canopy. These estimates suggest consistently high annual mortality rates.

Method used: Observations of ash and elm recorded at Artportalen.se are used to define the geographical ranges of the tree species, and consequently, the ranges of the pathogens. While these observations likely reflect the actual distribution of the pathogens, there are no estimates of the precision and accuracy of this delimitation. The same uncertainty applies to the geographical boundaries of the affected habitat types. Furthermore, ash and elm are so rare that they are not sampled frequently enough by the systematic design of the NFI, making it impossible to estimate their population numbers, volumes, or trends in abundance. Although inventories and scientific studies report high rates of canopy loss and mortality, which are considered precise and accurate, these studies are limited to specific localities or parts of the pathogens' and habitat types' ranges. Therefore, the 'method' for assessing 'influence' is ranked as 'b) based primarily on extrapolation from a limited amount of data'.

PK04 (Mixed source pollution) Atmospheric N-deposition

DG Environment (2024)'s description: This pressure is to be used when atmospheric nitrogen deposition is identified as the key contributing pressure but the source of which is either mixed or from too many sources to identify a main source. Nitrogen compounds can be either gaseous form or dry deposition (particulate matter) or precipitation (wet deposition). Sources can be natural (e.g. volcanic, oceanic, biological decay), biogenic (e.g. agricultural fertilizers) or industrial (e.g. fuel combustion, coal and power plants, settlements) and can be either point or diffuse sources. Where the main source can be identified, this should be reported under the relevant sector and not under mixed source pollution.

The corresponding conservation measure: MK01 Reduce impact of mixed source pollution.

The code 'PD09' is intended to be used for addressing various types of air pollutions caused by energy production, such as emissions and deposition of nitrogen. The adverse effects are mainly linked to deteriorations of the conditions within the area classified as habitat type.

More than 80% of deposited nitrogen originates from sources outside Sweden (Moldan et al. 2022). Domestically, the main sources of nitrogen emissions are agriculture and the energy and fuel sector.

Bog woodlands (91D0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal					
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Western taiga (9010)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Coniferous forests on, or connected to, glaciofluvial eskers (9060)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data

Beech forests (9110 and 9130)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Oak forests (9190)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	minority <50%	medium	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50-90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Scope: Information on nitrogen deposition is used to assess the 'scope' as 'minority <50%' in the Boreal region and as 'majority 50-90%' in the Continental region.

In each case, the 'scope' is determined by the area exposed to deposition exceeding critical loads. In Sweden, nitrogen deposition in forests shows a latitudinal gradient, with the southwestern parts of the country being the most impacted (**Appendix 3 Figure 3.6**). The deposition decreases toward the north, and approach background levels in the northernmost regions (Pihl-Karlsson et al. 2012; Karlsson et al. 2022).

The 'scope' is assessed based on the modelled total nitrogen deposition for the year 2019 (using the MATCH model from the Swedish National Environmental Monitoring Programme) and whether the deposition levels exceed the critical loads for specific habitat types (see assessments of 'influence' below), while also considering the distribution of the impacted focal habitat types (**Appendix 3 Figure 3.6**; Karlsson et al. 2022; Wylde et al. 2023).

In the Boreo-nemoral and Continental regions (**Appendix 3 Figure 3.1**), most of the land area is impacted by nitrogen deposition levels exceeding 10 kg N ha^{-1} (**Appendix 3 Figure 3.6**), surpassing critical loads for both broadleaved and coniferous forests.

Based on this information, nitrogen deposition rates are expected to fall within or exceed the critical load ranges for nitrogen on less than half of the area of coniferous forest habitat types (9010) in the Boreal region, but in most, if not all, of the area in the Continental region. For 9060, more than half of the area is expected to be impacted.

For broadleaved deciduous forest habitat types, deposition rates are expected to fall within or exceed the critical load ranges on less than half of the area in the Boreal region and more than half of the area in the Continental region (**Appendix 3 Figure 3.6**). For several nutrient rich broadleaved deciduous forest habitat types (9020, 9180, 9160), the deposition rates are under critical load ranges.

Influence: The 'influence' is generally assessed as 'medium' through extrapolation and expert judgement based information about the (1) adverse effects and (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method).

The (1) adverse effects are known. Research shows that increased levels of nitrogen deposition influences various ecological processes, including soil chemistry, tree growth, root biomass, as well as changes in species groups like soil microbiota, bryophytes, lichens, algae, and ground vegetation (Bobbink et al. 2022).

Based on the nitrogen deposition decision framework outlined by Jones et al. (2016), a 'high influence' may be expected if deposition rates are within or exceed the range of critical loads for nitrogen.

Empirical critical loads for nitrogen deposition (CLempN) have been established for several habitats classified according to the European Nature Information System (EUNIS) and where possible, applied to corresponding habitat types under the Habitats Directive (**Appendix 2 Table 2.6**; Aherne et al. 2020; Bobbink et al. 2022; Chytrý et al. 2024).

For coniferous forest habitat types, the CLempN ranges from 3–15 kg N ha^{-1} yr^{-1}. The majority of 9010 is assumed to fall within this range, but lower critical loads are assumed for some specific habitat types, such as 9050 and 9060 (**Appendix 2 Table 2.6**). For the broadleaved deciduous forest habitat types beech forests (9110, 9130) and oak forests (9190), the critical nitrogen loads are assumed to be 10–15 kg N ha^{-1} yr^{-1}. For other broadleaved habitat types (9020, 9160, 9180), higher critical loads of 15–20 kg N ha^{-1} yr^{-1} are adopted. (**Appendix 2 Table 2.6**; Aherne et al. 2020).

Current deposition rates (**Appendix 3 Figure 3.6**) fall within or exceed the critical load ranges for nitrogen in the Boreo-nemoral and Continental regions, indicating a 'high influence' on the focal habitat types in these parts of the country.

However, the reviewed (2) long-term trend indicators do not strongly support a 'high influence'. To start, nitrogen deposition increased throughout the 20th century, peaking in the 1980s, primarily due to intensification in agriculture and transportation. Nonetheless, long-term data show a decreasing trend in total atmospheric nitrogen deposition over the last decades (Andersson et al. 2018; Karlsson et al. 2022).

Furthermore, adverse changes in forest vegetation cannot be attributed solely to nitrogen deposition. While dwarf shrubs and lichens, which are expected to decrease due to nitrogen deposition, are indeed decreasing in the impacted regions, herbs and grasses – expected to proliferate – are also decreasing (Jonsson et al. 2021). This suggests that these changes result from multiple factors, including succession, climate change and nitrogen deposition, making it difficult to attribute them to a single cause.

Method used: The national monitoring of nitrogen deposition covers all of Sweden (Karlsson et al. 2022), and most critical loads used are considered reliable (Bobbink et al. 2022). However, uncertainties exist because the nitrogen sampling is based on deposition calculations for coniferous forests, which may not represent other forest types. No specific responses of focal habitat types have been investigated during the reporting period. Instead, the assessment approximates habitat-type responses based on observed changes in mature forests. Therefore, the method is classified as 'c) based mainly on expert opinion with very limited data'.

PL06 (Human-induced changes in water regimes) Physical alteration of water bodies (mixed or unknown drivers)

DG Environment (2024)'s description: Physical alteration of water bodies should only be reported under this category when the key driver of the change is unclear or where these changes are related to several causes. Where a key sectoral driver(s) can be identified, the pressure/threat should be reported under the corresponding sectoral category.

Includes, for example, removal of sediments, canalization and water deviation.

The corresponding conservation measure: MK02 Reduce impact of multi-purpose hydrological changes.

The code ‘PL05’ is intended to be used for addressing various types of human-induced changes of hydrological flow, such as damming and channelization for timber floating, where drivers are mixed or unknown (excluding hydropower activities). This pressure impacts primarily alluvial and riparian deciduous forests (91E0 and 91F0) and is mainly associated with deteriorations of conditions within the area classified as habitat types.

Assessments of Fennoscandian natural rivers (3210) and water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation (3260) serve as references.

Deciduous alluvial and riparian forests (91E0 and 91F0)

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine					
Boreal	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	high	medium importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ is assessed as ‘minority <50%’ based on data from WISS.

This pressure is widespread, with most rivers having been altered by construction of various structures and regulation of water flows for large-scale timber floating (Törnlund & Östlund 2002). Furthermore, exploitation along inland watercourses and lakes gradually increases (Nilsson 2023).

The quality variables registered for the hydrology of rivers in WISS indicate that that the hydromorphology have been altered in some way in approximately 3%, 15%, and 39% of watercourses in the Alpine, Boreal, and Continental regions, respectively. Hence, this information suggest that the ‘scope’ may be classified as a ‘minority <50%’ for the focal habitat types and regions concerned.

Influence: The ‘influence’ is assessed as ‘high’ based on research about the adverse effects. The assessments are based on the same information used for ‘PD02’ (see the section on ‘PD02’ and references therein).

The pressure has remained constant, as most dams were built during the 20th centuries. It has likely caused a gradual decrease in the area of habitat types in good condition.

Method used: The assessments rely on information and indicators that do not explicitly quantify the adverse effects of the pressures on the focal forest habitat types at regional scale during 2019-2024. Therefore, the method is classified as ‘c) based mainly on expert opinion with very limited data’.

