

Hardenbol A.A., Ørka H.O., Gobakken T., Kostensalo J. (2026). Optimising rare tree species detection for large-area mapping: a case study on European aspen (*Populus tremula*). *Silva Fennica* vol. 60 no. 3 article id 26012. <https://doi.org/10.14214/sf.26012>

## Supplementary file S4

Additional data on the ten previous, re-analysed publications on tree species classification from remotely sensed data in Fennoscandia where European aspen was included as a class. For comparison, our study is displayed in red.

| Author(s)                    | RS data                                           | Statistical method               | Study location | Commentary                                                                                                                                   |
|------------------------------|---------------------------------------------------|----------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Erikson 2004</b>          | Airborne CIR imagery                              | Custom algorithm                 | Sweden         | Instead of using field data, images were interpreted manually by the author to determine the tree species and delineate the crowns.          |
| <b>Kulikova et al. 2007</b>  | Airborne CIR imagery                              | Support vector machine           | Sweden         | Crowns were delineated manually.                                                                                                             |
| <b>Ørka et al. 2007</b>      | ALS (5 points m <sup>-2</sup> )                   | Linear discriminant analysis     | Norway         | Features were limited to just six intensity-based features.                                                                                  |
| <b>Viinikka et al. 2020</b>  | ALS (10 points m <sup>-2</sup> ) + HS             | Support vector machine           | Finland        | Various statistical methods were tested of which support vector machine proved best                                                          |
| <b>Mäyrä et al. 2021</b>     | ALS (10 points m <sup>-2</sup> ) + HS             | 3D-convolutional neural networks | Finland        | Various statistical methods were tested of which 3D-convolutional neural networks proved best                                                |
| <b>Kuzmin et al. 2021</b>    | Drone MS                                          | Support vector machine           | Finland        | Multispectral imagery barely improved the results over RGB imagery for aspen classification.                                                 |
| <b>Hardenbol et al. 2021</b> | Drone MS                                          | Linear discriminant analysis     | Finland        | Selected the case from 13 May which was optimized for aspen classification with manual segmentation. All trees reached the canopy.           |
| <b>Korpela et al. 2022</b>   | Full-waveform ALS (10–20 points m <sup>-2</sup> ) | Quadratic discriminant analysis  | Finland        | Part of the data was acquired when aspen just reached full-leaf state in early summer. All aspen were dominant trees.                        |
| <b>Bjørnbet 2024</b>         | ALS (5–6 points m <sup>-2</sup> ) + MS            | Random forest                    | Norway         | Focused on classifying retention trees rather than trees in intact forests.                                                                  |
| <b>Toivonen et al. 2024</b>  | ALS (7 points m <sup>-2</sup> ) + MS              | Random forest with SMOTE         | Finland        | Selected the case where a DBH limit of 22 cm was set for aspen, but not other trees, in which case aspen only made up ca. 0.1% of the trees. |
| <b>This work</b>             | ALS (250 points m <sup>-2</sup> ) + MS            | Random forest with SMOTE         | Finland        | -                                                                                                                                            |

Abbreviations: ALS=Airborne laser scanning, CIR=Colour-infrared, HS=Hyperspectral imagery, MS=Multispectral imagery, and RS=Remote sensing