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| **SLU Swedish Species Information Centre** Håkan Berglund | 12/12/2022 |

Applying the new stepwise approach for setting reference values to forest habitat types in Sweden

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# Setting favourable reference values (example)

The objective of this example is to describe the logics behind how the stepwise approach for setting FRVs is applied for FRAs of forest types registered in Sweden (SE). The example has been developed based on the information reported by Sweden during the first and second reporting round (2008-2012; [link](https://bd.eionet.europa.eu/activities/Reporting/Article_17/Reports_2013) to webpage). The final FRVs for the period 2013-2018 was reported by SE 2019.

## Western Taiga 9010

### **Step 1.** Data and information gathered

**(i) Structure, functions and typical species.** – The Western Taiga 9010 covers a range of site types (poor to rich, mesic to moist) on mineral soils in mainly the alpine and boreal regions of Sweden. Varying disturbance dynamics and different species composition and forest structure (pine, spruce, deciduous and mixed forests) are typical. Primarily fine-scale disturbances and spruce-dominated forests are characteristic in moist areas due to lasting or at least periodic (annual) high ground water table (Hörnberg et al. 1995, 1997[[1]](#footnote-1)). Stand-scale cohort dynamics due to frequent low-intensive fires or succession after high-intensive fires that result in various forest types are likely more important on particularly dry to mesic sites types with heath vegetation (drawf shrubs), but also on mesic to moist site types with graminoids and herbs. Cohort dynamics and pine-dominated forests are developing on poor and dry site types due to frequent low-intensity fires (cf. Aakala & kuuluvainen 2011[[2]](#footnote-2); Kuuluvainen et al. 2017[[3]](#footnote-3) and references therein).

**(ii) Current area cover.** – The current value of the area cover (CV) was estimated based on data collected by the national forest inventory (NFI; **Table 1**). The inventory of systematically distributed sample plots clustered within so called tracts across the whole country forms the basis for area estimates at the national and regional levels[[4]](#footnote-4). The estimates are based on data collected during five years (2008-2012) while roughly a fifth of all plots are inventoried every year. The inventory of terrestrial habitat types started in 2008. Forests classified as habitat types of the EU Directive need to cover a minimum area (≥0.25 hectares for habitats on mineral soils), have a canopy cover of trees ≥10% and fulfil a set of minimum criteria of naturalness, i.e. forests should have been naturally regenerated, not extensively affected by forestry during the last 25 years, and exhibit natural stand structure characteristics (Gardfjell & Hagner 2016[[5]](#footnote-5)). The latter implies that the stand age is at least 40 (or in some cases 20) years higher than the lowest recommended age of clear cutting, or that natural disturbances or management mimicking such disturbances affect the stand structure.

**Historical trends.** – Most pre-industrial landscapes of Sweden were characterized by extensive areas of natural forests affected by disturbances such as forest fires and low-intensive agrarian human forest use. Major changes in forest structure and functions occurred mainly during the last few centuries due to large-scale industrial forest use. The industrialization and an increasing demand for timber during mainly in the 19-20th centuries initiated an early phase of gradual intensified forest exploitations. A timber frontier due to selective logging of large timber trees advanced northward and inland (Östlund 1993[[6]](#footnote-6)). Remnant forest stands became sparser and contained fewer large trees than before the exploitation phase (Östlund et al. 1997[[7]](#footnote-7)). Natural disturbances such as forest fires were suppressed (Niklasson & Granström 2000[[8]](#footnote-8); Hellberg et al. 2004[[9]](#footnote-9)). Still, largely unaffected forests remained in the most remote and sparsely populated areas in the inland and northern regions. In the 1950s, modern clear-cutting forestry were introduced resulting in rationalized forest structure; a successive transformation towards monocultures and even-aged production forests (Östlund et al. 1997; Linder & Östlund 1998[[10]](#footnote-10)). Coniferous species (*Pinus sylvestris* and *Picea abies*) were promoted. Cleaning, selective thinning and herbicide treatments were used to remove deciduous trees and other species with low economical values.

Thus, the pre-industrial forest landscapes are important references for conservation (Angelstam & Andersson 2001[[11]](#footnote-11), Löhmus et al. 2004[[12]](#footnote-12)). In most parts of the boreal region, the majority (90-95%) of natural forests, including habitat types such as Western Taiga 9010, have been lost and fundamentally transformed in terms of structure and functions (Linder & Östlund 1998; Axelsson et al. 2001[[13]](#footnote-13)). Some specific habitat subtypes have been more or less eradicated; e.g. early successional stages (following fire or flooding) with large amounts of dead wood, successional deciduous forests and multi-cohort old-growth pine forests.

**Recent trends.** – The inventory of terrestrial habitat types has been done only at one point in time since the start in 2008. The trend during the period 2001-2012 can therefore not be quantified for individual habitat types due to the lack of re-inventory data. The trend is therefore assessed by extrapolating overall trends revealed by national statistics, research studies or other information to the habitat type and biogeographical region concerned. Thus, the overall trends are assumed indicating the likely direction of the trend of the habitat type.