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Appendix 1. Collective assessments of fragmentation

The broader code ‘PB02’ addresses various pressures from forestry activities, both historical and from 2019-2024, impacting most forest habitat types. Two key pressures are insufficient connectivity due to fragmentation and, on the other hand, continued loss and impeded regeneration from clear-cutting and intensive management on the other. These pressures are closely linked and require the same conservation measures – forest protection and restoration.

However, to maintain transparency, the pressures are addressed separately under different codes. Information on fragmentation alone is reviewed under the broader code ‘PB02’, while the others are covered under the specific codes ‘PB09’ (‘Clear-cutting, removal of all trees’) and ‘PB14’ (‘Forest management reducing old growth forests’) (refer to the sections on ‘PB09’ and ‘PB14’ for further details).

The assessments of fragmentation are done collectively for groups of habitat types that share history, ecology and distribution, but also serve as habitat for largely the same species pool. The collective assessments are then applied to each habitat type within its group. The first group includes western taiga (9010, hereafter referred to as 9010) and other boreal coniferous and deciduous forest habitat types (9030, 9050, 9060, 9080 and 91E0; names listed in **Appendix 2 Table 2.1**), while the second group includes broad-leaved deciduous forest habitat types (9020, 9110, 9130, 9160, 9180, 9190 and 91F0).

Fragmentation is assessed using a simple indicator: the current regional area proportion of habitat types is compared to a 20% ecological threshold, representing the minimum habitat required to sustain sufficiently connected functional networks and viable populations of specialized species that cannot persist in managed forests (Andrén 1994; Angelstam et al. 2004; 2020).

Statistics from the National Forest Inventory (NFI) are utilized. NFI classifies forests in sample plots as forest habitat types based on stand age and naturalness criteria (SLU 2019). Using this data, the current area across different regions can be estimated (**Appendix 2 Table 2.1**; **Appendix 3 Figure 3.1-3.2**). Additionally, NFI classifies the site type of plots, enabling estimates of habitat types’ current site-type areas (Berglund 2021). The ratio of the current area to its site-type area serves as an indicator of fragmentation and representativeness at regional scale. Proportions <20% suggest insufficient area and connectivity, as well as poor representativeness, highlighting the need for restoration.

The results show that the current proportions generally fall below the 20% threshold in all regions except the Alpine region (**Appendix 2 Table 2.2**). Since fragmentation and insufficient connectivity are expected to negatively impact most of the habitat network, the collective ‘scope’ is assessed as ‘majority 50-90%’. The ‘influence’ is generally rated as ‘medium’, as explained in the respective group sections below.

The actual current area proportions are likely higher than indicated (**Appendix 2 Table 2.2**), as an unknown proportion of habitat types remains undetected by NFI and NILS due their plot classification criteria (SLU 2019). For instance, since the age criterion to classify plots as forest habitat types increases with decreasing site productivity – reaching ca 150 years in low-productive sites – some younger forests that qualify as habitat types in reality may go undetected, leading to an underestimation of the true area. This issue is most relevant in the Alpine and northwestern Boreal regions, where low-productive forests are widespread, suggesting that the relatively high current area proportions estimated there may be underestimated. Similarly, the area proportion of swamp forests (9010, 9080) and bog woodlands (91D0) might be underestimated as forests in poor habitat conditions are disqualified if ditches are present within 25 meters from the plots.

Correcting these plot classification issues is unlikely to significantly impact the fragmentation results (**Appendix 2 Table 2.2**), as the underestimations occur in regions or habitat types where area proportions are already relatively high.

For structures and functions to be considered in favourable conservation status, fragmentation must not significantly impact ecological processes (DG Environment 2022b; 2023; see section ‘Aim & background’). Connectivity is essential for sustaining viable species populations of typical species and has a broad, top-down influence on overall habitat conditions. However, DG Environment’s (2022b; 2023) guidelines and criteria take a stand-level, bottom-up approach to assessing habitat conditions and do not provide guidance on incorporating habitat-condition indicators at landscape or regional scales. As a result, indicators of the area proportion in good condition at regional scale are typically based on local structural and compositional data traditionally recorded by existing monitoring programs (e.g., from NFI and NILS sample plots).

Nevertheless, the current area proportion, when appropriately rescaled (see Jacobsson et al. 2021 for the scaling concept), can serve as a general, top-down indicator of habitat condition. The 20% threshold may represent the point at which a sufficient proportion of the area achieves functional connectivity, thereby meeting DG Environment’s (2022b; 2023) criterion for favourable conservation status. Since current area proportions generally fall below this threshold, the extent of habitat types in good condition is considered insufficient.

Boreal coniferous and deciduous forests

Boreal coniferous and deciduous forest habitat types are expected to face insufficient connectivity due to fragmentation in the Boreal and Continental regions, whereas this is not expected in the Alpine region.

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data
Boreal	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ of fragmentation is expected to encompass the ‘minority <50% in the Alpine region and the ‘majority 50-90%’ in the Boreal and Continental regions.

The 9010 is the dominating habitat type within the group and is used as a basis for the assessment. It shares significant ecological and biodiversity characteristics with the other boreal coniferous and deciduous forest habitat types that develop on mineral soils (9030, 9050, 9060, 9080 and 91E0). Many of their conservation values are likely associated with the conditions of naturally dynamic forest landscapes (Berglund & Kuuluvainen 2021). This group of habitat types also face similar pressures, including fragmentation by forestry.

In Sweden, 9010 and other boreal coniferous and deciduous forest habitat types are vital terrestrial ecosystems, yet they have been extensively transformed by a long history of intensive use and modern forestry practices focused on even-aged management and clear-cut harvesting (Östlund et al. 1997; Linder and Östlund 1998). The proportion of natural or near-natural forests has decreased, replaced largely by young, post-harvest stands (Kuuluvainen et al. 2015). This large-scale transformation may be further exacerbated by ongoing clear-cutting and increasing forestry intensification.

Research indicates that habitat loss and fragmentation have led to significant regional variation in the distribution and connectivity of natural or near-natural boreal coniferous and deciduous forests, such as 9010. While a large proportion of these forests are in a transition phase due to forestry, extensive areas still exist in remote Alpine and northwestern Boreal regions (Svensson et al. 2019). However, current area proportions across most of the country remain low compared to a threshold value of 20%. The results indicate that most of the 9010, as well as other boreal coniferous and deciduous forest habitat types, face insufficient connectivity in the Boreal and Continental regions.

Western taiga (9010). – NFI statistics show that the current proportion ranges from 1 to 13%, clearly below the 20% fragmentation threshold in all regions except the Alpine region (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**). These estimates are considered robust, given that the current area is >100 000 hectares (**Appendix 2 Table 2.1**) and the potential site-type area is > 1 million hectares in each region (Berglund 2021). This indicates that most of the 9010, as well as other boreal coniferous and deciduous forest habitat types, face insufficient connectivity in the Boreal and Continental regions.

Natural forests of primary succession stages of landupheaval coast (9030). – NFI statistics indicate that the current area proportion of natural forests of primary succession stages of landupheaval coast (hereafter referred to as 9030) is ca 20% (**Appendix 2 Table 2.1-2.2**). However, the underlying area estimates are <20 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**; Berglund 2021). The assessments of fragmentation derived for boreal coniferous and deciduous forest habitat types, as a group, are therefore adopted.

Fennoscandian herb-rich forests with Picea abies (9050). – The current area proportion of Fennoscandian herb-rich forests with *Picea abies* (9050, hereafter referred to as 9050) ranges from 1 to 16%, and remains below the 20% fragmentation threshold in the Boreal region (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**). The assessments of fragmentation derived for boreal coniferous and deciduous forest habitat types, as a group, are therefore adopted.

Coniferous forests on, or connected to, glaciofluvial eskers (9060). – Due to lack of data, the assessments determined for 9010 in the Boreal region is also adopted for coniferous forests on, or connected to, glaciofluvial eskers (9060, hereafter referred to as 9060) (refer to the section on 9010 and references cited therein). However, the method is 'c) based mainly on expert opinion with very limited data'.

Fennoscandian deciduous swamp woods (9080). – NFI statistics suggest that the current area proportion of Fennoscandian deciduous swamp woods (hereafter referred to as 9080) is below the 20% fragmentation threshold in the Boreal region but not in the Continental region (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**). The boreal estimate is ca 15 000 hectares (**Appendix 2 Table 2.1**) and the potential site-type area is ca 300 000 hectares (Berglund 2021). However, the underlying area estimates in the Continental region are <20 000 hectares and therefore subject to uncertainties (**Appendix 2 Table 2.1**; Berglund 2021). The assessments of fragmentation derived for boreal coniferous and deciduous forest habitat types, as a group, are therefore adopted.

Deciduous alluvial and riparian forests (91E0 and 91F0). – NFI statistics suggest that the current area proportions of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (hereafter referred to as 91E0) are well above the 20% fragmentation threshold (**Appendix 2 Table 2.2**). However, the underlying area estimates are <20 000 hectares and subject to significant uncertainties (**Appendix 2 Table 2.1**; Berglund 2021). For riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (hereafter referred to as 91F0), no estimates were possible due to its rarity. The assessments for coniferous and deciduous forest habitat types, as well as broad-leaved deciduous forest habitat types are therefore adopted.

