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## Abstract

Rapid changes in the forest structure due to logging strongly affect lichen vegetation and can exceed tolerance of many organisms while being beneficial to others. *Cladonia botrytes* was supposed to be obligately lignicolous and having a high portion of the occurrences on stumps on clear-cuts. The aim of this study was therefore to clarify the ecology of *Cladonia botrytes* and especially how frequently it occurs on soil in clear-cuts. Scots pine *Pinus sylvestris* clear-cuts aged 10-12 years old were examined for the abundance of the species on stumps and exposed soil in three provinces of Sweden – Uppland, Dalarna and Västerbotten. *C. botrytes* was present on the soil in all the regions on two distinct substrates: humus on the ground and on boulders. There was a significant regional difference in the distribution of the lichen on the ground and on boulders ($p < 0.001$), indicating a trend of increasing abundance towards the north. Regional variation for the occurrence of the lichen on the stumps was significant ($p < 0.001$); however the distribution among the regions was more homogenous and did not have a distinct northward trend. Canopy cover of the new tree generation influenced the abundance of the lichen on all the substrates: ground, boulders and stumps. It was found that the species prefer dry conditions as it was less abundant in the plots with wet habitats. As for the occurrences on the stumps, it was found that stump size variables (height and surface area) have an effect on the presence of the lichen yet the relationship behind that is unknown. The species is positively affected by the logging activities as it provides short-term habitat. Due to the abundant presence of the lichen on soil, change in the classification as obligatory lignicolous should be considered.



Key words: logging, stumps, habitat, species occurrence

# Popular summary

Rapid changes in the forest structure due to logging activities can strongly affect the forest vegetation. Modern practice of clear-cutting, where almost no standing trees are left, clearly represents a different environment from the original forest cover, having more direct solar radiation, higher precipitation rates and amplified temperature fluctuations. These sudden dramatic changes and hostile new environment can exceed the tolerance of many organisms, while being beneficial to the ones that can adapt to them. Lichens are a group of symbiotic organisms that contain algal and fungal cells, which allows them to colonize and thrive in habitats where they could not survive separately. Response to felling can be very diverse among different lichen species, resulting in dramatic physiological changes or even extinction from the habitat. However, some species can manage to thrive in the habitat created by logging. Felling creates heterogeneity and the habitat complexity that allows occurrence of the new substrate for lichens, such as stumps. Stumps and other felling residues are important for the recovery of the species as they allow lichens to refugee while the original habitat quality is restored. Stumps can be colonized both by generalist lichen species and specialist, wood dependant, lichen species. However the reasons for wood affinity are not yet fully understood.

This study was done on lichen species *Cladonia botrytes*, also commonly known as the stump lichen. Despite the fact, that the species has been known to be confined to decaying or rotten wood, several findings indicate its occurrence on the soil substrate. This study aims were to clarify the ecology of *C. botrytes*. 180 plots in 36 clear-cuts located on the gradient from the central to northern Sweden were examined for the presence of *C. botrytes* on the stumps and soil, along with several ecological variables in attempt to explain the factors preceding the occurrence of the species.

*C. botrytes* was found to be present on the soil with an increasing abundance towards the north. As it is no longer confined to decaying wood as its only substrate change in the classification of the species is recommended. Apart from the substrate preference other factors were found to be significant for the occurrence of the lichen. Canopy cover of the new tree generation and ground moisture were found to be influential for the presence of the lichen, however there is no direct and clear relationship between these factors and abundance of *C. botrytes*. Same goes for the stump variables that were measured (stump surface area and height) in the field. Species occurrence is not directly connected to the size and height of the stump, although it is important for the presence of *C. botrytes*. Species abundance is a difficult matter affected by multiple variables with complex interactions, therefore making it hard to distinguish their direct influence.

*C. botrytes* is positively affected by the conditions created by clear-cutting as it assures long-term continuous supply of suitable habitat for colonization and allowes species to thrive. *C. botrytes* is a fast colonizer and can occur in natural habitats in similar conditions created by storms or forest fires. Despite the fact, that stumps are not naturally created substrate they host a large proportion of the species population. Therefore it is advised against stump harvest in the logging areas.

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# Introduction

*Effect of logging activities on the lichen vegetation*

Rapid changes in the forest structure due to logging can strongly affect lichen vegetation because of the altered local climate (Johansson 2008, Hauck 2011). Clear-cuts clearly represent a different environment from other forested areas in having more direct solar radiation, higher precipitation, higher evapotranspiration rates, and amplified daily fluctuation in moisture and temperature (Chen et al. 1993). These conditions exceed the tolerance of many boreal forest bryophytes and instead more desiccation-tolerant lichens increase (Rudolphi et al. 2011). High irradiation endorses the growth of forest lichens, as long as the water availability is high enough to support their metabolic activity (Rudolphi & Gustafsson 2011). However, acclimatisation to the open conditions can be rather drastic, resulting in the rapid re-organisation of structure and physiology of the lichen thalli in just a few months (Jairus et al. 2009).

Differences in species richness between managed and near-natural forests occur mainly due to variation within specific lichen subgroups and among lichens growing on specific substrates (Lommi et al. 2010). Coarse woody debris (CWD) is an example of such substrate, which in managed forests in Fennoscandia has declined with 90-98 % (Fridman & Walheim 2000, Linder & Östlund 1998). Overall increase in habitat complexity is created after felling, thus increasing the heterogeneity in the species composition (Bråkenhielm & Liu 1998). In fact, creation of new habitats during logging and succession might increase the species richness and density (Lommi et al. 2010).

Response to exposure after felling differs between lichen species with different morphology (Hedenås & Hedström 2007). Hedenäs & Ericson (2003) have shown that sorediate crustose lichens which partially lack a cortex are more sensitive to logging activities, while foliose cyanolichens thrive in selectively cut stands. In general lichen growth does not depend on forest conditions. However, lichen survival and vitality is reduced in clear-cuts, and negative effects increase with increasing logging severity (Johansson 2008). Most of the pre-logging lichen flora is epiphytic and thus recovery is limited by the lack of habitat, and the full re-establishment cannot be expected at least until the diversity of pre-logging habitat is restored (Kantvilas & Jarman 2006).

Species diversity decreases during the first five to eight years after felling, and then it starts to increase; *Cladina* (in this case *Cladonia arbuscula, C. rangiferina, C. stellaris*) thrive particularly on plots without felling residues while pioneer lichens do best on plots with slash (Bråkenhielm & Liu 1998). Overlap of stump/slash species is low, indicating the importance of these fractions for the recovery and the total lichen diversity (Caruso et al. 2008). Even though slash is more species dense than stumps in managed forests when equal volumes are compared (Kruys & Jonsson 1999, Caruso et al. 2008), the colonisable surface area of one single stump is, in general, greater and more heterogeneous than slash, and also better in retaining moisture (Botting & DeLong 2009) hence offering more diverse environment for lichens (Caruso et al. 2008). Stumps are colonised both by generalist lichen species and specialist, wood-dependant, lichen species. The number of lichen species increases with increasing stump height, which could be an effect of the drier microclimate of the cut surface due to greater light and wind exposure of the most elevated parts of the stump (Caruso & Rudolphi 2009).

The decay stage influences lichen species composition (Caruso & Rudolphi 2009) with the highest diversity of lichens at the intermediate to late stages of decay (Kryus & Johnson 1999, Humphrey et al. 2002). This peak seems to be the result of co-existence of early and late-successional species on dead wood (Rudolphi et al. 2011, Kushnevskaya et al. 2007, Caruso & Rudolphi 2009). Krüger & Daniels (1998) found that there is a succession of lichen species, progressing from normally epiphytic species to those that are more commonly found on soil at later stages of decay. As decomposition progresses, a thin humus layer develops over the surface of large coarse woody debris from over and understory vegetation, and from lignicolous cryptogams themselves (Qian et al. 1999). Low biomass and rapid sexual reproduction might be an adaptation to relatively ephemeral substrate of lignicoles that puts them in competitive disadvantage when establishing on more stable substrate than dead wood (Spribille et al. 2008).

*Ecology of* Cladonia botrytes

*Cladonia botrytes* is reported to be obligately lignicolous (Spribille et al. 2008) and as it is dependent on habitats with high solar radiation (de Jong & Lönnberg 2010) it could be expected to have a high portion of the occurrences on stumps in clear-cuts. Bio-fuel extractions from clear-cuts in Fennoscandia have so far concerned slash (e.g., tops and branches), but stumps left after final felling are also increasingly being used. The aim of this study was therefore to clarify the ecology of *Cladonia botrytes* on clear-cuts and especially how frequently it occurs on soil in clear-cuts.

*Cladonia botrytes* is a circumboreal species of decaying wood in continental climates. This species is distinguished from most other members of the genus by the small size, and yellow green colour of the podetia and pale pinkish-brown colour of the apothecia (Smith et al. 2002). *C. botrytes* is listed as a conservation target in several European countries as in Austria (Türk & Wittmann 1986), Germany (Wirth et al. 1984), Poland (Cieslinski et al. 1992), Britain and Ireland (Church et al. 1997), and Switzerland (Clerc et al. 1992). In Fennoscandia, it is fairly widespread and common in Finland, Norway (Moberg & Holmåsen 1995) and is one of the most common species on stumps in Sweden (Caruso et al. 2008). However in Denmark the species has only been found on six localities, with the last finding made in 1992 (Alstrup 2009). The species is found in exposed, well ventilated conditions, and is associated with middle to late stage in the succession (Coppins & Coppins 1998). From the records in Scotland it appears that stumps supporting *C. botrytes* are between 12 and 20 years old (Coppins & Coppins 1998), 15-85 cm in diameter and 15-80 cm in height, and can be categorised as being in states of weak to medium decay (Yahr 2006). Although *C. botrytes* is typically confined to decaying wood, it is occasionally found on humus rich soil (Coppins 1998, Yahr 2006, Fink 1906). Out of nine localities in Scotland seven are from stumps and two from peaty soil: one – on exposed hillside, second – on *Calluna* heath, regenerating after burning (Coppins & Coppins 1998, Yahr 2006). All recorded locations have two things in common: competitor free surface and close proximity to coniferous forests. Small number of reported occurrences makes it hard to establish the ecological factors that predict the presence of this lichen. However field observations in Sweden indicate its abundant presence on the soil (G. Thor & M. Svensson, pers. comm).

