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# Multitaxa species richness of a wood-pasture complex in the Finnish SW-archipelago

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Traditional rural biotopes such as semi-natural grasslands and wood-pastures are among the most threatened biotopes in Finland. Archipelago Sea area hosts an especially representative collection of these biotopes, considering both their combined area and average quality. We surveyed birds, vascular plants, bryophytes, polypores and ground-inhabiting stipitate macrofungi in one wood-pasture complex in Korppoo, Archipelago Sea area. Here we report and discuss the results of these surveys. We detected altogether 457 species, including 8 red-listed bird species and 6 red-listed vascular plant species. We didn´t detect any red-listed bryophytes or fungi, but also these groups included several rare or indicator species as well as some fungal species not included in the latest Finnish red-list evaluation. The conservation value of this wood-pasture complex constitutes of species that are dependent on highly variable set of ecological conditions and habitats. This is related to highly variable conditions typical to wood pastures as a habitat.

## Introduction

Agriculture is one of the main global conservation concerns, but controversially, it also maintains a significant proportion of European biodiversity (Henle et al. 2008). When compared to intensively cultivated agricultural landscapes, extensively managed mosaics of forests and agricultural lands have significantly higher species diversity (Kivinen et al. 2006). Traditional rural biotopes, i.e. semi-natural grasslands and wood-pastures, have characterized rural landscapes in Europe for centuries. They are among the most species-rich habitats in rural hemiboreal landscapes (Cousins & Eriksson 2002). As an example, species richness of vascular plants can vary from 25 to 74 species per square meter on semi-natural grasslands in Northern Europe (Pykälä 2001).

Traditional agricultural landscapes and the biodiversity within them are dramatically decreasing due to partial or complete abandonment of farmland and intensification of land use (Benton et al. 2003, Henle et al. 2008). Cessation of traditional management practices causes homogenization of landscapes, which leads to habitat loss (Benton et al. 2003, Halada et al. 2011). As traditional cattle husbandry has seized due to agricultural modernization, disturbance-dependent species and their habitats have become threatened throughout Europe (Pykälä 2000, Halada et al. 2011). In Finland, traditional rural biotopes belong to the most threatened of all habitats (Raunio et al. 2008) and host a total of 1 807 red-listed species (Rassi et al. 2010).

Because of their conservational value, biodiversity of traditional rural biotopes has become a rising research subject during recent years. The studies have focused on semi-natural grasslands; comprehensive research is done e.g. on plants (Cousins & Eriksson 2002, Pykälä et al. 2005, Aavik et al. 2008, Johansson et al. 2008, Bruun et al. 2009), butterflies and moths (Pöyry et al. 2004, Pöyry et al. 2009, Öckinger et al. 2012), and bryophytes (Takala et al. 2012). Some studies have explored the diversity across multiple taxa (Luoto et al. 2003, Kivinen et al. 2006, Löbel et al. 2006, Allan et al. 2014). A central finding is that active management through low-intensity grazing or mowing is a prerequisite for existence of a variety of grassland species.

Alike semi-natural grasslands, wood-pastures are acknowledged as European biodiversity hot spots, and face increasing attention from conservation science and policy (Bergmeier et al. 2010, Plieninger et al. 2015). However, the species assemblages of wood-pastures have not received as much attention as semi-natural grasslands. Bryophytes and vascular plants of wood-pastures have been studied recently in Finland (Takala et al. 2014, Takala et al. 2015, Oldén & Halme 2016a, Oldén et al. 2016). As semi-open habitats, wood-pastures provide habitat for grassland and forest species. Their tree coverage ranges up from 10 %, but the canopy is not completely closed, as even the densest wood-pastures have small clearings where grassland vegetation dominates over forest species (Schulman et al. 2008). Although grazing-related disturbance dynamics drives species communities on wood-pastures (Oldén & Halme 2016a, Oldén et al. 2016), also the selective removal of trees and the regeneration of seedlings play key roles in determining the ecosystem dynamics of wood-pastures (Oldén et al. 2017).

A national survey on traditional rural biotopes was conducted in Finland during 1990s. According to its results, the extent and ecological quality of remaining semi-natural grasslands and wood-pastures are most prevalent in southwestern Finland (Vainio et al. 2001). Due to long-term extensive cattle husbandry based on island pasturage, hemiboreal southwestern archipelago developed a rich biodiversity (Lindström 2000). However, since 1950s, the management of traditional rural biotopes on islands has almost completely ceased (Kotiluoto 1998, von Numers & Korvenpää 2007). The cessation of grazing has caused pronounced changes within island ecosystems: species of shores, mires, wetlands, and woods have increased, while species of coastal meadows, pastures, and heaths have decreased (von Numers & Korvenpää 2007). After abandonment, traditional rural biotopes have begun to develop into less species rich shrub and tree communities (Kotiluoto 1998).

The uniqueness of biodiversity in traditional rural biotopes in Finnish southwestern archipelago has been understood already long time ago and several species surveys have been conducted there (e.g. Kotiluoto 1998, Lindgren 2000, von Numers & Korvenpää 2007). Nevertheless, thorough case studies such as surveys of several species groups on the same site at the same time have been rare (Kunttu et al. 2015). The management of traditional rural biotopes has decreased dramatically in southwestern archipelago: for example, some decades ago, there were ca 5000 hectares of meadows and pastures in the Archipelago Sea National Park and its surroundings, but today only 322 hectares are managed in the national park.