Influence: The 'influence' of fragmentation is considered 'low' in the Alpine region but classified as 'medium' in the Boreal and Continental regions.

There are some indicators on the explicit adverse effects of fragmentation on the focal forest habitat types at regional scale during 2019-2024. A notable case is the white-backed woodpecker (*Dendrocopos leucotos*), a specialized umbrella species reliant on old deciduous boreal forests rich in dead wood (Roberge et al. 2008). Endangered for decades due to its small population size and limited recovery capacity (Stighäll et al. 2011), the species continue to struggle to establish viable populations as suitable habitat remains insufficient – primarily due to forestry and fire suppression (Stighäll et al. 2011).

Another case is the ongoing strong population declines (0.5-1.7% per year) and potential range contractions among epiphytic lichen species with restricted dispersal and colonization rates in managed boreal forests (Esseen et al. 2022). These cases suggest that fragmentation has a 'high influence' by restricting population growth and impeding the recovery of species with small, fragmented populations – especially those requiring large or specialized habitats and/or have limited dispersal capacity (Berglund & Maňák 2025).

The 'influence' can also be assessed through extrapolation and expert judgement based information about the (1) adverse effects and (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method). As mentioned, the (1) adverse effects of fragmentation are known. For instance, some bird species like the white-backed woodpecker are sensitive because they require large areas of some specific habitats to sustain their home ranges. Below a critical threshold area of suitable habitat in a landscape, their survival and breeding success are likely to deteriorate rapidly (Carlson 1998; 2000). Empirical data suggest that such threshold responses among animal species with large home ranges occur when 10-50% of their habitat remains at the scale of landscapes (Andrén 1994; Angelstam et al. 2004).

Regarding (2) long-term trend information at the regional scale, available indicators suggest that population trends for a set of selected forest bird species vary (Green et al. 2023). Equal numbers of species are increasing, decreasing, or remaining relatively stable in recent decades. Based on this information, the pressure's 'influence' can be categorized as either 'medium' or 'low' within its 'scope' (Berglund & Maňák 2025).

A 'medium influence' is generally adopted, as the white-backed woodpecker's inability to recover as well as other species decreasing populations are likely attributable to fragmentation and insufficient connectivity.

Method used: The statistical estimates of current area proportions are based on NFI's systematic, stratified sample-plot survey (Fridman et al. 2014). The statistical errors of area estimates are generally low and fulfill the criteria for high precision. However, the statistics used do not explicitly estimate the adverse effects in terms of losses or impeded regeneration of this pressure on the focal forest habitat type at regional scale during 2019-2024. Therefore, the method is classified as 'b) based mainly on extrapolation from a limited amount of data' in the Alpine and Boreal regions. In the Continental region, the method is classified and as 'c) based mainly on expert opinion with very limited data'.

Broad-leaved deciduous forests

The assessments of broad-leaved deciduous forest habitat types align with the approach used for boreal coniferous and deciduous forest habitat types. They are expected to face insufficient connectivity due to fragmentation in the Boreal and Continental regions.

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Boreal	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	majority 50 – 90%	medium	medium importance	c) based mainly on expert opinion with very limited data

Scope: The 'scope' of fragmentation is expected to encompass the 'majority 50-90%' in the Boreal and Continental regions.

The broad-leaved deciduous forest habitat types (9110, 9130 9020, 9160, 9180, 9190 and 91F0; names listed in **Appendix 2 Table 2.1**) share historical, ecological and biodiversity characteristics with wooded grassland habitat types (see also section on ‘PA05’). Many of their conservation values are likely associated with the conditions of landscapes shaped by the historical infield-outland farming system, which prevailed from medieval times until the agrarian revolution in the 18th century (Lindbladh et al. 2007; Eriksson and Cousins 2014). They also face similar pressures, including fragmentation.

It is know that during the rationalization of agriculture and forestry, up to 90 % of the areas of broad-leaved deciduous forest and wooded grassland habitat types were likely lost (Svenningsson 1992; Fritz et al 2008; Lindbladh et al. 2011).

To assess the ‘scope’ of fragmentation, NFI and National Inventory of Landscapes in Sweden (NILS) statistics are used. The statistics indicate that the current area proportions of broad-leaved deciduous forest habitat types, as a group, fall below the 20% threshold in the Boreal and Continental regions (**Appendix 2 Table 2.2**).

Beech forests (9110 and 9130). – The current area proportions of beech-forest habitat types (hereafter referred to as 9110 and 9130) align with the 20% threshold in the Boreal region but are below it in the Continental region (**Appendix 2 Table 2.2**). However, underlying area estimates are <20 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**; Berglund 2021). The assessments of fragmentation derived for broad-leaved deciduous forest habitat types, as a group, are therefore adopted.

Oak forests (9160 and 9190).– NFI and NILS statistics suggest that the current area proportions of oak-forest habitat types (hereafter referred to as 9160 and 9190) are below the 20% fragmentation threshold in the Boreal and the Continental regions (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**). These estimates are considered robust, given that the potential site-type areas of the oak forests are >20 000 hectares except for 9190 in the Continental region (Berglund 2021). Although the current area is small (<20 000 hectares; **Appendix 2 Table 2.1**), the fairly large potential site-type area supports the robustness of the estimate. The assessments of fragmentation derived for broad-leaved deciduous forest habitat types, as a group, are therefore adopted.

Mixed broad-leaved forests (9020 and 9180).– NFI and NILS statistics suggest that the current area proportions of mixed broad-leaved forest habitat types (hereafter referred to as 9020 and 9180) are below the 20% fragmentation threshold in the Boreal and the Continental regions (**Appendix 2 Table 2.2**). However, most underlying area estimates are <20 000 hectares and therefore subject to significant uncertainties (**Appendix 2 Table 2.1**; Berglund 2021). The results derived for broad-leaved deciduous forest habitat types, as a group, are therefore adopted: their current area proportions fall below the 20% threshold in the Boreal and Continental regions (**Appendix 2 Table 2.2**).

Influence: The ‘influence’ of fragmentation is classified as ‘medium’ in the Boreal and Continental regions. It is determined for broad-leaved deciduous forest habitat types as a group. Collectively, they are expected to face insufficient connectivity in the Boreal and Continental regions.

The scientific background is essentially the same as described in the previous section about 9010 and other coniferous and deciduous forest habitat types (see references therein; Andrén 1994; Angelstam et al. 2004).

The extensive historical loss has led to fragmentation and insufficient connectivity in today's areas, posing a pressure by increasing the risk of time-lagged extinctions of specialized species populations (Fritz et al. 2008; Ranius et al. 2008; Hannon et al. 2010). A notable case is species inhabiting large, ancient and hollow trees, such as the Hermit beetle (*Osmoderma eremita*), a specialized umbrella species that has remained endangered for decades due its limited capacity to disperse (Ranius 2007). Thus, these research findings (Fritz et al. 2008; Ranius 2007; Ranius et al. 2008) suggest that fragmentation has a 'high influence' on specialized species with small populations confined to broad-leaved deciduous forest habitat types by limiting population growth and impeding recovery (Berglund & Maňák 2025).

As (1) adverse effects are known, the 'influence' may also be assessed through extrapolation and expert judgement based on (2) long-term trend information (see Berglund & Maňák 2025 for explanation of method). There are no specific indicators regarding population trends of bird species or other animal species confined to broad-leaved deciduous forest or wooded grassland habitat types. However, as mentioned, general forest bird indicators suggest that equal numbers of species are increasing, decreasing, or remaining relatively stable (Green et al. 2023).

A 'medium influence' is therefore adopted, as research suggest that specialized species populations are facing extinction risks due to habitat fragmentation, but there is a lack of specialized species monitoring data at regional scale.

Method used: See previous section on coniferous and deciduous forest habitat types.

Bog woodlands (91D0)

Bog woodlands (91D0, hereafter referred to as 91D0) comprise coniferous and deciduous forests found on oligotrophic wetlands, shaped by hydrological processes and a high ground water table, resulting in moist to wet peaty soils. They share ecological and biodiversity characteristics with other wetland habitat types.

91D0 is not expected to experience insufficient connectivity due to fragmentation caused by forestry. The current area proportion ranges from 28% to 77%, clearly exceeding the 20% threshold in all regions (**Appendix 2 Table 2.1-2.2**; **Appendix 3 Figure 3.1-3.2**). These estimates are considered robust, given the large current areas (**Appendix 2 Table 2.1**) and potential site-type areas (Berglund 2021).

Region	Timing	Scope	Influence	Overall impact	Method used (optional)
Alpine	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data
Boreal	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data
Continental	ongoing and likely to be in the future	minority <50%	low	low importance	c) based mainly on expert opinion with very limited data

Scope: The ‘scope’ of fragmentation is expected to encompass the ‘minority <50%’ in the Boreal and Continental regions

Influence: The ‘influence’ of fragmentation is classified as ‘low’ in all regions.

Method used: See previous section on coniferous and deciduous forest habitat types.

Appendix 2. Tables

Table 2.1. Estimated total area of forest habitat types on forest land, excluding the alpine mountain zone, shown across biogeographical regions, subregions, and in total (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). Estimates are based on the National Forest Inventory 2019-2023, using their criteria for sample-plot classification (SLU 2019). The relative standard error is generally ≤20% for estimates ≥20 000 hectares but increases significantly for smaller estimates, resulting in great uncertainties. The taiga subtype stand-placing disturbance (marked with "*") includes forests recently impacted by fire, storms or flooding.