This study aims are to clarify the ecology of *C. botrytes* and factors preceding its occurrence on soil and stumps in clear-cuts as well as to establish whether there is a difference along a gradient from central Sweden to the north Sweden.

# Materials and methods

*Study sites*

The study areas were located within three different regions in Sweden (Fig. 1) along the south-north gradient: province of Uppland (59°50'N, 18°5'E), Dalarna (59°58'N, 14°34'E), and Västerbotten (64°15'N, 16°25'E). Field work was carried out in May 2012. From the forest owners stand databases 12 clear-cuts in each province were selected and thus a total of 36. Selection was based mainly on two criteria: previous tree vegetation type had to be Scots pine *Pinus sylvestris* and the age of the clear-cut should be from 10 to 12 years old. Clear-cuts were, chosen to be roughly the same size (ca. 3 ha) and randomly selected within each region to avoid unnecessary variation in the data. Initially the aim was to select 15 clear-cuts in each region, but only 12 were found in the province of Dalarna. Therefore the number was reduced to 12 in all the provinces.

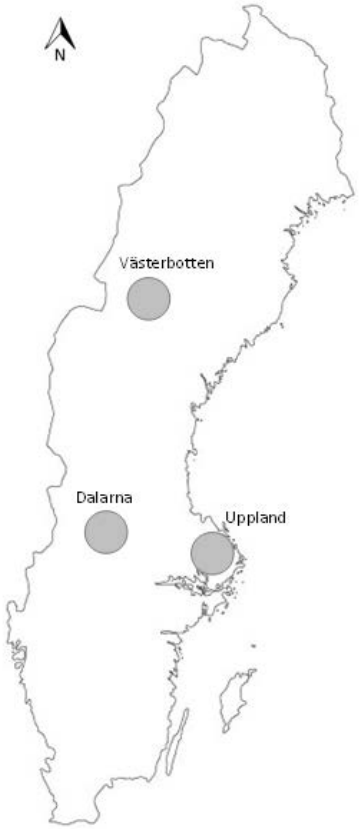



**Figure 1.** Location of the three study areas in Sweden.

*Sampling design*

In each clear-cut five circular plots 10 m in diameter were randomly selected. They were positioned along a transect that covered the longest distance from one edge of the clear-cut to the opposite. To avoid edge effects, the minimum distance from a plot to a clear-cut edge was 15 m. Depending on the size of the clear-cut, the distance between the plots was calculated so that they were equally distributed along the transect. Coordinates of the plot centres and height above sea level were measured by GPS (SWEREF99) and noted. The vegetation in every plot was described, including rough estimate of the height, species and total cover of new tree generation, diameter and length of logs > 10 cm in diameter, diameter and tree species of large standing trees from the previous tree generation, and presence of the "reindeer lichens"/"*Cladina*" genus *Cladonia* (*C. arbuscula, C. rangiferina, C. stellaris*). Plots were separated into two categories depending on the ground moisture level. If there was standing water present in the plot it was put in the category wet. The rest of the plots were placed in the not wet category. All the stumps > 5 cm in diameter inside the plot were counted and surveyed, along with the presence or absence of *Cladonia botrytes*, diameter, height, and where possible, stump species were noted. In the plots, presence of *C. botrytes* was searched for on bare, exposed soil. All boulders with humus layer on the surface were also examined. Number of podetia was counted in every delimited population and the area covered by *C. botrytes* was noted. Data was collected and recorded on the field datasheet (Appendix 1).

*Statistical analyses*

To estimate the abundance of *C. botrytes* on the stumps, record of presence or absence of the lichen was transformed into the mean stump occupancy per plot. To assess the availability of the stumps as a substrate, diameter data was used to calculate the mean stump surface area per plot. Comparison of the occurrence of *Cladonia botrytes* on different substrates between the regions was done applying a series of single factor ANOVAs. Two factor ANOVAs with replication were used to estimate the effect of the new tree generation cover on the occurrence of the lichen on all three substrates: boulders (number of podetia), soil (number of podetia), and stumps (occupancy). Analogous ANOVAs were used to analyse the relationship between stump size variables (surface area and height) and occupancy of them by *C. botrytes*. Chi-square-test was used to examine compositional differences between different moisture categories (wet/ not wet) in respect to presence or absence of the lichen in the plot. Linear regression was used to illustrate the relationship between the occurrence of the lichen on various substrates and the explanatory variables, coefficient of determination was produced. All the data analyses were conducted with MS EXCEL.

# Results

Number of clear-cuts surveyed was 36, resulting in 180 plots in total (Appendix 2).

*Regional variation*

Significant regional differences (Table 1) between the occurrence of *Cladonia botrytes* on boulders (Fig. 2A) and soil (Fig. 2B) were found (ANOVA Single Factor: both $p < 0.001$). The result indicates a trend of increasing abundance of the lichen towards the North. Occurrence of *C. botrytes* on the stumps shows significant variation between the regions (Table 1), although it does not follow the same pattern. Regional difference between the provinces is less drastic, with the greatest abundance level in Dalarna (Fig. 2C).

**Table 1.** Results from ANOVA: single factor analysis on regional variation among the *Cladonia botrytes* occurrence on boulders, soil and stumps (n=180)

| Category | SS | df | MS | P-value |
|---|---|---|---|---|
| boulders | 2348801 | 2 | 1174401 | < 0.001 |
| soil | 13271761 | 2 | 6635881 | < 0.001 |
| stumps | 1.890119 | 2 | 0.945059 | < 0.001 |