The purpose of this study was to survey the diversity of birds, polypores, stipitate macrofungi, vascular plants and bryophytes in a semi-natural wood-pasture with a long pasturage history in the Finnish southwestern archipelago to provide a holistic view of the biodiversity of one wood-pasture complex. Furthermore, the purpose was to explore differences between the study pastures

and to discuss the detected communities for example considering the presence or absence of specialized red-listed species. We focused especially on species that are dependent on or at least favor semi-open habitats or grazing.

## Materials and methods

### Study area

The study area is Nystu's cattle and sheep farm on Vattkast (also Wattkast) island in the Archipelago Sea (Fig. 1). The Archipelago Sea – part of the Baltic Sea – is the most southwestern part of the Finnish coastline and includes 40 000 islands or islets. The area belongs to the hemiboreal vegetation zone and is part of the biogeographic province of Varsinais-Suomi (*Regio aboënsis*) (Ahti et al. 1968, Knudsen & Vesterholt 2012).

The Archipelago Sea area has some special features compared to mainland Finland: the growing season is long (195 days), the diversity of biotopes is high, herb-rich forests are common, and wood-pastures and semi-natural grasslands are still relatively frequently grazed by domestic animals, especially on larger islands. Traditional rural biotopes are more common in the archipelago than elsewhere in the province of Varsinais-Suomi (Lehtomaa 2000) or the rest of Finland (Vainio et al. 2001). The Archipelago Sea National Park, which is located near our study area, is known for its high biodiversity, especially species and habitats related to traditional rural biotopes (Lindgren 2000, 2001, Lindgren et al. 2001).

The total land area of Nystu farm is ca 90 hectares, and it is almost entirely grazed by cattle and sheep. The farm area hosts diverse habitats: mesic meadows, coastal meadows, dry meadows, wood-pastures (wooded pastures and grazed woodlands, see Raunio et al. 2008), mixed uneven-aged forests and few pine or spruce mire patches. The forests have been managed with selective logging only, and biodiversity values have been taken into consideration by retention of deciduous trees such as *Quercus robur* and *Corylus avellana*. Dead wood has been retained in the forest. The most common tree species are *Pinus sylvestris, Picea abies, Alnus glutinosa, Betula pendula, Corylus avellana* and *Populus tremula*. The

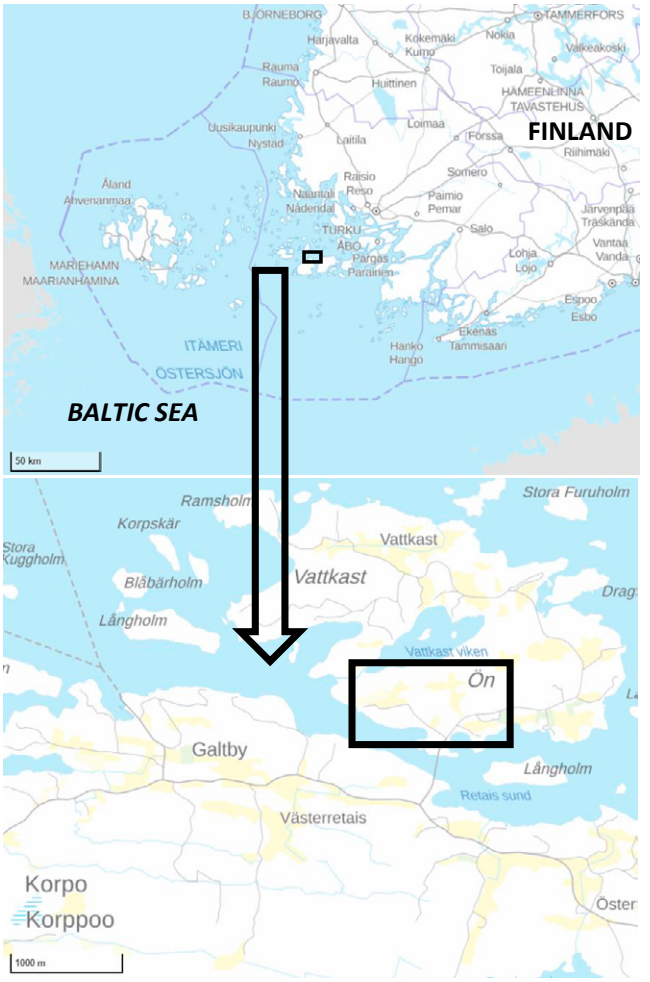


**Figure 1. Location of the study area. The map is from National Land Survey of Finland background map series database 6/2018.**

forests of Nystu have been managed as uneven-aged and only selective loggings have been done for household use. All forests are used as wood-pastures, at least for part of the grazing season.