Habitat type / group	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	115 500	597 538	630 100	261 132	1 488 770	18 293	1 622 563
Subalpine birch forests	9040	166 540	24 737			24 737		191 277
Boreal coniferous and deciduous forests		**851 174**	**903 955**	**452 978**	**249 367**	**1 624 935**	**9 778**	**2 467 252**
Primary successional forests on land upheaval coast	9030			6 361		6 361		6 361
Alluvial deciduous forests	91E0		276		3 210	3 486	479	3 965
Deciduous swamp forests	9080		1 630	1 970	11 779	15 380	7 424	22 804
Coniferous forests on glaciofluvial eskers	9060			1 652		1 652		1 652
Herb-rich Norway spruce forests	9050	92 732	54 639	33 947	5 497	94 083		186 815
Western taiga, total	9010	758 441	847 409	409 047	228 881	1 503 973	1 874	2 245 653
, stand-replacing disturbance*	9010	3310	10966	16735	5323	33024	1294	37629
, swamp forests	9010	14 557	20 802	8 185	1 586	30 572	0	45 130
, dry, poor pine forests	9010	62 322	93 168	27 091	9 603	129 862		192 185
, deciduous forests	9010	37 836	22 185	4 787	14 995	41 967	426	80 229
Continental (temperate) broad-leaved forest				**711**	**19 966**	**20 676**	**8 437**	**29 114**
Nutrient rich beech forests	9130				218	218	2 365	2 583
Nutrient poor beech forests	9110				1 826	1 826	1 460	3 286
Nutrient rich oak forests	9160				12 112	12 112	3 612	15 724
Nutrient poor oak forests	9190			711	3 186	3 896	450	4 346
Broad-leaved forests in screes	9180				564	564		564
Mixed broad-leaved forests	9020				2 059	2 059	551	2 610
Riparian, mixed broad-leaved forests	91F0							
All forest land including 9040		966 673	1 501 493	1 083 789	530 465	3 134 382	36 509	4 118 929
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		851 174	903 955	453 689	269 333	1 645 611	18 215	2 496 366

Table 2.2. The proportion of total site-type area that classified as forest habitat types on forest land, excluding the alpine mountain zone, shown across biogeographical regions, subregions, and in total (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). Site-type area estimates are five-year averages based on the National Forest Inventory (NFI) 2015-2019 (Berglund 2021). Current area estimates are five-year averages based on the NFI 2019-2023, using their criteria for sample-plot classification (SLU 2019). The taiga subtype stand-placing disturbance (marked with "*") includes forests recently impacted by fire, storms or flooding. Its proportion as well as the proportion of taiga subtype deciduous forests ("**") is measured relative to the approximate quarter of 9010's total site-type area expected to be shaped by even-aged dynamics over the course of 100+ years following stand-replacing disturbances in naturally dynamic boreal forest landscapes (Berglund & Kuuluvainen 2021). For broad-leaved deciduous forest habitat types, two figures separated by a "/" are given: the first represents current area estimates on forest land based on NFI 2019-2023, and the second is estimates on all land based on the National Inventory of Landscapes in Sweden 2020-2024 (SLU 2025). Estimates for rare habitat types are subject to large uncertainties (see **Table 2.1** and Berglund 2021) and may exceed 100% when current area estimates exceed site-type area estimates.

Habitat type / group	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	77	60	47	31	47	28	48
Subalpine birch forests	9040	72						83
Boreal coniferous and deciduous forests		**49**	**13**	**5**	**4**	**8/8**	**3/2**	**11/11**
Primary successional forests on land upheaval coast	9030			25	0	22		22
Alluvial deciduous forests	91E0		15		93	65/103	193/1150	71/150
Deciduous swamp forests	9080		1	2	14	5/9	41/15	7/10
Coniferous forests on glaciofluvial eskers	9060			9	0	2		2
Herb-rich Norway spruce forests	9050	40	16	6	1	6		11
Western taiga, total	9010	51	13	5	4	8	0.5	11
, stand-replacing disturbance*	9010	1	1	1	0.5	1	1.7	0.9
, swamp forests	9010	5	2	1	0.3	1	0	1
, dry, poor pine forests	9010	52	12	7	20	11		15
, deciduous forests**	9010	14	2	0.3	1	1	0.6	2
Continental (temperate) broad-leaved forest				**45**	**17**	**17/14**	**8/5**	**13/10**
Nutrient rich beech forests	9130				20	20/4	14/12	15/11
Nutrient poor beech forests	9110				16	16/28	4/3	7/9
Nutrient rich oak forests	9160			0	29	29/13	14/4	23/10
Nutrient poor oak forests	9190			110	9	11/9	3/0	9/6
Broad-leaved forests in screes	9180				39	39/62	NA	39/73
Mixed broad-leaved forests	9020			0	8	8/15	4/9	6/13
Riparian, mixed broad-leaved forests	91F0					NA	NA	NA
All forest land including 9040		**46**	**19**	**11**	**8**	**13/13**	**7/6**	**15/15**
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		**49**	**13**	**5**	**4**	**8/8**	**4/3**	**11/11**

Table 2.3. The proportion of total area of forest habitat types occurring on productive forest land outside formally protected areas, shown across biogeographical regions, subregions, and in total (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). The estimates are five-year averages based on the NFI 2019-2023, using their criteria for sample-plot classification (SLU 2019). An unknown proportion of this area is voluntarily protected from forestry, implying that the actual share unprotected from forestry is smaller than these figures suggest. Estimates for rare habitat types (see **Table 2.1**) are subject to large uncertainties. The taiga subtype stand-placing disturbance (marked with "*") includes forests recently impacted by fire, storms or flooding. A "-" indicates missing data.

Habitat type / group	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	2.6	8.6	21	49	21	56	20
Subalpine birch forests	9040	7.3	0			0		6.3
Boreal coniferous and deciduous forests		**24**	**45**	**65**	**60**	**53**	**74**	**43**
Primary successional forests on land upheaval coast	9030			78		78		78
Alluvial deciduous forests	91E0		100		56	59	100	64
Deciduous swamp forests	9080		36	100	53	57	82	65
Coniferous forests on glaciofluvial eskers	9060			100		100		100
Herb-rich Norway spruce forests	9050	47	52	79	80	64		55
Western taiga, total	9010	21	45	64	60	52	36	42
, stand-replacing disturbance*	9010	12	43	40	29	39	20	36
, swamp forests	9010	0	60	59	46	59	-	40
, dry, poor pine forests	9010	-	-	-	-	-	-	-
, deciduous forests	9010	-	-	-	-	-	-	-
Continental (temperate) broad-leaved forest					**62**	**60**	**33**	**52**
Nutrient rich beech forests	9130				100	100	43	48
Nutrient poor beech forests	9110				63	63	17	43
Nutrient rich oak forests	9160				72	72	32	63
Nutrient poor oak forests	9190			0	17	14	0	13
Broad-leaved forests in screes	9180				0	0		0
Mixed broad-leaved forests	9020				80	80	70	78
Riparian, mixed broad-leaved forests	91F0							
All forest land including 9040		**23**	**31**	**40**	**55**	**38**	**56**	**34**
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		**24**	**45**	**65**	**60**	**53**	**55**	**43**

Table 2.4. Estimated annual loss due to clear-cutting of permanent sample plots classified as habitat types on productive forest land outside formally protected areas, shown across biogeographical regions, subregions, and in total (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). Estimates are derived by comparing the National Forest Inventory permanent sample plot data from 2008-2012 to 2013-2017, and 2013-2017 to 2018-2022, using their criteria for sample-plot classification (SLU 2019). An unknown proportion of non-clear-cut plots is voluntarily protected from forestry, implying the actual clear-cutting loss rate is higher than indicated. Estimates for rare habitat types, in particular (see **Table 2.1**), are subject to large uncertainties. The taiga subtype stand-placing disturbance (marked with "*") includes forests recently impacted by fire, storms or flooding. A "-" indicates missing data.