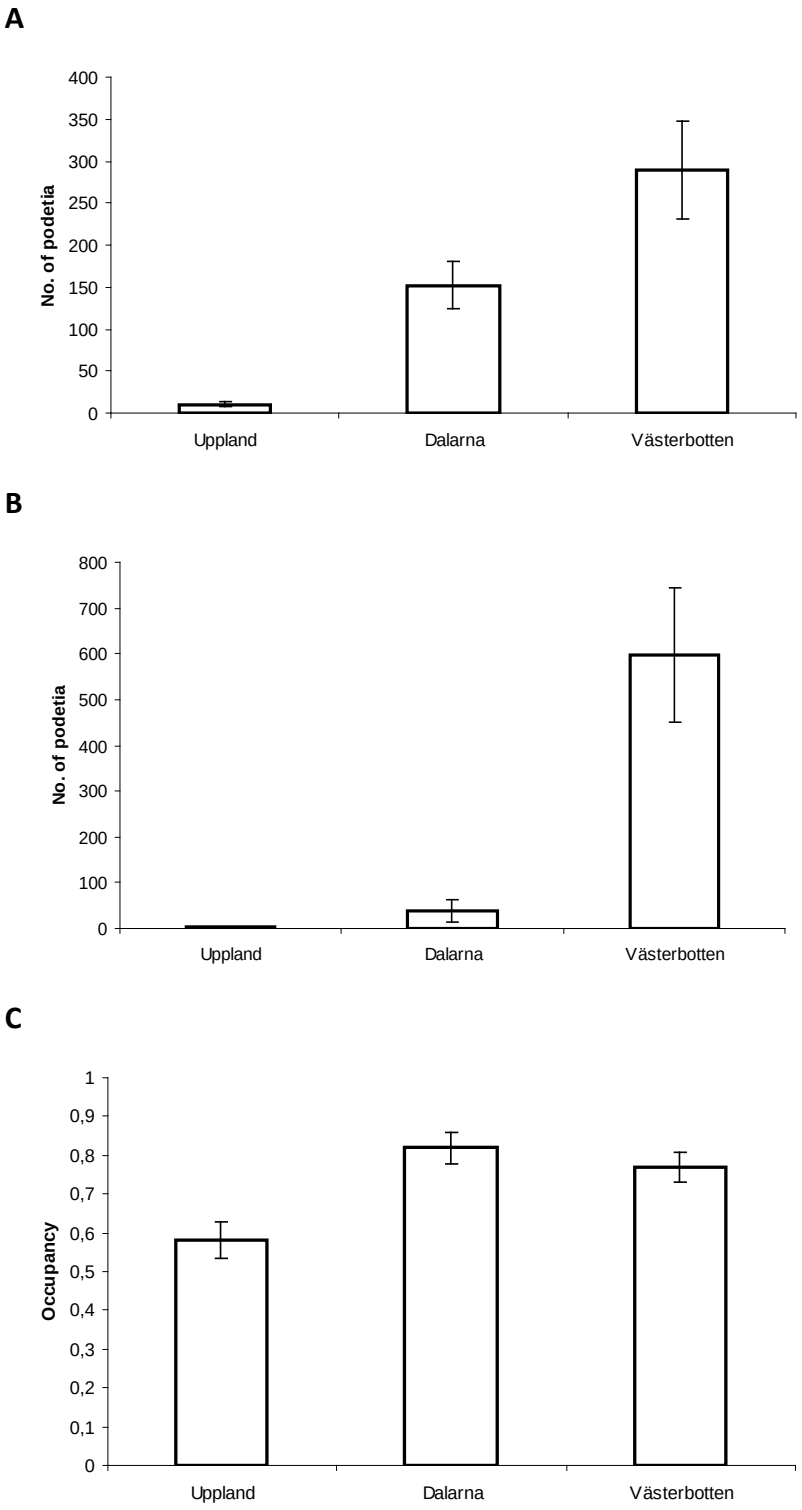


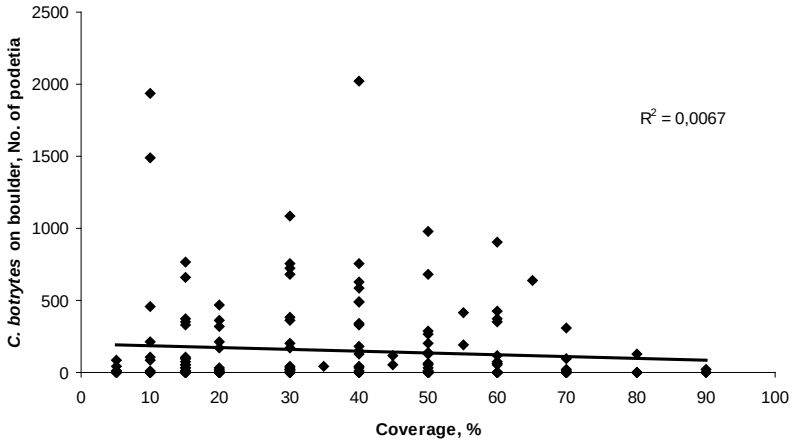

**Figure 2.** Regional variation of mean occurrence on different substrates of *Cladonia botrytes* (n= 180). A) Boulders, expressed as the mean number of podetia per region (± standard error); B) Soil (same units); C) Stumps, as the mean occupancy of the stump per region (± standard error).

*Canopy cover*

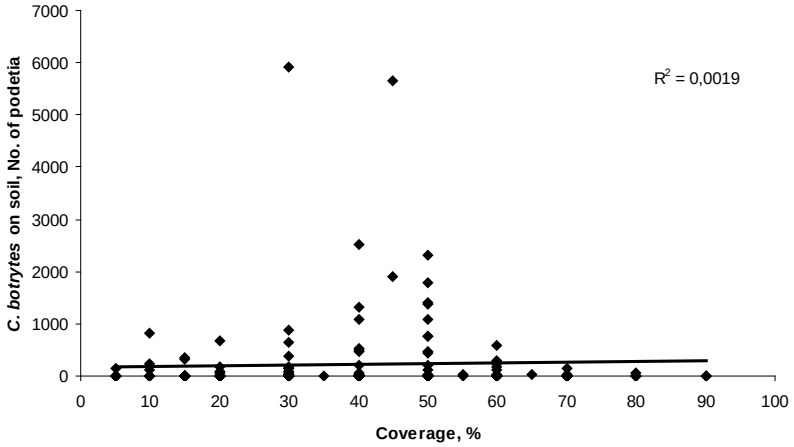
Occurrence of *C. botrytes* is affected by the percentage of the new tree generation cover in the plot, with significant regional variation. Despite the high significance levels (ANOVA Two

Factor: df 2, p< 0.001 for all substrates) there is no clear relationship between the occurrences of *C. botrytes* on any of the substrates (Fig. 3) in regards to the coverage.

**A**




**B**




**C**

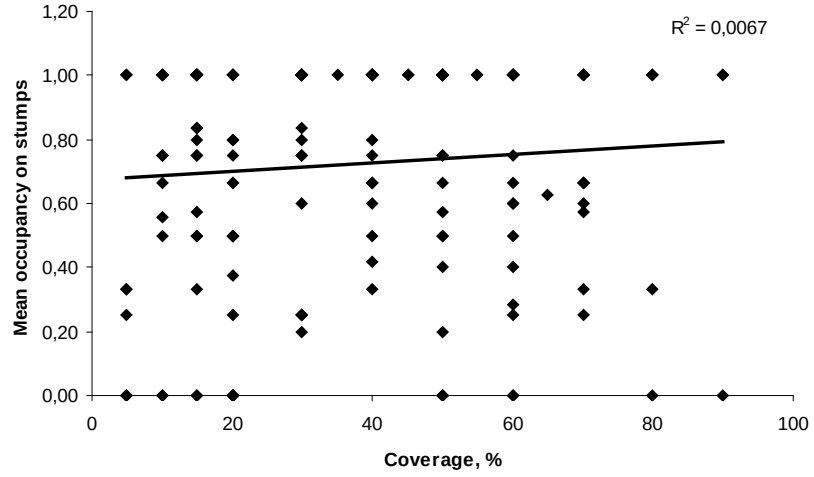



**Figure 3.** Occurrence of *Cladonia botrytes* on boulders (A), soil (B) and stumps (C), plotted against coverage of new tree generation with the respective coefficient of determination ($R^2$).

*Ground moisture*

Lichen occurrence was also analysed in relation to the ground moisture level in the plot (wet/not wet). The results show that there is a regional variation (Fig. 4). It appears that the moisture level is more important for the occurrence on boulders (Chi-value= 25.46, p< 0.001, df=1) than on soil (Chi-value= 3.13, p= 0.078, df=1). Even though the proportions between the regions are somewhat similar for the occurrences on boulders, there is a significant difference between the wet/not wet categories for Uppland (Chi-value= 12.19, p < 0.001, df =1) and for Västerbotten (Chi-value= 5.39, p< 0.001, df=1). For the occurrence of *C. botrytes* on soil the difference between the categories was found to be significant only in Västerbotten (Chi-value= 14.61, p< 0.001, df= 1).

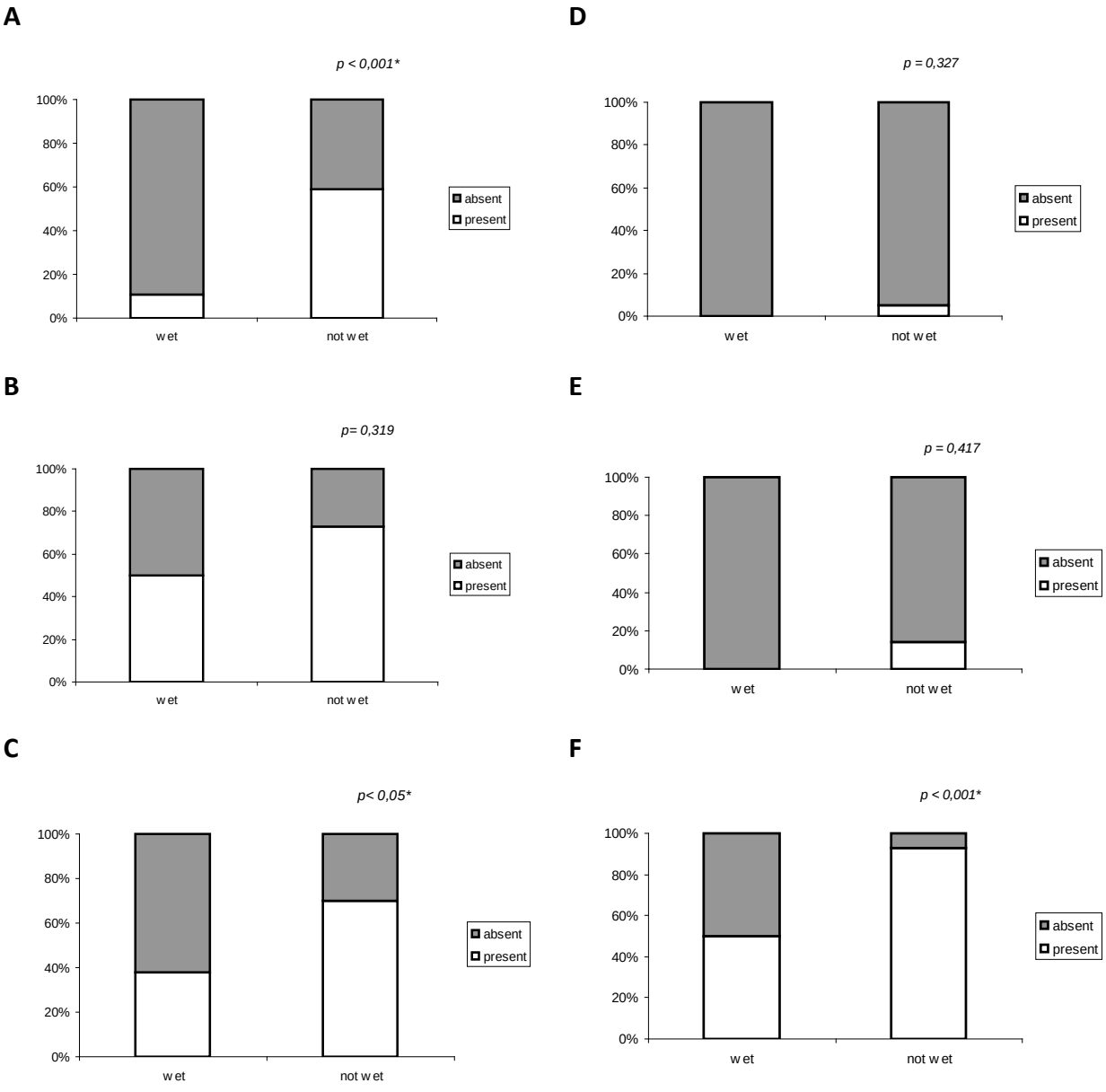
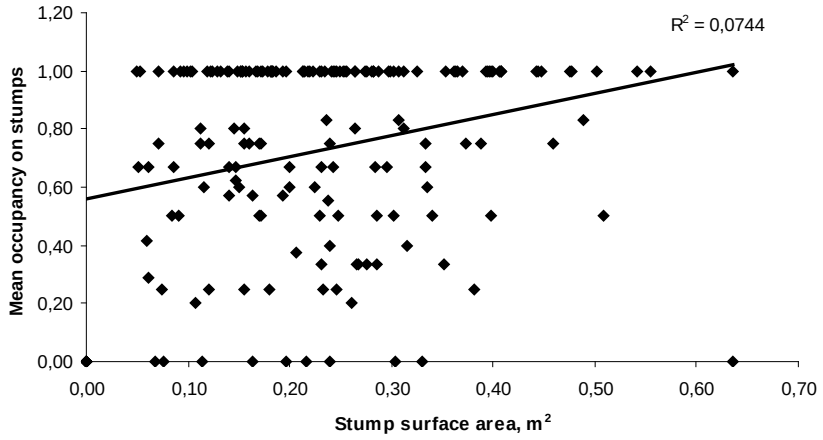



**Figure 4.** Distribution of the occurrences of *Cladonia botrytes* depending on the moisture level in the plot on boulders: A) Uppland, B) Dalarna, C) Västerbotten, and on soil: D) Uppland, E) Dalarna and F) Västerbotten

*Stump size variables*

Occurrences on stumps do not have a clear correlation to the stump surface area (Fig. 5A) or height (Fig. 5B), although there is a significant interaction between the size variables and the occupancy of the stumps (ANOVA Two Factor: df= 2, p< 0.001 for both).