Nystu farm was moved to its current location in the southern part of Vattkast island in the 1930's. Until then Nystu and two other farms were centered around Vattkast village in the middle of the island and their cattle were allowed to forage freely in the forest pastures of the southern part of the island. The grazing pressure was initially low in the Nystu farm that had around ten dairy cows, three horses and a few sheep. In the late 1970's the dairy cattle were replaced with calves and their numbers started to rise gradual-

ly. In 1997 a new cowshed was built, allowing for larger cattle and higher grazing pressure in the farm's grasslands and wood-pastures. Nowadays the grazing pressure is intermediate.

We selected three wood-pastures for our surveys among the grazed traditional rural biotopes of Nystu farm (Fig. 2). Most of the surveys were placed on these three wood-pastures which were selected during a site visit by all authors except PH (see birds for different study area). The purpose was to select pastures that represent typical wood-pastures in the Archipelago Sea area.

Pasture A (1.3 ha) is in a wood-pasture situated in the middle of the farmland. The lowest part of the pasture consists of moist broadleaved herb-rich forest, which gradually changes to dry pine-dominated forest towards the uphill part of the pasture (Fig. 3). The pasture had been selectively logged four years earlier. In the pine-dominated dry part of the pasture the dominant vascular plant species were *Vaccinium myrtillus* and *Deschampsia flexuosa*, and the dominant bryophytes were the common forest-floor species *Pleurozium schreberi* and *Hylocomium splendens.* In the *Corylus avellana* -dominated herb-rich part of the pasture the dominant vascular plant species were *Milium effusum*, *Anemone nemorosa*, and *Hepatica nobilis*. The most common species in the bryophyte layer were *Brachythecium rutabulum*, *Climacium dendroides*, *Plagiomnium medium*, *Rhytidiadelphus triquetrus* and *Sciuro-hypnum oedipodium*.

Pasture B is a small (0.3 ha) wood-pasture situated next to a grazed coastal meadow (Fig. 3). On the other side it is bordered by a road. The sparsely wooded pasture is dominated by mixed *Betula* spp., *Picea abies* and *Pinus sylvestris*. The dominant vascular plant species are *Achillea millefolium*, *Leontodon autumnalis*, *Taraxacum* spp., *Poa pratensis*, and *Stellaria media*. The ground layer is dominated by *Brachythecium rutabulum*.

Pasture C (1.3 ha) is constituted by a narrow, relatively open wood-pasture edge with mixed trees (dominated by *Pinus sylvestris, Betula* spp. and *Picea abies*) (Fig. 3). It is bordered from one side by a meadow and from the other side by a recently selectively logged pine-dominated wood-pasture. This pasture has aesthetic landscape values and it hosts many red-listed vascular plant species. The mixed-tree wood-pasture edge is of herb-rich heath forest. Dominant vascular plant


**Figure 2. Aerial photograph of the study area, indicating the location of the studied pastures (A, B and C) within it.**

**Figure 3. The main habitat types of each study pasture. Study pasture A, photo by Kaisa Tervonen.**

**Figure 3. Study pasture B, photo by Kaisa Raatikainen.**

**Figure 3. Study pasture C, photo by Kaisa Tervonen.**

species were *Rumex acetosa*, *Lathyrus pratensis*, *Poa pratensis* and *Pimpinella saxifraga*. Bryophyte *Rhytidiadelphus squarrosus* dominated in the semi-open edge while *Pleurozium schreberi* dominated higher up in the spruce-dominated wood-pasture. The plot area also includes patches of bare cliff (dominated by *Dicranum scoparium*) and some moist herb-rich patches in the shallow depressions (*Brachythecium rutabulum*, *Climacium dendroides* and *Plagiomnium* spp.).

### Vascular plants

Vascular plants were surveyed on the three study pastures on the18th and 19th of June 2012. Time-limited survey of 1.5 hours per pasture was used, during which species were searched and recorded from the whole pasture by KT and KJR. Almost all vascular plants were recorded at species level, but some species were retained at genus level (like *Alchemilla, Hieracium* and *Taraxacum*), if grazing had left the shoots unidentifiable. The nomenclature of vascular plants follows Hämet-Ahti *et al.* (1998), the classification of red-list species Rassi et al. (2010) and quality indicator species Pykälä (2009) and Helle & Mussaari (2004). Quality indicator species of semi-natural grasslands indicates moderately current and historical land use (grazing or mowing) when they occur in semi-natural grasslands (Pykälä 2001). These quality indicator species have positive indicator value.

### Bryophytes

Bryophytes were surveyed by AO with time-limited 1.5 hour surveys per pasture on the18th and 19th of June 2012. Unfortunately, a heavy downpour of rain occurred during the surveys in pastures B and C, which limited the chances of observing the smallest bryophyte species. Specimens of bryophytes were collected when necessary and identified later by AO. The nomenclature and classification of bryophytes follows Sammaltyöryhmä (2015).