***From 2008-2012 to 2013-2017*:** **Habitat type / group**	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	0	0	0.2	0.4	0.3	0	0.3
Subalpine birch forests	9040	0						0
Boreal coniferous and deciduous forests		**0.9**	**0.9**	**1.3**	**1.1**	**1.1**	**2.1**	**1.1**
Primary successional forests on land upheaval coast	9030			0		0		0
Alluvial deciduous forests	91E0				0	0	0	0
Deciduous swamp forests	9080			0	0	0	1.5	0.5
Coniferous forests on glaciofluvial eskers	9060			0		0		0
Herb-rich Norway spruce forests	9050	0	0	2.3	0	1.2		0.9
Western taiga, total	9010	1.0	0.9	1.2	1.2	1.1	4.0	1.1
, stand-replacing disturbance*	9010	0	0	0	0	0	-	0
, swamp forests	9010	0	0	0	0	0	-	0
, dry, poor pine forests	9010	-	-	-	-	-	-	-
, deciduous forests	9010	-	-	-	-	-	-	-
Continental (temperate) broad-leaved forest				**0**	**1.6**	**1.6**	**1.2**	**1.4**
Nutrient rich beech forests	9130						2.0	2.0
Nutrient poor beech forests	9110						5.0	5.0
Nutrient rich oak forests	9160				1.7	1.7	0	1.0
Nutrient poor oak forests	9190				0	0	0	0
Broad-leaved forests in screes	9180				2.9	2.9		2.9
Mixed broad-leaved forests	9020			0	0	0	0	0
Riparian, mixed broad-leaved forests	91F0							
All forest land including 9040		**0.9**	**0.8**	**1.0**	**0.9**	**0.9**	**1.2**	**0.9**
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		**0.9**	**0.9**	**1.3**	**1.2**	**1.1**	**1.5**	**1.1**

***From 2013-2017 to 2018-2022*:** **Habitat type / group**	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	0	0	0.5	0.3	0.3	0	0.3
Subalpine birch forests	9040	0						0
Boreal coniferous and deciduous forests		**0.3**	**1.2**	**1.8**	**0.8**	**1.3**	**2.5**	**1.2**
Primary successional forests on land upheaval coast	9030			4.0		4.0		4.0

Alluvial deciduous forests	91E0			0	0	0		0
Deciduous swamp forests	9080			0	0	0	0	0
Coniferous forests on glaciofluvial eskers	9060			0		0		0
Herb-rich Norway spruce forests	9050	0	0	3.8	0	2.1		1.4
Western taiga, total	9010	0.3	1.2	1.6	0.9	1.3	2.9	1.1
, stand-replacing disturbance*	9010	-	0	0	-	0	-	0
, swamp forests	9010	0	0	0	0	0	-	0
, dry, poor pine forests	9010	-	-	-	-	-	-	-
, deciduous forests	9010	-	-	-	-	-	-	-
Continental (temperate) broad-leaved forest				**0**	**0.6**	**0.6**	**0**	**0.3**
Nutrient rich beech forests	9130				0	0	0	0
Nutrient poor beech forests	9110				0	0	0	0
Nutrient rich oak forests	9160				0	0	0	0
Nutrient poor oak forests	9190				0	0	0	0
Broad-leaved forests in screes	9180				0	0		0
Mixed broad-leaved forests	9020			0	2.0	1.8	0	1.7
Riparian, mixed broad-leaved forests	91F0							
All forest land including 9040		**0.3**	**1.1**	**1.5**	**0.6**	**1.1**	**0.4**	**0.9**
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		**0.3**	**1.2**	**1.8**	**0.8**	**1.3**	**0.5**	**1.1**

Table 2.5. The proportion of total site-type area that is classified as forest habitat types on productive forest land outside formally protected areas, shown across biogeographical regions, subregions, and in total (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). The site-type areas are ten-year average area estimates based on the National Forest Inventory (NFI) 2009-2018 (Roberge & Lindberg 2020). The current areas of habitat types are five-year average area estimates based on the NFI 2019-2023, using their criteria for sample-plot classification (SLU 2019). The taiga subtype stand-placing disturbance (marked with “*”) includes forests recently impacted by fire, storms or flooding. Its proportion is measured relative to the approximate quarter of 9010’s total site-type area expected to be shaped by even-aged dynamics over the course of 100+ years following stand-replacing disturbances in naturally dynamic boreal forest landscapes (Berglund & Kuuluvainen 2021). An unknown proportion of the respective areas are voluntarily protected from forestry, implying that the actual unprotected proportion may be somewhat different. Estimates for rare habitat types (see **Appendix 2 Table 2.1**) are subject to large uncertainties.

Habitat type / group	**EU code**	**ALP**	NWB	SEB	BN	**BOR**	**CON**	**Total**
Bog woodlands	91D0	23	20	21	20	20	22	20
Subalpine birch forests	9040	23	0			0		18
Boreal coniferous and deciduous forests		**28**	**7**	**4**	**3**	**4**	**2**	**5**
Primary successional forests on land upheaval coast	9030			26	0	24		24
Alluvial deciduous forests	91E0	0	21	0	45	29	135	33
Deciduous swamp forests	9080	0	1	2	8	3	40	5
Coniferous forests on glaciofluvial eskers	9060		0	35	0	5		5
Herb-rich Norway spruce forests	9050	29	9	4	1	4		6
Western taiga, total	9010	28	7	4	3	5	0	5
, stand-replacing disturbance*	9010	0.3	0.5	0.5	0.1	0.4	0.4	0.4
, swamp forests	9010	0	2	0.4	0.2	0.7	0	0.7
, dry, poor pine forests	9010	-	-	-	-	-		-
, deciduous forests	9010	-	-	-	-	-		-
Continental (temperate) broad-leaved forest				**0**	**12**	**11**	**3**	**8**
Nutrient rich beech forests	9130				13	13	5	6
Nutrient poor beech forests	9110				10	10	1	4
Nutrient rich oak forests	9160				21	21	7	17
Nutrient poor oak forests	9190			0	2	2	0	1
Broad-leaved forests in screes	9180				0	0		0
Mixed broad-leaved forests	9020			0	6	6	3	5
Riparian, mixed broad-leaved forests	91F0	28	7	4	3	5	0	5
All forest land including 9040		**27**	**8**	**5**	**5**	**6**	**4**	**6**
Forests on mineral soils (not 91D0) below the subalpine birch forest zone (not 9040)		**28**	**7**	**4**	**3**	**5**	**2**	**5**

Table 2.6. Empirical nitrogen (N) critical loads estimated by Bobbink et al. (2022) for habitats classified according to the European Nature Information System (EUNIS) and their relationships with the habitat types under the Habitats Directive.

Ecosystem type	**EUNIS habitats**	**Habitats Directive habitat types**	**Emprical N critical load (kg N ha^{-1} yr^{-1})**
Broadleaved deciduous forest	T1	-	10-15
Fagus forest on non-acid and acid soils	T17, T18	9110, 9130	10-15
Acidophilous *Quercus* forest	T1B	9190	10-15
Carpinus and *Quercus* mesic deciduous forest	T1E	9020, 9160	15-20
Coniferous forests	T3	-	3-15
Dark taiga	T3F	9050, 9010*	3-5
Pinus sylvestris light taiga	T3G	9010, 9060	2-5
Mires and bogs			
Raised and blanket bogs	Q1	7110, 7130	5-10
Valley mires, poor fens and transition mires	Q2	7140	5-15

* denotes a limited correspondence between 9010 and the EUNIS habitat

Appendix 3. Figures

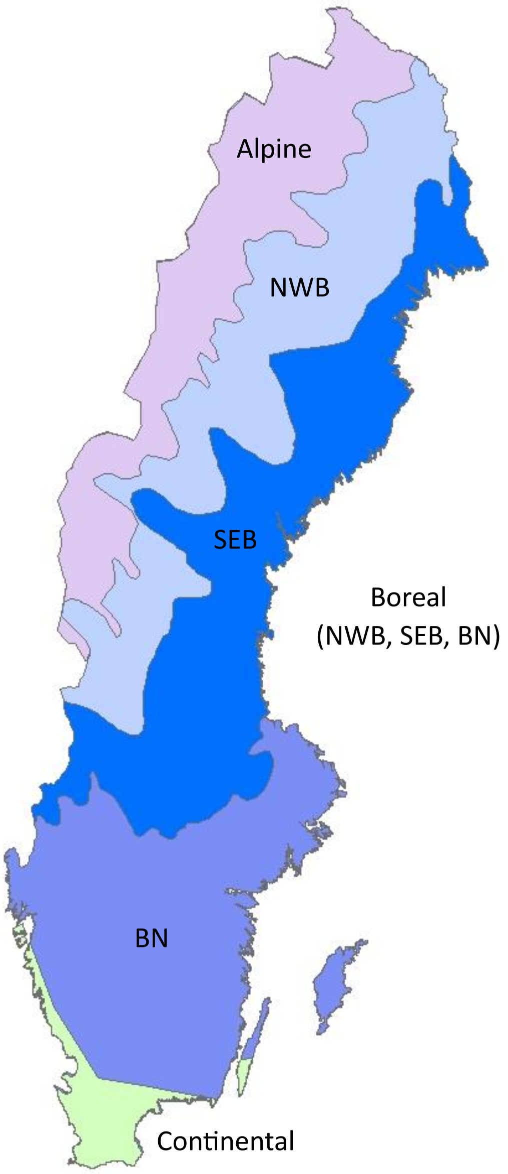

Figure 3.1. The regional division follows the EU's three terrestrial biogeographical regions – Alpine, Boreal and Continental (EEA 2002). The Boreal region is further divided into three subregions: North-western Boreal (NWB), South-eastern Boreal (SEB) and Boreo-nemoral (BN; synonymous with Hemi-boreal) according to Ahti et al. (1968).