**A**




**B**

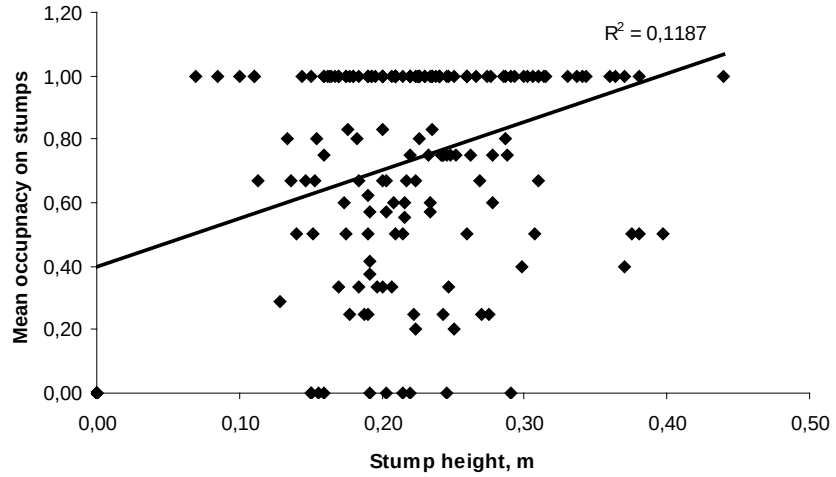



**Figure 5.** Occupancy of the stumps with *Cladonia botrytes* plotted against A) mean stump surface area, and B) mean height, with the respective coefficient of determination.

*Edge effect*

No significance between the distance from the edge and the occurrence of the lichen on soil or boulders could be detected. As for the stump occupancy, edge effect seems to be significant only for the stumps in the province of Uppland (Chi-value= 4.5, p< 0.05, df= 1).

# Discussion

Despite the known assumption that *Cladonia botrytes* is confined to decaying or rotten wood, it appears that it is indeed fairly abundant on soil in Sweden (Fig. 6). The classification

of the species as obligately lignicolous in Fennoscandia (Spribille et al. 2008) should therefore be reconsidered.

**Figure 6.** *Cladonia botrytes* found on soil in Västerbotten, Dorotea.

Occurrences on stumps and soil on clear-cuts still share the same traits. Both habitats are exposed and well ventilated, represent competitor free surface, are dynamic and limited in time. Field experience indicates that two different substrates preferred by *C. botrytes* on the soil can be distinguished: one on thin humus layer found on boulders, and another on exposed humus layer on the ground.

This study also compared the occurrences of *C. botrytes* between the different regions and different substrates. As hypothesized, variation among the regions was significant for all three substrates (for all $p < 0.001$): soil, boulders and stumps. Furthermore, the results were similar for both, *C. botrytes* on soil and boulders, and showed a distinct northward trend (Figs 2A & 2B). This put together with the rare occurrences of the lichen in the southern locations in Europe (Coppins & Coppins 1998, Yahr 2006), shows that the species has a northern distribution. Field observations showed that *C. botrytes* visually appeared to be more vital in the northern locations and here competed with bryophytes for space. It was found growing on the soil among dense mats of bryophytes and lichens. However, despite significant differences ($p < 0.001$) within regional occurrences on the stumps, the compositional distribution follows a different pattern (Fig. 2C). Regional variation is less pronounced, with the greatest abundance in the province of Dalarna. These differences might be partly due to the variation in logging practices, land use history (Lõhmus & Lõhmus 2007), local climate or the substrate quality, as the plots were diverse in their habitat (Fig. 7).

Apart from occurrence of the lichen on different substrates, other variables were measured in an attempt to explain the ecological factors preceding its abundance. Canopy cover of the new tree generation was analyzed in respect to the presence of *C. botrytes* in the plot, and it was proven to be an important factor ($p < 0.001$) for the lichen on all of the substrates: soil, boulders and stumps. However, despite this result, no obvious pattern of this relationship could be found. Revealing that canopy cover is influencing the occurrence of the species but in a more complex manner. It could be due to foliage cover of the available substrate for colonization or lack of light.

**A**

**B**

**C**

**Figure 7.** Inventoried landscapes in a) Uppland, Länna (clear-cut Up4) b) Dalarna, near lake Grässjön (clear-cut Da2) and c) Västerbotten, near Lavsjö (clear-cut Dr7)

All plots were separated into two categories, depending on the ground moisture level: wet and not wet. The results indicate significant compositional differences between the two categories. It appears that the moisture level is more important for the occurrences on the boulders (Chi-value = 25.46) than on the soil (Chi-value = 3.13). This variation could be caused by differences in the vegetation in plots with different ground moisture levels, and therefore in the competition. Furthermore there is also a regional difference, as more significant results were found for Uppland (Chi-value = 12.19) and Västerbotten (Chi-value = 5.39). Overall, this confirms that the species prefers not only exposed, but also rather dry environments, as occurrence of *C. botrytes* is lower in the plots with high ground moisture level. Occurrences on stumps were not analyzed in regards to the moisture level, as clear-cuts represent such an exposed environment that any potential moisture effect is overshadowed by the fact that the stumps are prone to desiccation due to elevation from the ground (Rudolphi et al. 2011).

As for the *C. botrytes* presence on stumps in the plots, several stump size variables were estimated, including stump surface area and height. Since the clear-cuts surveyed were pine *Pinus sylvestris* dominated - the majority of the stumps belonged to this species, although *C. botrytes* was also found on aspen *Populus tremula* stumps on a few occasions. Apart from the fact that stump size variables do have a significant effect on the occurrence of *C. botrytes*, no clear relationship or pattern could be revealed. In the field, only presence or absence of the lichen on the stump was noted and therefore a direct comparison between the numbers of podetia is not possible. Height from the ground may have an affect on the moisture availability, as stumps that are

higher generally have slower decay and increased drying (Humphrey et al 2002; Chen et al, 1993). It is difficult to separate the influence of stump height above the ground from decay class; however there is an indication that the height above the ground appears to be more important (Botting & DeLonf 2009). Stumps as a substrate represent a very complex environment with various and diverse microhabitats (Caruso et al 2008). Different abundance levels of *C. botrytes* on the stumps between the plots could also be partly explained by the evident differences in local climate between the plots. This means that there are multiple variables influencing the abundance of *C. botrytes* on the stumps, and that size variables are not the main prerequisites to predict its presence.

Logging activities causes drastic modifications of the environment. The general trend after felling is the disappearance of a number of vascular plants, a decrease in bryophyte abundances and an increase in cover of lichens, due to the heterogeneity of various new microhabitats (Bråkenheim & Liu 1998). Clear-cuts represent an extreme and exposed environment with increased solar radiation and high temperature and moisture fluctuations (Rudolphi et al. 2011). As an adaptation to fast and hostile changes in the environment some species display habitat shift. For example, in Tasmania, *Placynthecia icmalea* and *Trapeliopsis granulosa*, were previously uncommon and linked to very old trees, however now they are common on rotten organic matter, which could to some extent mimic the buttresses of old trees where competition from bryophytes is reduced (Kantvilas & Jarman 2006). *C. botrytes* has also previously been found by Lõhmus & Kruustuk (2010) on an unusual substrate: charred wood in Estonia. It is unknown which features of charred wood make it a successful habitat for lichens, apart from it being a competitor free surface. This indicates that lichens show a shift in the habitat if the new substrate is available and suitable for colonisation.

*C. botrytes* clearly benefits from the conditions created by logging activities, as they assure a long-term continuous supply of suitable habitat and allow the species to thrive. However, stumps on clear-cuts are an artificially created substrate. The cause of wood affinity in lichens is poorly understood (Spribille et al. 2008). However it seems that humidity conditions are of primarily importance for the obligate epixylic species (Jansova & Soldan 2006). *C. botrytes* is a colonizer on newly exposed and decaying coniferous wood and other exposed substrates rich in wood fibres or humus. It is apparently a fast colonizer as well, as it can appear on substrates only ca. 2 years old (G. Thor, pers. comm.). Therefore, in more natural habitats it can occur in exposed habitats created by e.g. storms or forest fires. The species is positively affected by the forestry industry and the clear-cutting approach that it uses, as after felling it creates short-term habitat where a large proportion of the *C. botrytes* population can be found. Therefore it is advised that felling residues, such as stumps, are not to be removed.