### Stipitate macrofungi

Stipitate species of Agaricales, Boletales and Aphylloporales (Ramarioid species, stipitate polypores etc.) fungal species were surveyed on the 9th and 10th of October 2013. The surveys were conducted by one hour time-limited survey by KT and PH on each pasture. For each species

on each pasture we recorded the number of separate occurrences with the maximum of three. I.e. if we detected more than three clearly separate fruit bodies (distance from another fruit body at least 10 meters) we regarded the species to be ”common all over the pasture”. We collected specimens for further identification when needed. Sorting the specimens and further notes were done after the one hour survey time. 70 specimens were collected and identified with microscope by KT and PH, and by specialists Juhani Ruotsalainen, Mika Toivonen and Ilkka Kytövuori. The nomenclature of agarics follows Knudsen & Vesterholt (2012), Gasteromycetes and Typhulaceae Salo et al. (2006), and Aphylloporales Kotiranta et al. (2009) if not given otherwise. The classification of non-evaluated (NE) species follows von Bonsdorff (2012). The preferred habitat of different fungal species have been listed in Kytövuori et al. (2005) and Kotiranta et al. (2009). Moreover, indicator species for valuable biotopes are listed by von Bonsdorff et al. (2014). We note both of these statuses considering traditional rural biotopes.

### Polypores

The polypore survey was carried out on the 9th and 10th of October 2013 and was focused on sporocarps of all polypore species. Occasional corticioids were also collected during the survey. The data was collected by PK who also identified polypores, but Matti Kulju identified corticioids. October is a suitable period for performing polypore inventories according to occurrence of basidiocarps (Halme & Kotiaho 2012). Every dead wood piece with a diameter of at least 5 cm was surveyed. In total 28 specimens were collected for later identification or documentation. Taxonomy and nomenclature are mainly according to Kotiranta et al. (2009) and Niemelä (2012), but the nomenclature of the genus *Hyphodontia* sensu lato follows Hjortstam & Ryvarden (2009). Voucher specimens are deposited in the herbarium of the University of Turku (TUR).

### Birds

The breeding bird survey was carried out in May – June 2013 by JT. The survey method was mapping census (Koskimies & Väisänen 1988), but the number of breeding pairs was counted only in for the rarest species. The study area covered 90 hectares (Fig. 2) and it was surveyed twice, following a general protocol in farmland bird censuses (e.g. Piha et al. 2007, Vepsäläinen et al. 2007). In addition, the results include some records of rare breeding birds from previous years (see Appendix). Bird nomenclature follows Crochet & Joynt (2015) and the red-list statuses are according to Tiainen et al. (2016).

## Results and discussion

### Vascular plants

We observed altogether 152 vascular plant species in the three study pastures (Appendix). The vascular plant species richness is quite high and is caused by the patchiness of the tree cover, soil conditions and grazing. Grazing has positive effects on vascular plant species richness in traditional rural biotopes (Pykälä 2003, Oldén et al. 2016). Our study pastures were grazed quite heavily which affected the detectability of species and caused some difficulties in species identification.

We found six red-list and eleven quality indicator species (incl. four red-listed species) in the pastures. In pasture A we found 99 species including red-listed *Cardamine parviflora* (EN), *Galium verum* (VU, also quality indicator) and quality indicator species *Primula veris*, *Quercus robur*, and *Satureja vulgaris*. In pasture B we observed 87 species including *Cardamine parviflora* (EN) and *Plantago lanceolata* (NT, also quality indicator), and quality indicator species *Tilia cordata*. Pasture C was the most species rich pasture (110 species) and included six red-listed and nine quality indicator species (incl. four red-list species). Red-listed species in pasture C were: *Cardamine parviflora* (EN), *Galium verum* (VU), *Nardus stricta* (NT), *Plantago lanceolata* (NT), *Polygala vulgaris* (VU), and *Thalictrum aquilegiifolium* (VU), which *Galium verum*, *Nardus stricta*, *Plantago lanceolate*, and *Polygala vulgaris* are also quality indicators. Quality indicator species were *Bistorta vivipara, Primula veris*, *Quercus robur*, and *Tilia cordata*.

Almost all above mentioned red-listed species are dependent on semi-natural grasslands and are also indicators of high-quality management. *Cardamine parviflora* and *Thalictrum aquilegiifolium* are not directly dependent on traditional rural biotopes, but the end of grazing and the following overgrowth of bushes in shores have been mentioned as a threat for *Cardamine parviflora* (Ryttäri & Kettunen 1997). *Cardamine parviflora* was observed in all of the pastures. *Thalictrum aquilegiifolium* naturally grows in herb-rich forests or in wooded meadows, but the species is also used as a garden plant (Hämet-Ahti et al. 1998). In this study, we most likely observed *T. aquilegiifolium* escaped from a garden, and thus the observation should be taken in to account with concern. All detected indicator species, except three are indicators of valuable semi-natural grasslands and can be called as traditional rural biotope species. *Quercus robur*, *Satureja vulgaris*, *Tilia cordata* also somewhat indicate valuable semi-natural grasslands but the primary habitats of those species are herb-rich forests or herb-rich heath forests (Hämet-Ahti et al. 1998).

Especially pasture C is very valuable as a habitat for many red-list and noteworthy vascular plant species mostly due to its quite dry soil, continuity of grazing and varying tree structure. Pasture B hosted the lowest species richness, but also the surveyed area was smallest. Pasture A has more closed canopy than other pastures and included a species rich patch with abundant *Corylus avellana*.