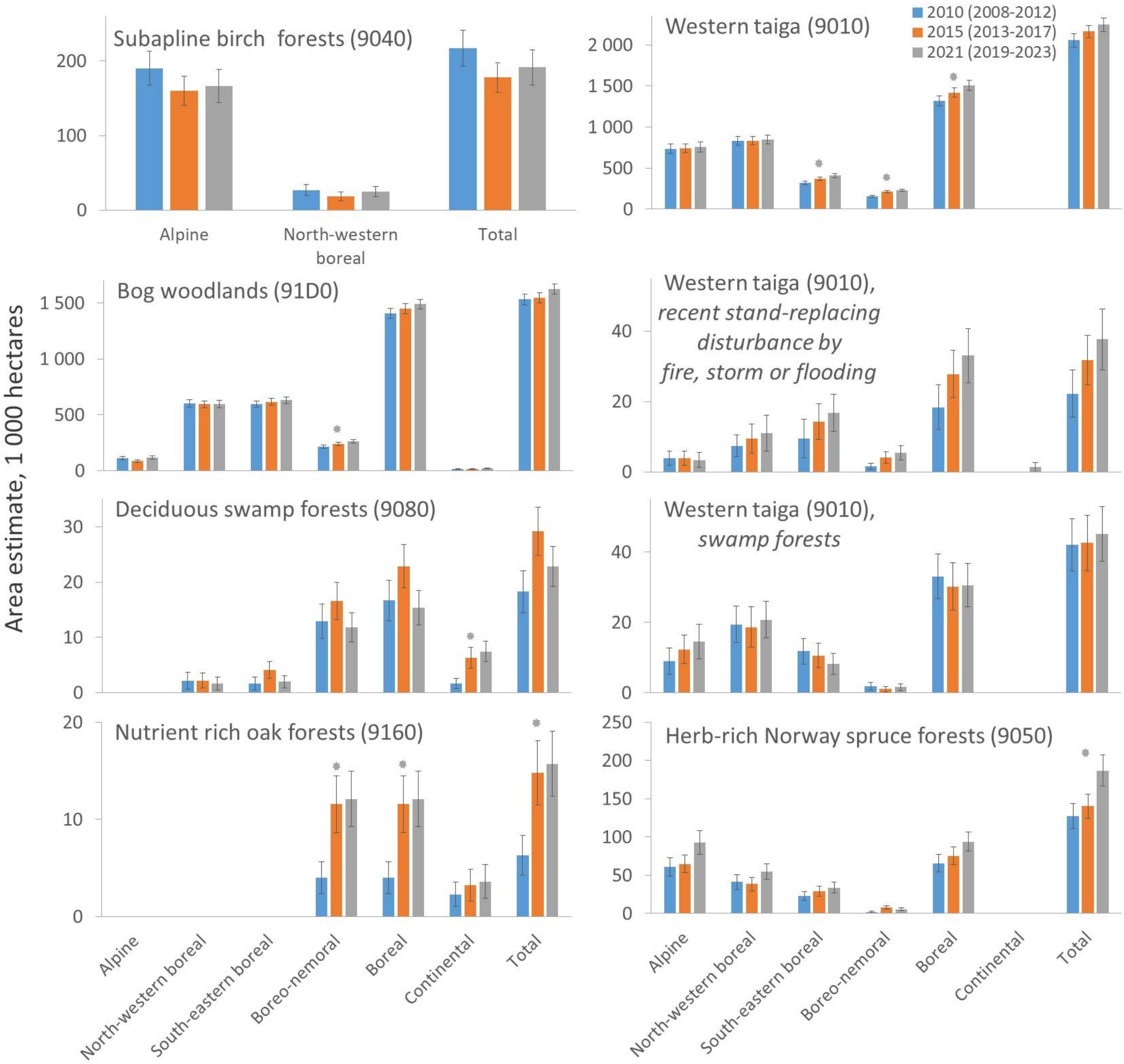

Figure 3.2. Area estimates of selected forest habitat types and Western taiga (9010) subtypes on forest land across different regions, limited to those with a relative standard error ≤25% for the estimate from the last five-year inventory period at national level (Total). Estimates are derived from National Forest Inventory data using their criteria for sample-plot classification (SLU 2019) and spanning three non-overlapping five-year inventory periods with mid years 2010, 2015 and 2021. Standard errors are indicated, and significant differences (increases) in area estimates between the first (2010) and the last period (2021) are marked with a grey asterisk (*). Estimates for the last period (2021) are detailed in **Appendix 2 Table 2.1.**

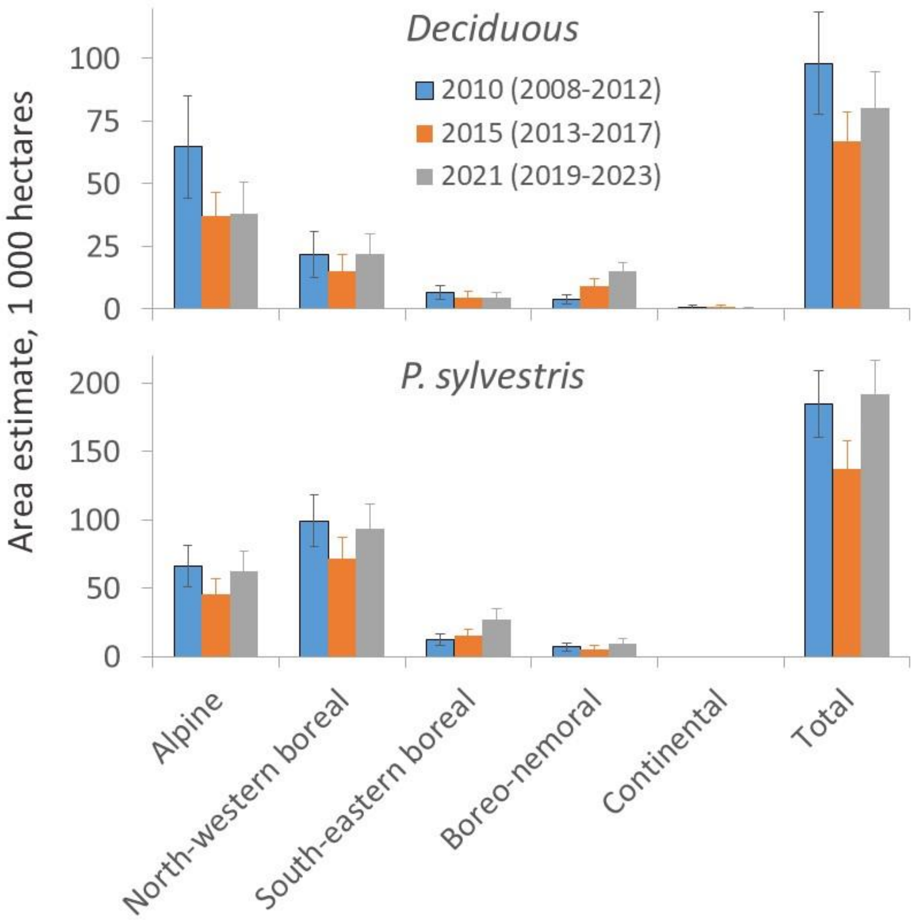

Figure 3.3. Area estimates of two western taiga (9010) subtypes on forest land across different regions: (top) those dominated by deciduous tree species and (bottom) ground lichen-abundant *Pinus sylvestris* forests. Estimates are derived from National Forest Inventory data using their criteria for sample-plot classification (SLU 2019) and spanning three non-overlapping five-year inventory periods with mid years 2010, 2015 and 2021. Standard errors are indicated. No significant differences in area estimates between the first (2010) and the last period (2021) were found.