It is surprising that soil-inhabiting populations only rarely have been reported in the literature. Two localities have been recorded on soil in Scotland (Coppins & Coppins 1998, Yahr 2006). The opposite is also the case. Some soil inhabiting species like *Cladonia arbuscula*, *C. rangiferina* and *C. stellaris* are now and then found on stumps on clear-cuts (Caruso et al. 2008). Obviously, the substrates exposed soil rich in humus and stumps, share similarities and species mostly found in one of these habitats can also occur in the other.

## Conclusions

The main conclusion of this study is that *Cladonia botrytes* is present on the soil and its abundance increases in the northern localities. As it is no longer confined to decaying wood as its only substrate, a change in the classification of the species as obligately lignicolous can be recommended. Apart from the substrate availability, numerous factors are affecting the occurrence of the species, such as canopy cover, ground moisture and stump size variables. However their interactions are very complex and interdependent, making it difficult to distinguish their influence on the abundance of *C. botrytes*. The species is positively influenced by the conditions created by clear-cutting. It assures continuous supply of suitable habitat available for colonization and support of the large proportion of the *C. botrytes* population. Therefore it is advised not to stump harvest in logging areas.

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# Appendices

*Appendix 1.* Designed field datasheet as used in the fieldwork.

| | | | | |
|---|---|---|---|---|
| Datasheet Nr. | | | Date | |
| Location: | | | Height a.s.l. | |
| Clear-cut | | | Slope | |
| **Plot Nr.** | | | | |
| **Coordinates** | | | *Comments:* | |
| x | | long | | |
| y | | lat | | |
| **Habitat:** | | | | |
| tree spp. planted (coverage, height) | | | | **Sketch** |
| boulders | | | | |
| Logs (> 10 cm), diam, length | | | | |
| Large trees (diam, spp.) | | | | |
| *Cladonias* | | | | |

| **Stump** | | | | |
|---|---|---|---|---|
| Diam. | m | m | m | m |
| Height | m | m | m | m |
| Species | | | | |
| *C. botrytes* | | | | |

| **Stump** | | | | |
|---|---|---|---|---|
| Diam. | m | m | m | m |
| Height | m | m | m | m |
| Species | | | | |
| *C. botrytes* | | | | |

| **Soil** | | |
|---|---|---|
| Description (area, humus) | | |
| No of podetia (*C. botrytes*) | | *Comments:* |

| | | |
|---|---|---|
| | | |
| **Soil** | | |
| Description (area, humus) | | |
| No of podetia (*C. botrytes*) | | *Comments:* |

*Appendix 2.* Descriptive variables of plots: allocated plot number, clear-cut acronym, longitude and latitude (in SWEREF99), height above sea level and location in regards to the edge of the plot with the slope. Descriptive habitat variables: ground moisture category, canopy cover of the new tree generation, presence of boulders, presence of large trees, presence of *Cladinas*. *Cladonia botrytes* abundance variables: stump surface area per plot, stump occupancy by *Cladonia botrytes* per plot, number of podetia found on boulders and soil.

| Plot | Clear-cut | Region | Coordinates | | Height | Edge effect | Slope | Wet/ Not wet | Total tree cover | Boulders present | Large trees present | *Cladinas* present | Stump surface area | Stump occupancy | *C. botrytes* boulder | *C. botrytes* soil |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Longitude (X) | Latitude (y) | a.s.l. (m) | | (degrees) | | (%) | | | | ($m^{2)}$ | | (No of podetia) | (No of podetia) |
| 1 | Up7 | Uppland | 6637699 | 673950 | 30 | edge | 5 | not wet | 20 | yes | no | no | 0.23 | 0.67 | 25 | 0 |
| 2 | Up7 | Uppland | 6637727 | 673865 | 35 | not edge | 7 | not wet | 30 | yes | no | no | 0.31 | 0.83 | 33 | 0 |
| 3 | Up7 | Uppland | 6637759 | 673793 | 46 | not edge | 0 | not wet | 40 | no | no | no | 0.51 | 0.50 | 0 | 0 |
| 4 | Up7 | Uppland | 6637790 | 673706 | 29 | not edge | 2 | not wet | 40 | yes | yes | no | 0.34 | 0.60 | 4 | 0 |
| 5 | Up7 | Uppland | 6637823 | 673640 | 41 | edge | 0 | not wet | 15 | yes | yes | yes | 0.19 | 0.57 | 2 | 0 |
| 6 | Up8 | Uppland | 6635993 | 674667 | 37 | edge | 5 | not wet | 15 | yes | yes | yes | 0.25 | 0.50 | 3 | 0 |
| 7 | Up8 | Uppland | 6635933 | 674716 | 30 | not edge | 0 | not wet | 15 | no | yes | no | 0.34 | 0.50 | 0 | 0 |
| 8 | Up8 | Uppland | 6635851 | 674736 | 27 | not edge | 5 | not wet | 10 | yes | no | yes | 0.36 | 1.00 | 4 | 0 |
| 9 | Up8 | Uppland | 6635780 | 674747 | 30 | not edge | 3 | not wet | 10 | yes | no | yes | 0.44 | 1.00 | 0 | 0 |
| 10 | Up8 | Uppland | 6635694 | 674775 | 33 | edge | 0 | not wet | 10 | yes | yes | yes | 0.24 | 0.56 | 9 | 0 |
| 11 | Up6 | Uppland | 6635957 | 671366 | 28 | edge | 5 | not wet | 15 | yes | no | no | 0.36 | 1.00 | 8 | 0 |
| 12 | Up6 | Uppland | 6635906 | 671346 | 34 | not edge | 0 | wet | 20 | no | yes | no | 0.33 | 0.00 | 0 | 0 |
| 13 | Up6 | Uppland | 6635822 | 671348 | 22 | not edge | 0 | wet | 30 | no | yes | no | 0.38 | 0.25 | 0 | 0 |
| 14 | Up6 | Uppland | 6635742 | 671342 | 29 | not edge | 0 | wet | 50 | no | no | no | 0.30 | 0.00 | 0 | 0 |
| 15 | Up6 | Uppland | 6635689 | 671338 | 44 | edge | 5 | not wet | 40 | yes | no | yes | 0.06 | 0.67 | 0 | 0 |
| 16 | Up4 | Uppland | 6633960 | 668931 | 31 | edge | 0 | not wet | 30 | yes | no | yes | 0.39 | 1.00 | 47 | 0 |
| 17 | Up4 | Uppland | 6634039 | 668948 | 37 | not edge | 5 | not wet | 20 | yes | no | yes | 0.33 | 0.67 | 0 | 0 |
| 18 | Up4 | Uppland | 6634115 | 668966 | 29 | not edge | 0 | not wet | 15 | yes | yes | no | 0.49 | 0.83 | 76 | 0 |
| 19 | Up4 | Uppland | 6634212 | 668992 | 47 | not edge | 5 | not wet | 15 | yes | no | yes | 0.26 | 1.00 | 32 | 0 |
| 20 | Up4 | Uppland | 6634288 | 669071 | 33 | edge | 0 | wet | 30 | yes | no | no | 0.37 | 0.75 | 0 | 0 |
| 21 | Up1 | Uppland | 6649670 | 653546 | 47 | edge | 0 | wet | 60 | no | no | no | 0.24 | 1.00 | 0 | 0 |
| 22 | Up1 | Uppland | 6649782 | 653493 | 45 | not edge | 0 | wet | 70 | no | yes | no | 0.29 | 0.33 | 0 | 0 |
| 23 | Up1 | Uppland | 6649875 | 653439 | 61 | not edge | 0 | not wet | 80 | yes | no | no | 0.16 | 0.00 | 0 | 0 |
| 24 | Up1 | Uppland | 6650001 | 653394 | 46 | not edge | 0 | wet | 60 | no | yes | no | 0.20 | 0.60 | 0 | 0 |
| 25 | Up1 | Uppland | 6650070 | 653328 | 45 | edge | 0 | wet | 60 | yes | yes | no | 0.40 | 0.50 | 0 | 0 |
| 26 | Up2 | Uppland | 6648461 | 654223 | 55 | edge | 1 | not wet | 20 | yes | no | no | 0.30 | 0.50 | 0 | 0 |
| 27 | Up2 | Uppland | 6648385 | 654196 | 42 | not edge | 2 | not wet | 15 | yes | no | no | 0.24 | 0.83 | 0 | 0 |