Ole Eklund (1958) made extensive botanical studies in the Archipelago Sea at the first part of 20th century. He made species inventories also on Wattkast island. His findings included many vascular plant species specialized on traditional rural biotopes. For example, *Filipendula vulgaris, Avenula pubescens* and *Ranunculus polyanthemos* were found then, but not this time on these study pastures. It is possible that these species and many other found by Eklund can still exist on Wattkast, because our study pastures are only a tiny part of the whole island.

Semi-natural grasslands are the primary habitat for many of the common species at the pastures (see vascular plant species list of semi-natural grasslands in Pykälä 2001, Appendix). In general, high species richness of vascular plants in traditional rural biotopes is mainly due to decreasing biomass of dominant vascular plant species by grazing (van der Maaler & Sykes 1993, Olff & Ritchie 1998). Decreasing biomass and size of vascular plants decreases competition between vascular plant species and trampling of soil liberate space and resources to a wider range of vascular plant species. These processes promote increased species richness (Olff & Ritchie 1998, Pykälä 2001).

**Bryophytes**

A total of 54 bryophyte species were observed in Nystu (Appendix). They included 51 moss species and only three liverwort species. The number of moss species is rather high due to the patchy soil conditions that include naturally fertile and moist patches, the variable tree densities, varying tree species and the occurrence of variable pieces of decaying wood. In addition, bryophyte richness is increased by the effects of grazers, such as the bare soil and rock patches created by trampling and the decreased competition due to vascular plant defoliation (Oldén & Halme 2016b, Oldén et al. 2016). The low number of liverwort species in wood-pastures may be explained by the semi-open conditions as well as the scarcity of large decaying logs (Oldén & Halme 2016b). Many liverworts favor moist microclimatic conditions and are therefore most common in moist old-growth forests (Ulvinen et al. 2002). Finally, the diversity of both mosses and liverworts is lower on this kind of areas with siliceous bedrock than in calcareous sites. For example, Ingerpuu et al. (1998) found several calciphilous species in a wooded meadow in Estonia, and those species do not occur in Nystu.

No red-listed bryophyte species were observed on the pastures, but five of the observed species indicate nature values such as rare or diverse habitats (Sammaltyöryhmä 2015). Pasture A was the most diverse in terms of total bryophyte species richness (36) and the number of indicator species (3). Most of the species occurred in the moist and meso-eutrophic herb-rich depression, including the indicator species *Sphagnum teres* and *Thuidium tamariscinum* that are typical to meso-eutrophic areas with the effects of flood or spring water. The bryophyte communi-

ty of pasture A was also diversified by the occurrence of relatively diverse decaying wood, which provided a habitat for the third indicator species, *Herzogiella seligeri*. The bryophyte community on pasture B was affected by the occasional effects of flooding, especially on the lower edge of the wood-pasture where the indicator species *Leskea polycarpa* grew on the bases of deciduous trees. Pasture C was the least diverse because of the mostly dry and sunny conditions, but the small depressions hosted species typical to moist or spring-fed areas, including the indicator species *Plagiomnium undulatum*.

None of the above-mentioned rare bryophyte species are directly dependent on the effects of pasturage, but are instead dependent on moist, flooded, spring-fed and/or mesotrophic conditions. Therefore, the conservation values of wood-pastures may be more related to the maintenance of continuous albeit semi-open tree canopies in such sites with rare soil conditions. On the other hand, the species do not seem to be harmed by the grazers and may even benefit from the creation of empty patches by trampling. Similarly, rare bryophytes in boreal wood-pastures in Central Finland have been observed to depend more on specific microhabitats or moist and fertile conditions than on the pasture use itself (Oldén & Halme 2016b, Oldén et al. 2016). Many of the common species benefit from the high light availability (e.g. *Brachythecium albicans* and *Rhytidiadelphus squarrosus*) and the availability of trampled patches with bare soil (e.g. *Brachythecium mildeanum*, *Bryum capillare*, *Ceratodon purpureus* and *Pohlia nutans*) (see Ulvinen et al. 2002).

**Stipitate macrofungi**

In total 101 fungal species (Agaricales and Aphyllophorales) were observed on the study pastures (Appendix). The most species rich was pasture A with 64 species, the second was pasture C with 54 species and the poorest was pasture B with 33 species. These species numbers at pasture scale are among the average diversity if compared to our previous similar surveys in wood pastures in Central Finland (Tervonen et al. 2019, Tervonen et al. unpublished, However, strong conclusions on ground-inhabiting fungal species richness should not be drawn based on a single survey (van der Linde et al. 2012, Straatsma et al. 2001).

We did not detect any red-listed fungal species in our study pastures. Two non-evaluated species were detected on pasture A. These species (*Deconica crobula* and *Marasmius setosus*) have also been found in several wood-pastures in Central Finland (Tervonen et al. unpublished). They seem to be common in many other kinds of semi open habitats as well, and should be classified as LC in the next evaluation. *Galerina perplexa* was detected on pasture C and has also been found from about third of the studied wood-pastures in Central Finland (Tervonen et al. unpublished), but it is still very little collected and was not considered at all in the previous red-list evaluation. Bonsdorff et al. (2015) reported *Galerina perplexa* new to Finland, thus its status in our species list is ”new”. *Russula puellaris* var. *cupreovinosa* Reumaux was found from pasture A and it is quite common (*Russula* specialist Juhani Ruotsalainen, pers. comm.), although it was not treated in the previous red-list evaluation. *Mycena floridula* has obviously been collected in Finland already before this study, but it was not considered in the previous red-list evaluation but included to *Mycena adonis*. According to von Bonsdorff (bulletin by e-mail 2016) *M. floridula* status in next evaluation will be LC, thus its status in our species list is LC.