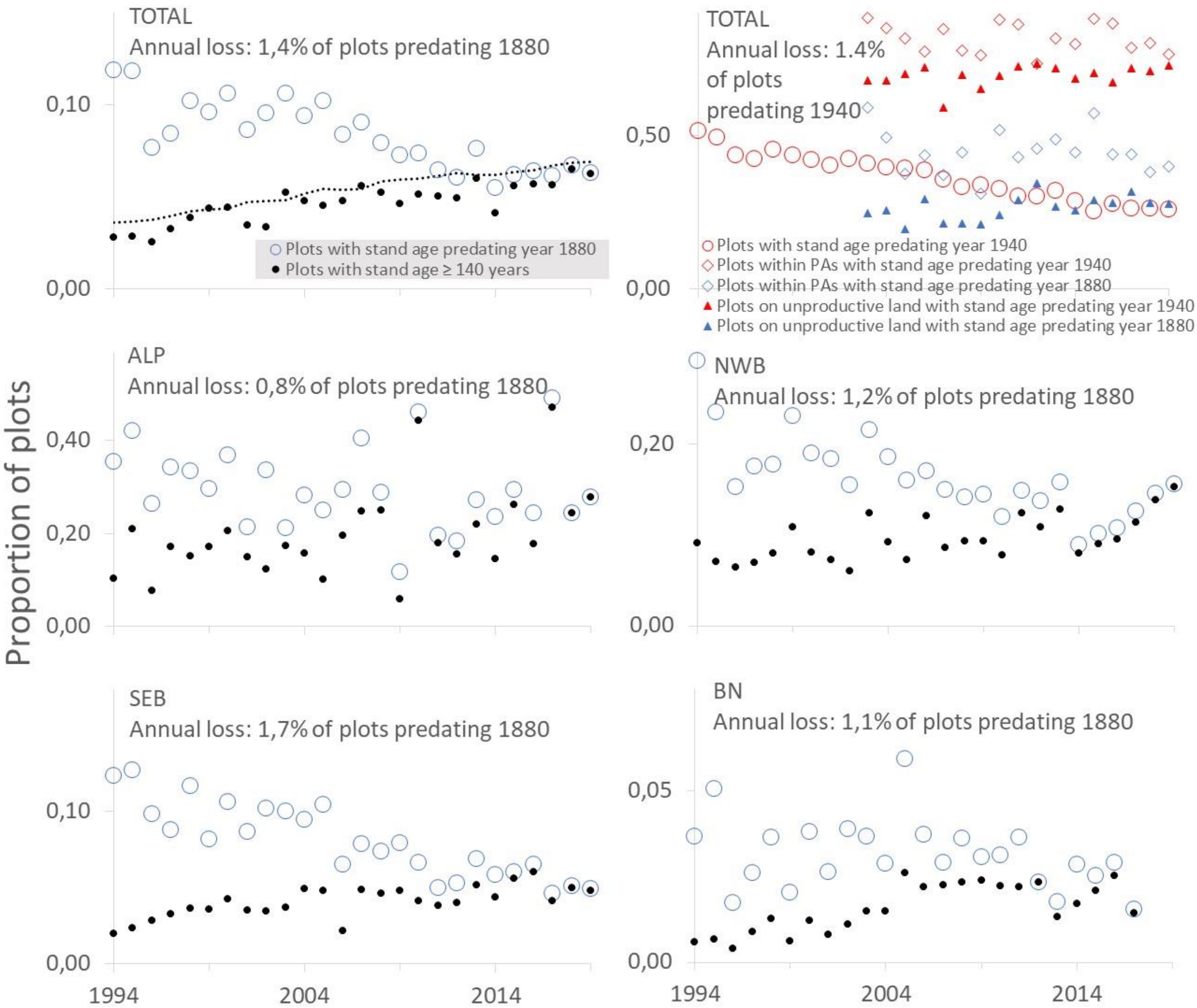

Figure 3.4. Estimated annual loss due to clear-cutting of temporary sample plots classified as forests with stand ages predating 1880 – an indicator for forest habitat types such as western taiga (9010) – and the change in their proportion over time (1996-2019) on productive forest land outside formally protected areas (based on data from Ahlström et al. 2022). Results are presented both in total (for indicators predating 1880 and 1940) and across biogeographical regions and subregions (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; **Appendix 3 Figure 3.1**). Each graph presents two indicators: (1) the proportion of plots classified as forests with stand ages predating 1880 (or 1940) and (2) the proportion of plots classified as forests with stand ages ≥ 140 years. Both indicators are based on the stand ages determined for the plots. Indicator (1) represents establishment-year-based criteria for 'natural forests' or forest that have likely never been clear-cut (Storaunet & Rolstad 2020; Ahlström et al. 2022). Indicator (2) reflects achieved-stand-age-based criteria for 'old forests' (Nilsson & Dahlberg 2023; SLU 2024b) or 'habitat type' classifications (SLU 2019; **Appendix 2 Table 2.1**; **Appendix 3 Figure 3.2**). Since plots meeting indicator (2) also meet criteria for indicator (1), they are included within indicator (1). Thus, the proportion of indicator (2) represent its share of indicator (1) throughout the time series 1996-2019. The proportion of these indicators are currently the same but varies significantly across regions and subregions. Indicator (1) has decreased overall, primarily in the northwestern and southeastern boreal regions, while indicator (2) shows an opposite trend. In the top-left graph, the proportion of indicator (2) based on National Forest Inventory area estimates (SLU 2024b) is shown with a dashed line. In the top-right graph, the proportions of plots predating 1880 and 1940 within protected areas (PAs) and on unproductive forest land are shown as scatter points for comparison. Note that the scale of the y-axis differs significantly between the graphs. Preliminary results from Berglund (In prep.).

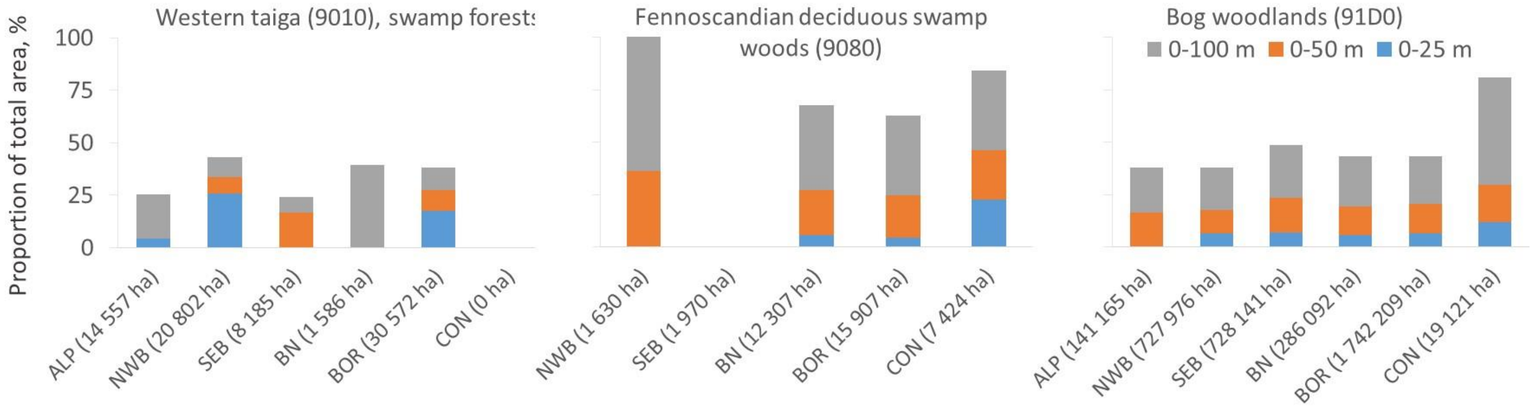

Figure 3.5. Estimated proportion of area (hectares in brackets; ha) at different distances from ditches outlined in a digital map (Laudon et al. 2022) across biogeographical regions and boreal subregions (ALP: Alpine; NWB: North-western boreal; SEB: South-eastern boreal; BN: Boreo-nemoral; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**). Estimates are based on National Forest Inventory sample plot data on all land, including formally protected areas and the alpine mountain zone, from the five-year inventory period 2019-2023, using NFI criteria for classifying plots as habitat types (SLU 2019). The digital map includes both false ditches and fails to detect true ditches, leading to an overestimation of the area within 100 meters of ditches in the Alpine region - though to a lesser extent in the Boreal region – and an underestimation in the Continental region, particularly for 91D0.

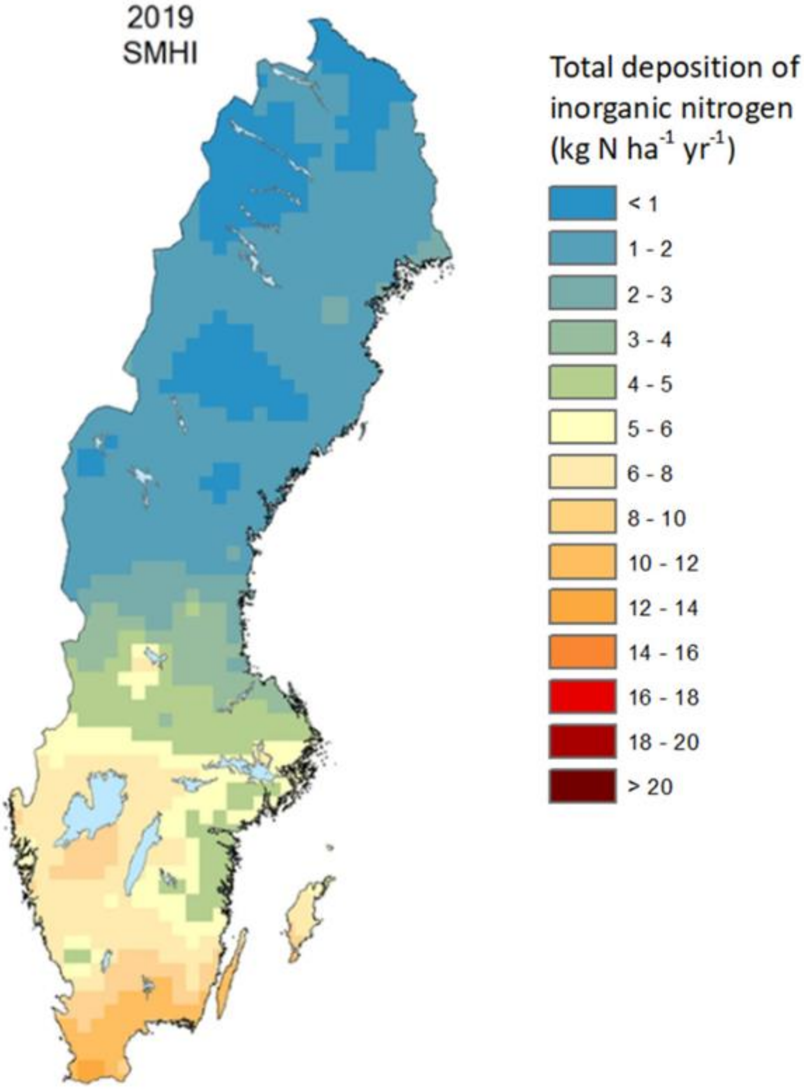

Figure 3.6. Nitrogen deposition estimates for year 2019 based on a modelled approach (MATCH model) from the Swedish National Environmental Monitoring Programme. The figure is adapted from Karlsson et al. (2022).