| Plot | Clear-cut | Region | Coordinates Longitude (X) | Coordinates Latitude (y) | Height a.s.l. (m) | Edge effect | Slope (degrees) | Wet/ Not wet | Total tree cover (%) | Boulders present | Large trees present | *Cladinas* present | Stump surface area ($m^{2)}$ | Stump occupancy | *C. botrytes* boulder (No of podetia) | *C. botrytes* soil (No of podetia) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | Up2 | Uppland | 6648323 | 654158 | 43 | not edge | 0 | not wet | 15 | yes | no | no | 0.45 | 1.00 | 27 | 0 |
| 29 | Up2 | Uppland | 6648255 | 654128 | 47 | not edge | 2 | not wet | 30 | yes | no | no | 0.24 | 1.00 | 21 | 0 |
| 30 | Up2 | Uppland | 6648191 | 654085 | 45 | edge | 0 | not wet | 60 | yes | yes | no | 0.50 | 1.00 | 0 | 0 |
| 31 | Up12 | Uppland | 6664798 | 698686 | 11 | edge | 0 | not wet | 15 | yes | no | no | 0.46 | 0.75 | 0 | 0 |
| 32 | Up12 | Uppland | 6664867 | 698686 | 19 | not edge | 0 | wet | 15 | no | no | no | 0.22 | 0.00 | 0 | 0 |
| 33 | Up12 | Uppland | 6664951 | 698698 | 12 | not edge | 0 | wet | 10 | no | no | no | 0.48 | 1.00 | 0 | 0 |
| 34 | Up12 | Uppland | 6665018 | 698688 | 17 | not edge | 1 | wet | 10 | no | no | no | 0.29 | 0.50 | 0 | 0 |
| 35 | Up12 | Uppland | 6665088 | 698689 | 22 | edge | 3 | not wet | 15 | yes | no | yes | 0.11 | 0.00 | 57 | 0 |
| 36 | Up9 | Uppland | 6667272 | 697015 | 1 | edge | 0 | not wet | 15 | yes | no | no | 0.40 | 1.00 | 9 | 0 |
| 37 | Up9 | Uppland | 6667373 | 697070 | 16 | not edge | 0 | wet | 10 | yes | no | no | 0.07 | 0.00 | 0 | 0 |
| 38 | Up9 | Uppland | 6667439 | 697116 | 9 | not edge | 1 | not wet | 5 | yes | yes | yes | 0.00 | 0.00 | 14 | 0 |
| 39 | Up9 | Uppland | 6667501 | 697147 | 8 | not edge | 0 | not wet | 5 | yes | no | yes | 0.35 | 0.33 | 11 | 0 |
| 40 | Up9 | Uppland | 6667556 | 697189 | 8 | edge | 5 | not wet | 5 | yes | yes | yes | 0.16 | 0.25 | 0 | 0 |
| 40 | Up11 | Uppland | 6665527 | 697571 | 14 | edge | 0 | wet | 30 | yes | no | no | 0.37 | 1.00 | 0 | 0 |
| 41 | Up10 | Uppland | 6666997 | 696743 | 16 | not edge | 3 | not wet | 15 | no | yes | no | 0.28 | 1.00 | 0 | 0 |
| 42 | Up10 | Uppland | 6666951 | 696758 | 10 | not edge | 10 | not wet | 10 | yes | no | yes | 0.12 | 0.75 | 89 | 0 |
| 43 | Up10 | Uppland | 6666913 | 696758 | 6 | not edge | 3 | not wet | 5 | yes | no | yes | 0.24 | 0.00 | 86 | 138 |
| 44 | Up10 | Uppland | 6666877 | 696763 | 6 | edge | 0 | not wet | 5 | yes | no | no | 0.27 | 0.33 | 0 | 0 |
| 45 | Up10 | Uppland | 6666835 | 696769 | 4 | edge | 1 | wet | 20 | yes | no | no | 0.21 | 0.38 | 0 | 0 |
| 46 | Up11 | Uppland | 6665654 | 697435 | 17 | not edge | 0 | not wet | 5 | yes | no | no | 0.31 | 1.00 | 1 | 0 |
| 47 | Up11 | Uppland | 6665632 | 697457 | 22 | not edge | 0 | not wet | 15 | yes | no | no | 0.23 | 0.33 | 6 | 0 |
| 48 | Up11 | Uppland | 6665606 | 697486 | 22 | not edge | 0 | not wet | 30 | yes | no | no | 0.23 | 0.25 | 2 | 0 |
| 49 | Up11 | Uppland | 6665574 | 697533 | 14 | edge | 0 | wet | 30 | yes | no | no | 0.31 | 0.80 | 21 | 0 |
| 51 | Da8 | Dalarna | 6647212 | 480077 | 242 | edge | 1 | not wet | 20 | yes | yes | yes | 0.25 | 0.25 | 0 | 0 |
| 52 | Da8 | Dalarna | 6647238 | 480085 | 251 | not edge | 1 | not wet | 20 | yes | no | yes | 0.24 | 1.00 | 0 | 0 |
| 53 | Da8 | Dalarna | 6647254 | 480092 | 250 | not edge | 5 | not wet | 50 | yes | no | yes | 0.22 | 1.00 | 0 | 0 |
| 54 | Da8 | Dalarna | 6647287 | 480096 | 251 | not edge | 5 | not wet | 90 | yes | no | yes | 0.64 | 0.00 | 0 | 0 |
| 55 | Da8 | Dalarna | 6647306 | 480105 | 248 | edge | 3 | not wet | 20 | yes | yes | yes | 0.00 | 0.00 | 0 | 0 |
| 56 | Da9 | Dalarna | 6645623 | 478849 | 261 | edge | 0 | not wet | 70 | yes | no | yes | 0.18 | 1.00 | 0 | 0 |
| 57 | Da9 | Dalarna | 6645641 | 478866 | 263 | not edge | 3 | not wet | 60 | yes | no | no | 0.26 | 1.00 | 0 | 0 |

| Plot | Clear-cut | Region | Coordinates Longitude (X) | Coordinates Latitude (y) | Height a.s.l. (m) | Edge effect | Slope (degrees) | Wet/ Not wet | Total tree cover (%) | Boulders present | Large trees present | *Cladinas* present | Stump surface area ($m^{2)}$ | Stump occupancy | *C. botrytes* boulder (No of podetia) | *C. botrytes* soil (No of podetia) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 | Da9 | Dalarna | 6645664 | 478888 | 261 | not edge | 2 | not wet | 60 | yes | no | yes | 0.15 | 1.00 | 115 | 0 |
| 59 | Da9 | Dalarna | 6645677 | 478899 | 269 | not edge | 5 | not wet | 40 | yes | no | yes | 0.17 | 1.00 | 490 | 0 |
| 60 | Da9 | Dalarna | 6645690 | 478931 | 251 | edge | 0 | wet | 50 | no | no | yes | 0.36 | 1.00 | 0 | 0 |
| 61 | Da11 | Dalarna | 6645430 | 476048 | 244 | edge | 5 | not wet | 30 | yes | no | yes | 0.07 | 1.00 | 14 | 0 |
| 62 | Da11 | Dalarna | 6645441 | 476047 | 244 | not edge | 20 | not wet | 20 | yes | no | yes | 0.18 | 1.00 | 0 | 0 |
| 63 | Da11 | Dalarna | 6645453 | 476646 | 243 | not edge | 20 | not wet | 50 | yes | no | yes | 0.21 | 1.00 | 32 | 0 |
| 64 | Da11 | Dalarna | 6645461 | 476043 | 245 | not edge | 20 | not wet | 60 | yes | no | yes | 0.19 | 1.00 | 1 | 0 |
| 65 | Da11 | Dalarna | 6645467 | 476044 | 247 | edge | 30 | not wet | 70 | yes | no | yes | 0.24 | 0.67 | 15 | 0 |
| 66 | Da12 | Dalarna | 6647963 | 476051 | 228 | edge | 0 | not wet | 50 | yes | no | yes | 0.28 | 0.67 | 290 | 0 |
| 67 | Da12 | Dalarna | 6647970 | 476067 | 234 | not edge | 0 | not wet | 30 | yes | no | yes | 0.33 | 0.75 | 684 | 0 |
| 68 | Da12 | Dalarna | 6647985 | 476074 | 243 | not edge | 0 | wet | 90 | yes | no | yes | 0.05 | 1.00 | 21 | 0 |
| 69 | Da12 | Dalarna | 6647992 | 476099 | 238 | not edge | 0 | not wet | 70 | yes | no | yes | 0.30 | 0.67 | 313 | 0 |
| 70 | Da12 | Dalarna | 6648001 | 476113 | 233 | edge | 0 | not wet | 80 | yes | no | yes | 0.27 | 0.33 | 130 | 0 |
| 71 | Da10 | Dalarna | 6644939 | 479490 | 244 | edge | 5 | not wet | 70 | yes | no | yes | 0.20 | 0.67 | 26 | 43 |
| 72 | Da10 | Dalarna | 6644987 | 479480 | 236 | not edge | 5 | not wet | 40 | yes | no | yes | 0.41 | 1.00 | 580 | 0 |
| 73 | Da10 | Dalarna | 6645048 | 479462 | 243 | not edge | 0 | wet | 20 | yes | yes | no | 0.17 | 1.00 | 33 | 0 |
| 74 | Da10 | Dalarna | 6645102 | 479439 | 268 | not edge | 0 | not wet | 20 | yes | no | yes | 0.11 | 0.80 | 361 | 0 |
| 75 | Da10 | Dalarna | 6645198 | 479424 | 244 | edge | 5 | not wet | 15 | yes | no | yes | 0.09 | 1.00 | 656 | 0 |
| 76 | Da1 | Dalarna | 6653711 | 477008 | 306 | edge | 5 | not wet | 20 | yes | no | no | 0.22 | 1.00 | 2 | 0 |
| 77 | Da1 | Dalarna | 6653777 | 476971 | 317 | not edge | 5 | not wet | 50 | yes | no | yes | 0.23 | 1.00 | 0 | 0 |
| 78 | Da1 | Dalarna | 6653820 | 476920 | 317 | not edge | 3 | not wet | 10 | yes | no | yes | 0.25 | 1.00 | 216 | 0 |
| 79 | Da1 | Dalarna | 6653825 | 476856 | 323 | not edge | 45 | not wet | 50 | yes | yes | no | 0.20 | 0.00 | 0 | 0 |
| 80 | Da1 | Dalarna | 6653828 | 476780 | 298 | edge | 2 | not wet | 5 | yes | no | yes | 0.25 | 1.00 | 41 | 0 |
| 81 | Da7 | Dalarna | 6641755 | 467759 | 224 | edge | 2 | not wet | 60 | yes | no | no | 0.23 | 0.60 | 79 | 0 |
| 82 | Da7 | Dalarna | 6641827 | 467716 | 223 | not edge | 2 | not wet | 50 | yes | no | yes | 0.14 | 1.00 | 63 | 0 |
| 83 | Da7 | Dalarna | 6641886 | 467664 | 215 | not edge | 1 | not wet | 15 | yes | no | no | 0.15 | 1.00 | 109 | 0 |
| 84 | Da7 | Dalarna | 6641938 | 467621 | 208 | not edge | 2 | not wet | 60 | no | no | yes | 0.17 | 0.75 | 353 | 0 |
| 85 | Da7 | Dalarna | 6642011 | 467590 | 208 | edge | 1 | not wet | 90 | no | no | yes | 0.18 | 1.00 | 0 | 0 |
| 86 | Da6 | Dalarna | 6642674 | 470714 | 217 | edge | 5 | not wet | 15 | yes | no | yes | 0.16 | 0.75 | 771 | 331 |
| 87 | Da6 | Dalarna | 6642696 | 470747 | 226 | not edge | 3 | not wet | 15 | yes | no | yes | 0.22 | 1.00 | 372 | 0 |