We found also four indicator species but the target habitat is not traditional rural biotopes for three of them. *Macrolepiota procera* (indicator value=IV 2 according to von Bonsdorff et al. 2014) was found from pasture A and C. It was the only indicator species of valuable wood-pastures in our study pastures, but it is also listed as an indicator of valuable deciduous herb-rich forests. *Galerina clavata* (IV 1) was found from pasture A and it is an indicator species of valuable wooded swamps and flooded forests. *Mycena polygramma* (IV 1) was abundant in all of our study pastures. It is an indicator species of valuable deciduous herb-rich forests and parklike habitats. *Mycena purpureofusca* (IV 2) was found from pasture C and it is an indicator of valuable unmanaged pine-dominated forests and parklike habitats.

We detected only one species, *Conocybe brunneidisca,* whose main habitat is traditional rural biotopes according to Kytövuori et al. 2005,

but there were 17 additional species for which traditional rural biotopes is given as one of the habitats but not the main one.

Pasture A is a valuable fungal biotope because of its herb-rich forest patches and moist spots that produce suitable habitat for many fungal species. Pasture B is quite a typical wood-pasture from the fungal point of view, and valuable as such. Pasture C did not host much detected values, but it seems to have potential to have much more species than we found. More fungal survey repeats should be conducted to evaluate the real conservation value of the studied pastures for fungal species.

Surveys were conducted only once and thus many species were not detected. Most Basidiomycete fungi fruit in the autumn, so we conducted our survey in optimal season (Moore et al. 2008, Halme et al. 2012). However, many fruit bodies are short-lived and in addition fruit body production varies between years and many species do not produce fruit bodies every year (Stadler & Sterner 1998, Straatsma et al. 2001, Moore et al. 2008). It has been noticed that to reveal even the majority of species richness of the area, surveys must be conducted along several years, especially considering ground dwelling agarics (Straatsma et al. 2001, but see also Halme & Kotiaho 2012, Abrego et al. 2016).

Earlier studies on the fungi of traditional rural biotopes have shown that grazing creates more habitats for grassland fungi than mowing (Nauta & Jalink 2001). However, it is not known how much cattle eats fruit bodies and how this affects both the detected and truly present community. Fungal biodiversity in wood-pastures is still very poorly known (but see Rotheroe 2001, Griffith et al. 2012)

## Polypores

In total, 38 polypore species were detected in the study pastures. In addition, 32 corticioid species were collected as a by-product without any systematic inventory method (Appendix). The highest polypore diversity (23 species) was detected on study pasture A (Figs. 2 & 3).

Four old-growth forest indicator species (according to Kotiranta & Niemelä 1996) were found: *Anomoporia kamtschatica, Meruliopsis taxicola, Phellinus pini* and *Postia leucomallella*. All of them grew on *Pinus sylvestris*. Other noteworthy records were *Antrodiella romellii* and *Ganoderma lucidum* which are occasional species growing on dead wood in mixed or deciduous forests, mainly in South and Central Finland (Niemelä 2005, Kotiranta et al. 2009). No red-listed species were found.

The most remarkable corticioid record was *Xylodon pruni*. This was the fourth record in Finland (Kotiranta et al. 2009). It grew on a stump of *Juniperus communis*. Other interesting species was *Hyphoderma roseocremeum*, a relatively rare species in Finland, occurring only in southwestern Finland. The other detected species are common and fairly typical species in South Finland, mainly growing on deciduous trees (Kotiranta et al. 2009).

There are only few studies on polypores in traditional rural habitats or other semi-open forested habitats, which is understandable because many polypore species are favoring old-growth forest or at least some structures typical to old-growth forests (Penttilä et al. 2004, Junninen et al. 2006, Komonen & Junninen 2011). Vauras (2000) and Kunttu (2016) have made studies on Aphyllophorales in traditionally managed semi-natural biotopes on the islands of the Archipelago Sea National Park.

There are no polypores or corticioids in Finland which are directly dependent on wood-pastures, but traditional rural biotopes are a combination of species living mainly on herb-rich forests, old-growth forests (especially species depending on big trees) and semi-open wooded habitats (Kotiranta & Niemelä 1996, Vauras 2000, Kotiranta et al. 2009). The Swedish list of indicator species mentions two polypores that are indicators of wood-pastures (Nitare 2000). Rare or threatened species of wood-pastures were not met in this study, but all found indicator species and two herb-rich forest species are examples of species to which wood-pastures can provide suitable habitats.