Appendix 4. Overview of assessments

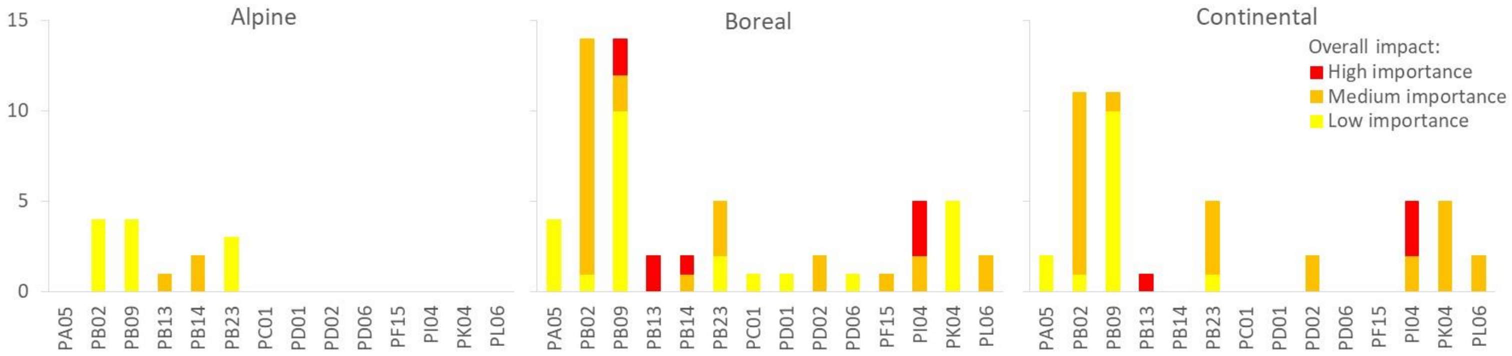

Figure 4.1. Number of assessments by overall impact, pressure code and biogeographical region. The 'overall impact' is derived from the combination of 'scope' and 'influence' assessments. Detail descriptions of 'scope', 'influence' and 'overall impact' – along with the names and definitions of individual pressures – are provided in the respective sections of this report. A summary overview is available in **Appendix 4 Table 4.1**.

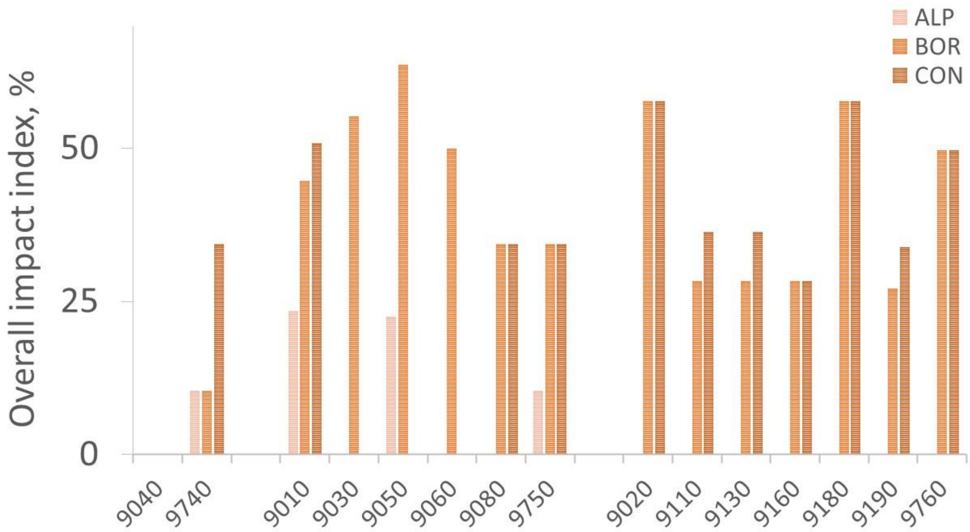

Figure 4.2. The overall impact index (OI) of pressures affecting a forest habitat type within a region (ALP: Alpine; BOR: Boreal; CON: Continental; see **Appendix 3 Figure 3.1**). The OI is a composite metric that summarizes the cumulative impact of pressures on a habitat type in a specific region. It is calculated based on the assessed 'scope' and 'influence' of each pressure: 'Scope' (S): minority (<50%) → S = 0.25; majority (50–90%) → S = 0.75; whole (>90%) → S = 0.95. 'Influence' (I): low → I = 0.1; medium → I = 0.5; high → I = 1. For each pressure *i*, the individual 'overall impact' is calculated as: $IA_i = S_i \times I_i$. The weighted average (WA) across all *n* pressures is: $WA = \frac{\sum_{i=1}^{n}(IA_i^2)}{\sum_{i=1}^{n} IA_i}$. The overall impact index (OI) is then computed as: $OI = WA + \left(\frac{\sum_{i=1}^{n} IA_i}{19} \times (1 - WA)\right)$. This normalization accounts for the theoretical maximum cumulative impact (19), assuming 20 pressures each with maximum 'scope' (0.95) and 'influence' (1). The index ranges from 0% (no pressures) to 100% (maximum cumulative impact).

Table 4.1. Assessments of pressures on forest habitat types (names listed in **Appendix 2 Table 2.1**) across biogeographical regions (ALP: Alpine; BOR: Boreal; CON: Continental; **Appendix 3 Figure 3.1**).

Sector & pressure code	Habitat code	Region	Timing	Scope	Influence	Impact
PA Agriculture						
PA05	9050	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PA05	9060	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PA05	9160	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PA05	9160	CON	ongoing and likely to be in the future	minority <50%	Medium	Low
PA05	9190	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PA05	9190	CON	ongoing and likely to be in the future	minority <50%	Medium	Low
PB Forestry						
PB02	9010	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	9010	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9010	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9020	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9020	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9030	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9050	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	9050	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9060	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9080	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9080	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9110	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9110	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9130	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9130	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9160	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9160	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9180	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9180	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9190	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	9190	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	91D0	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	91D0	BOR	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	91D0	CON	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	91E0	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB02	91E0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	91E0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	91F0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB02	91F0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB09	9010	ALP	ongoing and likely to be in the future	minority <50%	Medium	Low
PB09	9010	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PB09	9010	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PB09	9020	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9020	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9030	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB09	9050	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	9050	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB09	9060	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PB09	9080	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9080	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9110	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low

PB09	9110	CON	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	9130	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9130	CON	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	9160	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9160	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9180	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9180	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	9190	BOR	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	9190	CON	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	91D0	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	91D0	BOR	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	91D0	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	91E0	ALP	ongoing and likely to be in the future	minority <50%	Low	Low
PB09	91E0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	91E0	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	91F0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB09	91F0	CON	ongoing and likely to be in the future	majority 50 – 90%	Low	Low
PB13	9010	ALP	ongoing and likely to be in the future	minority <50%	High	Medium
PB13	9010	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB13	9010	CON	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB13	9060	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB14	9010	ALP	ongoing and likely to be in the future	minority <50%	High	Medium
PB14	9010	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PB14	9050	ALP	ongoing and likely to be in the future	minority <50%	High	Medium
PB14	9050	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PB23	9010	ALP	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	9010	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	9010	CON	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	9080	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	9080	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	91D0	ALP	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	91D0	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	91D0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	91E0	ALP	ongoing and likely to be in the future	minority <50%	Medium	Low
PB23	91E0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	91E0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	91F0	BOR	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PB23	91F0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PC Extraction of resources						
PC01	9010	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PD Energy production						
PD01	9010	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PD02	91E0	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PD02	91E0	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PD02	91F0	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PD02	91F0	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PD06	9010	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
PF Commercial, industrial and recreational infrastructures and areas						
PF15	9030	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PI Alien and problematic species						
PI04	9020	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PI04	9020	CON	ongoing and likely to be in the future	majority 50 – 90%	High	High
PI04	9080	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PI04	9080	CON	ongoing and likely to be in the future	minority <50%	High	Medium

PI04	9180	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PI04	9180	CON	ongoing and likely to be in the future	majority 50 – 90%	High	High
PI04	91E0	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PI04	91E0	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PI04	91F0	BOR	ongoing and likely to be in the future	majority 50 – 90%	High	High
PI04	91F0	CON	ongoing and likely to be in the future	majority 50 – 90%	High	High
PK Mixed sources pollution						
NY! PK04	9010	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
NY! PK04	9010	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
NY! PK04	9060	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
NY! PK04	9110	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
NY! PK04	9110	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
NY! PK04	9130	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
NY! PK04	9130	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
NY! PK04	9190	BOR	ongoing and likely to be in the future	minority <50%	Medium	Low
NY! PK04	9190	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
NY! PK04	91D0	CON	ongoing and likely to be in the future	majority 50 – 90%	Medium	Medium
PL Human-induced changes in water regimes						
PL06	91E0	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PL06	91E0	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PL06	91F0	BOR	ongoing and likely to be in the future	minority <50%	High	Medium
PL06	91F0	CON	ongoing and likely to be in the future	minority <50%	High	Medium
PX Unknown/Not applicable						
PX05	9040	ALP	(tom)	Not applicable	Not applicable	