| Plot | Clear-cut | Region | Coordinates Longitude (X) | Coordinates Latitude (y) | Height a.s.l. (m) | Edge effect | Slope (degrees) | Wet/ Not wet | Total tree cover (%) | Boulders present | Large trees present | *Cladinas* present | Stump surface area ($m^2$) | Stump occupancy | *C. botrytes* boulder (No of podetia) | *C. botrytes* soil (No of podetia) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | Da6 | Dalarna | 6642712 | 470781 | 224 | not edge | 10 | not wet | 40 | yes | no | yes | 0.19 | 1.00 | 28 | 0 |
| 89 | Da6 | Dalarna | 6642739 | 470812 | 223 | not edge | 2 | not wet | 55 | yes | no | yes | 0.25 | 1.00 | 193 | 0 |
| 90 | Da6 | Dalarna | 6642761 | 470844 | 223 | edge | 2 | not wet | 80 | yes | yes | yes | 0.28 | 1.00 | 5 | 0 |
| 91 | Da4 | Dalarna | 6643762 | 469488 | 221 | edge | 1 | not wet | 40 | yes | no | yes | 0.15 | 1.00 | 132 | 0 |
| 92 | Da4 | Dalarna | 6643795 | 469463 | 221 | not edge | 2 | not wet | 30 | yes | no | yes | 0.27 | 1.00 | 167 | 0 |
| 93 | Da4 | Dalarna | 6643824 | 469427 | 228 | not edge | 3 | not wet | 60 | yes | no | yes | 0.54 | 1.00 | 66 | 0 |
| 94 | Da4 | Dalarna | 6643862 | 469404 | 227 | not edge | 0 | not wet | 20 | yes | no | yes | 0.23 | 0.50 | 469 | 0 |
| 95 | Da4 | Dalarna | 6643824 | 472770 | 244 | edge | 2 | not wet | 15 | yes | no | yes | 0.41 | 1.00 | 58 | 0 |
| 96 | Da5 | Dalarna | 6644429 | 469964 | 249 | edge | 10 | not wet | 50 | yes | no | yes | 0.18 | 1.00 | 14 | 6 |
| 97 | Da5 | Dalarna | 6644465 | 469992 | 248 | not edge | 5 | not wet | 50 | yes | yes | no | 0.18 | 1.00 | 3 | 0 |
| 98 | Da5 | Dalarna | 6644499 | 470021 | 254 | not edge | 10 | not wet | 70 | yes | no | no | 0.44 | 1.00 | 0 | 0 |
| 99 | Da5 | Dalarna | 6644524 | 470053 | 252 | not edge | 10 | not wet | 15 | yes | no | yes | 0.09 | 1.00 | 330 | 0 |
| 100 | Da5 | Dalarna | 6644554 | 470082 | 258 | edge | 5 | not wet | 50 | no | no | yes | 0.12 | 1.00 | 131 | 0 |
| 101 | Da3 | Dalarna | 6644760 | 468123 | 253 | edge | 1 | not wet | 60 | yes | no | yes | 0.00 | 0.00 | 908 | 291 |
| 102 | Da3 | Dalarna | 6644650 | 468178 | 247 | not edge | 0 | wet | 10 | no | no | no | 0.00 | 0.00 | 0 | 0 |
| 103 | Da3 | Dalarna | 6644544 | 468213 | 250 | not edge | 2 | not wet | 50 | yes | no | no | 0.16 | 1.00 | 0 | 1412 |
| 104 | Da3 | Dalarna | 6644443 | 468247 | 246 | not edge | 0 | not wet | 80 | yes | no | yes | 0.64 | 1.00 | 0 | 45 |
| 105 | Da3 | Dalarna | 6644329 | 468277 | 247 | edge | 12 | not wet | 70 | yes | no | yes | 0.13 | 1.00 | 100 | 0 |
| 106 | Da2 | Dalarna | 6645604 | 467277 | 230 | edge | 10 | not wet | 55 | yes | no | yes | 0.12 | 1.00 | 415 | 15 |
| 107 | Da2 | Dalarna | 6645683 | 467315 | 234 | not edge | 5 | not wet | 10 | yes | no | yes | 0.11 | 0.75 | 110 | 223 |
| 108 | Da2 | Dalarna | 6645754 | 467364 | 231 | not edge | 12 | not wet | 5 | yes | no | yes | 0.00 | 0.00 | 0 | 0 |
| 110 | Da2 | Dalarna | 6645933 | 467316 | 233 | not edge | 1 | not wet | 40 | yes | no | yes | 0.26 | 1.00 | 185 | 0 |
| 111 | Da2 | Dalarna | 6645849 | 467285 | 233 | edge | 1 | not wet | 35 | yes | no | yes | 0.20 | 1.00 | 45 | 0 |
| 112 | Up3 | Uppland | 6639821 | 666271 | 27 | edge | 0 | not wet | 40 | yes | no | yes | 0.27 | 0.33 | 8 | 0 |
| 113 | Up3 | Uppland | 6639865 | 666275 | 27 | not edge | 0 | wet | 20 | yes | no | no | 0.00 | 0.00 | 9 | 0 |
| 114 | Up3 | Uppland | 6639893 | 666280 | 23 | not edge | 10 | not wet | 50 | yes | no | yes | 0.17 | 0.50 | 0 | 0 |
| 115 | Up3 | Uppland | 6639930 | 666270 | 29 | not edge | 0 | not wet | 50 | no | no | no | 0.31 | 1.00 | 8 | 0 |
| 116 | Up3 | Uppland | 6639967 | 666266 | 30 | edge | 0 | not wet | 70 | no | no | no | 0.30 | 1.00 | 0 | 0 |
| 117 | Up5 | Uppland | 6640366 | 669125 | 23 | edge | 1 | wet | 40 | no | no | no | 0.39 | 0.75 | 0 | 0 |
| 118 | Up5 | Uppland | 6640243 | 669081 | 28 | not edge | 1 | wet | 50 | no | yes | no | 0.00 | 0.00 | 0 | 0 |
| 119 | Up5 | Uppland | 6640153 | 669027 | 26 | not edge | 30 | not wet | 70 | yes | yes | yes | 0.16 | 0.57 | 0 | 0 |