## Birds

Altogether 74 species were observed in our surveys, and five additional species had been observed during previous years (Appendix). The

breeding bird fauna in the farm is rich due to diverse forests, high habitat diversity and pasturage. Grazing benefits birds that feed in short-grown vegetation habitats or feed on invertebrates associating with grazing domestic animals. Forests with low-intensity management history provide dead trees and tree hollows (Atlegrim & Sjöberg 2004, Sippola et al. 2001), which are suitable nesting and feeding sites for birds. Wood-pastures also provide ampler invertebrate fauna than normal managed forests (Falk 2014), and it is essential for many insect-feeding bird species. Breeding birds of our study area included 16 red-listed species and two red-listes species from the previous years (Appendix).

We observed the following species that benefit from open or semi-open biotopes created by pasturage: *Sturnus vulgaris, Hirundo rustica* (NT), *Delichon urbicum* (EN), *Oenanthe oenanthe* (NT)*, Motacilla alba, Alauda arvensis, Emberiza citrinella* and *Tringa totanus* (VU). Furthermore, *Anas clypeata, Anser anser* and *Gallinago gallinago* (VU) nested on an open meadow near the shore. Dry meadows dominated by *Juniperus communis* were suitable habitats to *Lanius collurio* (VU)*, Sylvia nisoria* (VU)*, Sylvia communis, Sylvia curruca* and *Carduelis chloris* (VU).

Moreover, following birds have benefited directly from grazing domestic animals, cattle and sheep feeding on invertebrates associated with grazing domestic animals, cattles and sheeps: *Passer domesticus, Passer montanus, Emberiza citrinella, Corvus monedula, Pica pica, Corvus corone cornix, Hirundo rustica, Delichon urbica. Passer domesticus* (VU) and *C. monedula* bred inside farm buildings. For example, ten pairs of *P. domesticus* bred inside the sheep barn, and they had there up to three broods per year.

The selective logging forest management has positive effects on bird fauna (Calladine et al. 2015, 2017, Peura et al. 2017). For example, the following hole-nesting species benefit from the old trees retained in wood-pastures: all woodpeckers, *Parus* spp., like *Parus cristatus* (VU), *Certhia familiaris, Sturnus vulgaris, Phoenicurus phoenicurus, Jynx torquilla, Apus apus* (VU)*, Columba oenas, Bucephala clangula, Aegolius funereus* (NT), and *C. monedula*. *Buteo buteo* (VU) can build its nest to the large old trees typical to wood-pastures. The forests are spared as mixed forest with deciduous trees and also scrubs are retained. These are important nesting habitats to *Sylvia spp., Phylloscopus sibilatrix, Luscinia luscinia, Turdus* spp., *Carduelis spinus* and *Carpodacus erythrinus* (NT). Forests included also wet patches where *Scolopax rusticola, Tringa ochropus* and *Grus grus* nested.

There are few studies about breeding birds in wood-pastures (Velmala 2000), but some of the species typical to wood-pastures also occur in agricultural areas (Pitkänen & Tiainen 2001), whereas birds of meadows, particularly shore meadows, have been studied very much.

Agricultural intensification, large-scale changes in farming practices, changes in landscape structure and the loss of semi-natural grasslands have resulted in a loss of spatial and temporal habitat heterogeneity and key habitats, and caused a decline of bird populations in agricultural habitats (Fuller et al. 1995, Söderström & Pärt 2000, Benton et al. 2003, Tiainen & Pakkala 2000). Our observations include for example *S. vulgaris, O. oenanthe, A. arvensis, Carpodacus erythrinus, H. rustica* and *D. urbicum* which are species that have declined strongly in agricultural areas in Finland (Tiainen & Pakkala 2000, Pitkänen & Tiainen 2001, Piha et al. 2003, Valkama et al. 2011). It is obvious that these species benefit from traditional rural biotopes and grazing. In turn, *Sylvia nisoria* has one of the most restricted habitat requirements and it mainly breeds in semi-natural, semi-open biotopes (Laine 1988, Kunttu 2009).

All of the 16 species that had highest population densities in a study made in the wood-pastures in the Archipelago Sea National Park (Lindgren 2000), i.a. *S. rusticola, J. torquilla, Luscinia luscinia, Prunella modularis, P. phoenicurus, S. curruca, S. nisoria, Phylloscopus trochilus, Muscicapa striata, L. collurio* and *Carduelis chloris*, were met in our survey.

## Conclusions

This article provides a quite comprehensive list of species associated with a wood-pasture complex in southwestern Finland. It is useful as a reference when discussing the biodiversity of traditional rural biotopes. According to the biology of

the detected red-listed and indicator species, the conservation value of the studied wood-pasture site is constituted of very different elements, i.e. its heterogeneity as a habitat complex. Some species require flooded patches, some others continuous grazing, some species constant shadow and so on. We argue that Nystu is a representative example of the complexity of the conservation values of traditional rural biotopes. More specifically, considering wood-pastures, such multiple values are tied to the continuous presence of old trees, the semi-open conditions, the direct presence of the grazers (through dunging, defoliation and trampling), low amount of available nutrients in the top soil layers and the presence of undisturbed lower soil layers. Together these and potential other factors create a highly diverse mosaic-like habitat.

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## Appendix. List of species.