The alpine region have the shortest and least intense history of industrial forest use. The majority of forests that currently are clear cut are likely to still be in a relatively natural state while they not or to a small extent have been affected by modern forestry before. Thus, the area of clear cut forests in the alpine region may indicate the likely regional loss of forest habitat types such as the Western Taiga 9010. The area of subalpine forests notified for clear cutting in the years 2005 to 2011 corresponds to about 2,000 to 3,000 hectares per year (Statistical Yearbook of Forestry 2012[[14]](#footnote-14)), which sum up to about 45,000 to 50,000 hectares in total since 1995. Further, the Swedish Forest Agency’s data ([link](http://skogsdataportalen.skogsstyrelsen.se/Skogsdataportalen/)) indicate that 70,000 hectares of forest were clear cut in the alpine region of the counties Norrbotten, Västerbotten and Jämtland during 2001-2012, corresponding to the cutting of 5,000 to 6,000 hectares per year. Based on this information, the total loss of Western Taiga 9010 since 1995 is assumed to be around 50,000 hectares.

The area of clear cut forests cannot readily be used as indicator of recent area loss in the boreal region due to the more complex and varying history of industrial forest use. Most forests clear cut forests have already been managed and lack the natural structure and functions characterizing Western Taiga 9010. Data on recent trends in the boreal region are therefore generally lacking. To assess the likely recent trend, data from permanent plots of NFI were analyzed. Plots visited during the previous five-year period (2003-2007) were classified to Western Taiga 9010 based on collected field data. The number of plots were compared between the two periods (2003-2007 and 2008-2012). The results showed that 43 / (43 +482) = 8.2% of the permanent plots outside formally protected areas was clear cut during the last five years (no plot was cut in protected areas that was used as controls). Thus, 1.7% of the permanent sample plots located outside reserves was clear cut every year.

### **Step 2.** Applying the reference-based approach (2a) for setting the FRAs

The reference-based approach (2a) is chosen for setting the FRAs of the Western Taiga 9010 in the biogeographical regions concerned.

The FRAs are assessed in the same way as the minimum forest reserve needs have been estimated in Sweden (Angelstam & Andersson 2001). The area needed – the FRA – is estimated based assumptions of critical habitat threshold values for metapopulation persistence and the loss of specialist species. Both theoretic models and empirical data show that the effects of habitat loss on extinction risks at the landscape level varies among species, but are realized when 10-50% of the original habitat cover remains (Andrén 1994[[15]](#footnote-15); Angelstam et al. 2004[[16]](#footnote-16)). A general threshold value of 20% of the original (historical) area cover is therefore used in the assessments of the FRAs. Note that the use of such threshold values implies that the original habitat type is assumed completely incompatible with forests managed by clear-cutting forestry. The threshold value and the FRAs may thus be lower if the original habitat type are found only partly management compatible. However, the management compatibility of different subtypes and successional stages of the habitat type is not assessed and taken into account in the calculations presented below.

In the alpine region, the current area cover of Western Taiga 9010 still comprise a significant proportion (38%) of the forest land area (**Table 1**). The FRA is therefore set equal to the area cover in 1995, the year of entry into force of the Directive. It is estimated to be 790,000 hectares while the area has most likely decreased by some 50,000 hectares (ca 7%) due to clear cutting since 1995 (details given above).

In the boreal region, the current area cover is insignificant (5%). The FRA is therefore set equal to a value that corresponds to a general threshold value of 20% of the original (explained above; Andrén 1994; Angelstam et al. 2004). A rough estimate of the FRA is obtained while assuming that the current area cover (1.33 million hectares) is an indicator of the habitat type (including subtypes) and that the area have decreased by 90-95% (on average 92.5%) compared to pre-industrial landscapes due to exploitations and forestry, but also cessation of disturbance dynamics, traditional cultural usage and / or gradual transition to other habitat or stand types (Linder & Östlund 1998; Axelsson et al. 2001). The FRA is thereby estimated to be 20%\*1.33/(100-92.5%) million hectares, which can be rounded to 3.5 million hectares.

In the continental region, the current area cover is insignificant (1%). However, only the most southern outposts of the Western Taiga 9010 are expected to expand into this region. The FRA is therefore set equal to the area cover in 1995, the year of entry into force of the Directive, estimated based on NFI data. The estimated area cover is small (8,500 hectares) and highly uncertain due to limited data.

**Table 1.** Estimated current area cover (CV), trend and favourable reference area (FRA) of the Western Taiga 9010 in different biogeographical regions of Sweden. Areas are given in hectares (ha) and direction of trends are indicated (“+” increasing; “-“ decreasing; “=” stable; “X”: unknown). The coefficient of variation (cv; %) is given for the estimated total current area cover. The share (%) indicate the proportion of the total forest land area on mineral soils (1,688,000, 20,784,000 and 486,000 hectares) within the respective regions.

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| Code | Factor | Alpine | Boreal | Continental | Total | cv |
| 9010 | CV (ha) | 737,000\* | 1,330,000\*\* | 4,400\*\* | 2 070 000 | 4% |
|  | CV share (%) | 38% | 5% | 1% |  |  |
|  | Trend (+/-/=/X) | - | - | X |  |  |
|  | FRA (ha) | 790,000 | 3,500,000 | 8,500 |  |  |
|  | FRA share (%) | 47% | 17% | 2% |  |  |

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