| Plot | Clear-cut | Region | Coordinates Longitude (X) | Coordinates Latitude (y) | Height a.s.l. (m) | Edge effect | Slope (degrees) | Wet/ Not wet | Total tree cover (%) | Boulders present | Large trees present | *Cladinas* present | Stump surface area ($m^{2)}$ | Stump occupancy | *C. botrytes* boulder (No of podetia) | *C. botrytes* soil (No of podetia) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | Up5 | Uppland | 6640048 | 668993 | 30 | not edge | 1 | not wet | 50 | yes | yes | no | 0.32 | 0.40 | 0 | 20 |
| 121 | Up5 | Uppland | 6639959 | 668950 | 16 | edge | 0 | wet | 80 | no | no | no | 0.55 | 1.00 | 0 | 0 |
| 122 | Dr12 | Dorotea | 7117986 | 565303 | 272 | edge | 3 | not wet | 40 | yes | no | yes | 0.21 | 1.00 | 339 | 26 |
| 123 | Dr12 | Dorotea | 7118002 | 565263 | 270 | not edge | 3 | wet | 50 | yes | no | yes | 0.10 | 1.00 | 983 | 0 |
| 124 | Dr12 | Dorotea | 7118019 | 565220 | 270 | not edge | 2 | wet | 40 | yes | yes | yes | 0.06 | 0.42 | 2018 | 0 |
| 125 | Dr12 | Dorotea | 7118024 | 565172 | 264 | not edge | 1 | wet | 30 | yes | yes | no | 0.11 | 0.20 | 0 | 38 |
| 126 | Dr12 | Dorotea | 7118043 | 565114 | 266 | edge | 3 | not wet | 50 | yes | no | yes | 0.09 | 0.50 | 0 | 464 |
| 127 | Dr11 | Dorotea | 7119973 | 563796 | 307 | edge | 3 | wet | 30 | yes | no | no | 0.25 | 1.00 | 725 | 883 |
| 128 | Dr11 | Dorotea | 7120047 | 563801 | 309 | not edge | 2 | wet | 40 | yes | yes | yes | 0.05 | 1.00 | 149 | 15 |
| 129 | Dr11 | Dorotea | 7120111 | 563802 | 307 | not edge | 7 | wet | 65 | yes | no | no | 0.15 | 0.63 | 642 | 30 |
| 130 | Dr11 | Dorotea | 7120206 | 563806 | 317 | not edge | 15 | not wet | 10 | yes | no | yes | 0.07 | 0.75 | 1941 | 0 |
| 131 | Dr11 | Dorotea | 7120272 | 563792 | 332 | edge | 40 | not wet | 60 | yes | no | no | 0.14 | 0.67 | 425 | 163 |
| 132 | Dr9 | Dorotea | 7121471 | 562001 | 273 | edge | 3 | not wet | 50 | yes | no | yes | 0.28 | 1.00 | 51 | 110 |
| 133 | Dr9 | Dorotea | 7121472 | 562079 | 272 | not edge | 1 | not wet | 20 | yes | no | no | 0.26 | 0.80 | 210 | 670 |
| 134 | Dr9 | Dorotea | 7121490 | 562156 | 273 | not edge | 0 | wet | 60 | no | no | no | 0.18 | 1.00 | 0 | 0 |
| 135 | Dr9 | Dorotea | 7121499 | 562236 | 271 | not edge | 1 | wet | 30 | yes | no | no | 0.24 | 1.00 | 3 | 34 |
| 136 | Dr9 | Dorotea | 7121512 | 562323 | 281 | edge | 3 | not wet | 50 | yes | no | yes | 0.28 | 1.00 | 269 | 776 |
| 137 | Dr6 | Dorotea | 7120523 | 575792 | 318 | edge | 3 | not wet | 45 | yes | no | yes | 0.10 | 1.00 | 50 | 5645 |
| 138 | Dr6 | Dorotea | 7120504 | 575737 | 320 | not edge | 1 | not wet | 45 | yes | no | yes | 0.30 | 1.00 | 115 | 1896 |
| 139 | Dr6 | Dorotea | 7120487 | 575690 | 319 | not edge | 15 | not wet | 50 | yes | no | yes | 0.17 | 1.00 | 685 | 1790 |
| 140 | Dr6 | Dorotea | 7120459 | 575640 | 318 | not edge | 15 | not wet | 50 | yes | no | no | 0.33 | 1.00 | 0 | 1365 |
| 141 | Dr6 | Dorotea | 7120443 | 575585 | 314 | edge | 20 | not wet | 40 | yes | no | no | 0.22 | 1.00 | 0 | 60 |
| 142 | Dr7 | Dorotea | 7118290 | 578373 | 337 | edge | 2 | not wet | 70 | yes | no | no | 0.12 | 0.60 | 0 | 150 |
| 143 | Dr7 | Dorotea | 7118328 | 578330 | 337 | not edge | 1 | wet | 30 | no | no | no | 0.10 | 1.00 | 0 | 635 |
| 144 | Dr7 | Dorotea | 7118362 | 578286 | 337 | not edge | 3 | not wet | 40 | yes | no | no | 0.10 | 1.00 | 330 | 2525 |
| 145 | Dr7 | Dorotea | 7118403 | 578254 | 339 | not edge | 2 | not wet | 50 | yes | no | no | 0.12 | 1.00 | 200 | 2300 |
| 146 | Dr7 | Dorotea | 7118445 | 578215 | 343 | edge | 3 | not wet | 30 | no | no | no | 0.41 | 1.00 | 0 | 5920 |
| 147 | Dr8 | Dorotea | 7121417 | 583671 | 352 | edge | 3 | not wet | 40 | yes | no | yes | 0.17 | 1.00 | 40 | 1325 |
| 148 | Dr8 | Dorotea | 7121509 | 583684 | 356 | not edge | 2 | not wet | 60 | no | yes | yes | 0.00 | 0.00 | 0 | 245 |
| 149 | Dr8 | Dorotea | 7121614 | 583691 | 357 | not edge | 3 | not wet | 40 | yes | yes | yes | 0.14 | 1.00 | 0 | 470 |
| 150 | Dr8 | Dorotea | 7121707 | 583701 | 359 | not edge | 2 | not wet | 50 | no | no | yes | 0.40 | 1.00 | 0 | 210 |

| Plot | Clear-cut | Region | Coordinates Longitude (X) | Coordinates Latitude (y) | Height a.s.l. (m) | Edge effect | Slope (degrees) | Wet/ Not wet | Total tree cover (%) | Boulders present | Large trees present | *Cladinas* present | Stump surface area ($m^{2)}$ | Stump occupancy | *C. botrytes* boulder (No of podetia) | *C. botrytes* soil (No of podetia) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 151 | Dr8 | Dorotea | 7121812 | 583709 | 365 | edge | 1 | not wet | 40 | yes | no | yes | 0.35 | 1.00 | 5 | 525 |
| 152 | Dr3 | Dorotea | 7129515 | 567636 | 366 | edge | 2 | wet | 50 | no | no | no | 0.39 | 1.00 | 0 | 0 |
| 153 | Dr3 | Dorotea | 7129516 | 567608 | 355 | not edge | 7 | wet | 50 | no | no | no | 0.26 | 0.20 | 0 | 0 |
| 154 | Dr3 | Dorotea | 7129525 | 567574 | 360 | not edge | 20 | not wet | 30 | yes | no | no | 0.13 | 1.00 | 360 | 30 |
| 155 | Dr3 | Dorotea | 7129530 | 567541 | 366 | not edge | 30 | not wet | 30 | yes | no | yes | 0.15 | 1.00 | 1090 | 140 |
| 156 | Dr3 | Dorotea | 7129540 | 567512 | 366 | edge | 15 | not wet | 15 | yes | no | no | 0.30 | 1.00 | 95 | 0 |
| 157 | Dr2 | Dorotea | 7128572 | 562170 | 291 | edge | 50 | not wet | 40 | yes | no | no | 0.40 | 1.00 | 630 | 210 |
| 158 | Dr2 | Dorotea | 7128539 | 562231 | 300 | not edge | 45 | not wet | 30 | yes | no | yes | 0.48 | 1.00 | 380 | 55 |
| 159 | Dr2 | Dorotea | 7128497 | 562285 | 287 | not edge | 45 | not wet | 10 | yes | no | yes | 0.41 | 1.00 | 460 | 820 |
| 160 | Dr2 | Dorotea | 7128469 | 562340 | 296 | not edge | 0 | not wet | 15 | yes | no | no | 0.29 | 1.00 | 350 | 10 |
| 161 | Dr2 | Dorotea | 7128436 | 562393 | 298 | edge | 45 | not wet | 30 | yes | no | no | 0.15 | 1.00 | 200 | 90 |
| 162 | Dr1 | Dorotea | 7137148 | 560688 | 376 | edge | 2 | wet | 70 | no | no | no | 0.12 | 0.25 | 0 | 0 |
| 163 | Dr1 | Dorotea | 7137056 | 560720 | 376 | not edge | 4 | not wet | 50 | no | no | no | 0.24 | 0.75 | 0 | 775 |
| 164 | Dr1 | Dorotea | 7136991 | 560730 | 383 | not edge | 5 | not wet | 60 | no | no | no | 0.24 | 0.40 | 0 | 110 |
| 165 | Dr1 | Dorotea | 7136918 | 560758 | 380 | not edge | 7 | not wet | 50 | no | no | no | 0.14 | 0.57 | 0 | 435 |
| 166 | Dr1 | Dorotea | 7136844 | 560758 | 380 | edge | 15 | not wet | 60 | yes | no | no | 0.18 | 0.25 | 50 | 25 |
| 167 | Dr10 | Dorotea | 7121321 | 563735 | 291 | edge | 4 | not wet | 15 | yes | no | no | 0.15 | 0.80 | 100 | 365 |
| 168 | Dr10 | Dorotea | 7121330 | 563764 | 288 | not edge | 20 | not wet | 20 | yes | no | no | 0.17 | 0.50 | 320 | 55 |
| 169 | Dr10 | Dorotea | 7121329 | 563798 | 294 | not edge | 15 | not wet | 20 | yes | no | no | 0.17 | 0.75 | 170 | 100 |
| 170 | Dr10 | Dorotea | 7121335 | 563834 | 292 | not edge | 10 | not wet | 10 | yes | no | no | 0.15 | 0.67 | 1490 | 130 |
| 171 | Dr10 | Dorotea | 7121334 | 563863 | 296 | edge | 25 | not wet | 30 | yes | no | no | 0.15 | 0.60 | 760 | 185 |
| 172 | Dr4 | Dorotea | 7128278 | 575167 | 350 | edge | 5 | not wet | 60 | yes | no | no | 0.16 | 1.00 | 375 | 600 |
| 173 | Dr4 | Dorotea | 7128297 | 575108 | 332 | not edge | 15 | not wet | 50 | yes | no | yes | 0.16 | 0.75 | 140 | 1080 |
| 174 | Dr4 | Dorotea | 7128333 | 575049 | 332 | not edge | 12 | not wet | 40 | yes | no | yes | 0.09 | 0.67 | 760 | 500 |
| 175 | Dr4 | Dorotea | 7128363 | 574985 | 337 | not edge | 15 | not wet | 20 | yes | no | yes | 0.08 | 0.50 | 0 | 180 |
| 176 | Dr4 | Dorotea | 7128407 | 574917 | 329 | edge | 10 | not wet | 40 | yes | no | no | 0.16 | 0.80 | 490 | 1080 |
| 177 | Dr5 | Dorotea | 7128455 | 576594 | 330 | edge | 0 | wet | 60 | no | no | no | 0.06 | 0.29 | 0 | 0 |
| 178 | Dr5 | Dorotea | 7128512 | 576589 | 335 | not edge | 0 | wet | 30 | no | no | no | 0.23 | 1.00 | 0 | 150 |
| 179 | Dr5 | Dorotea | 7128563 | 576585 | 332 | not edge | 0 | wet | 20 | no | yes | no | 0.08 | 0.00 | 0 | 0 |
| 180 | Dr5 | Dorotea | 7128616 | 576581 | 331 | not edge | 0 | not wet | 40 | no | yes | no | 0.05 | 0.67 | 0 | 0 |
| 181 | Dr5 | Dorotea | 7128668 | 576570 | 328 | edge | 0 | wet | 30 | no | no | no | 0.07 | 0.25 | 0 | 375 |