**Explanations**

- • = Species is typical for traditional rural biotopes and it is quality indicator (Helle & Mussaari 2004)
- – = If species occurs abundant, it indicates negative quality (too nutrient) of semi-natural grassland (Helle & Mussaari 2004)
- ▲ = Species is quality indicator when it occurs in traditional rural biotope but its main habitat is not traditional rural biotope (Pykälä 2001)

| VASCULAR PLANTS Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Achillea millefolium* | | | x | x | x |
| *Achillea ptarmica* | | | x | x | x |
| *Agrostis capillaris* | | | x | x | x |
| *Alchemilla* sp. | | | | | x |
| *Alnus glutinosa* | | | x | x | |
| *Alopecurus geniculatus* | | | | x | |
| *Anemone nemorosa* | | | x | | x |
| *Angelica sylvestris* | | | x | x | x |
| *Anthoxanthum odoratum* | | | x | x | x |
| *Anthriscus sylvestris* | | – | x | x | x |
| *Aquilegia vulgaris* | | | | x | |
| *Betula pendula* | | | x | x | x |
| *Betula pubescens* | | | x | x | x |
| *Bistorta vivipara* | | • | | | x |
| *Briza media* | | | | | x |
| *Calamagrostis arundinacea* | | | x | x | |
| *Calamagrostis epigejos* | | | | | x |
| *Calamagrostis* sp. | | | | x | |
| *Calystegia sepium* | | | | x | |
| *Campanula patula* | | | | | x |
| *Campanula persicifolia* | | | x | | x |
| *Campanula rotundifolia* | | | | | x |
| *Cardamine parviflora* | EN | | x | x | x |
| *Cardamine pratensis* | | | | x | x |
| *Carex canescens* | | | | | x |
| *Carex digitata* | | | x | | x |
| *Carex echinata* | | | x | x | |
| *Carex nigra* | | | x | x | x |
| *Carex ovalis* | | | x | x | x |
| *Carex pallescens* | | | x | x | x |
| *Carex* sp. | | | x | | x |
| *Carex vaginata* | | | | | x |
| *Carum carvi* | | | | | x |
| *Centaurea jacea* | | | | x | x |
| *Cerastium fontanum* | | | | x | x |
| *Chelidonium majus* | | | x | | |
| *Chenopodium album* coll. | | | | x | |
| *Circium helenioides* | | | x | | |
| *Circium palustre* | | | x | x | x |
| *Circium vulgare* | | | x | | x |
| *Corylus avellana* | | | x | | x |
| *Dactylorhiza maculata* | | | x | | |

| VASCULAR PLANTS Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Deschampsia cespitosa* | | | x | x | x |
| *Deschampsia flexuosa* | | | x | x | x |
| *Dryopteris carthusiana* | | | x | x | x |
| *Dryopteris filix-mas* | | | x | | |
| *Elymus repens* | | – | | x | |
| *Epilobium* sp. | | | | | x |
| *Equisetum arvense* | | | x | | |
| *Equisetum sylvaticum* | | | x | | |
| *Festuca ovina* | | | | x | x |
| *Festuca pratensis* | | – | | | x |
| *Festuca rubra* | | | | x | |
| *Festuca trachyphylla* | | | x | | x |
| *Filipendula ulmaria* | | | x | x | x |
| *Fragaria vesca* | | | x | x | x |
| *Galeopsis* sp. | | | | | x |
| *Galium album* | | | | | x |
| *Galium aparine* | | | | x | |
| *Galium boreale* | | | x | | x |
| *Galium* sp. | | | x | | |
| *Galium spurium* | | | | | x |
| *Galium trifolium* | | | x | x | x |
| *Galium verum* | VU | • | x | | x |
| *Geranium sylvaticum* | | | x | | |
| *Geum rivale* | | | x | | x |
| *Geum* sp. | | | | | x |
| *Geum urbanum* | | | | x | |
| *Glechoma hederacea* | | | | x | |
| *Gymnocarpium dryopteris* | | | x | | |
| *Hepatica nobilis* | | | x | x | x |
| *Heracleum* sp. | | | | | x |
| *Hieracium* sp. | | | x | x | |
| *Hypericum maculatum* | | | x | x | x |
| *Juncus alpinoarticulatus* | | | x | | |
| *Juncus filiformis* | | | x | | |
| *Juniperus communis* | | | x | x | x |
| *Lathyrus pratensis* | | | x | | x |
| *Lathyrus vernus* | | | x | | |
| *Leontodon autumnalis* | | | | x | x |
| *Leucanthemum vulgare* | | | x | | x |
| *Luzula multiflora* | | | x | | x |
| *Luzula pallescens* | | | x | x | |
| *Luzula pilosa* | | | x | x | x |

| VASCULAR PLANTS Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Lychnis viscaria* | | | | | x |
| *Lysimachia* sp. | | | x | x | x |
| *Maianthemum bifolium* | | | x | x | x |
| *Matricaria matricarioides* | | | | x | |
| *Melampyrum pratense* | | | x | | x |
| *Melampyrum sylvaticum* | | | x | x | x |
| *Melica nutans* | | | x | | x |
| *Milium effusum* | | | x | | |
| *Mycelis muralis* | | | x | | x |
| *Nardus stricta* | NT | • | | | x |
| *Oxalis acetosella* | | | x | x | x |
| *Paris quadrifolia* | | | | | x |
| *Persicaria minor* | | | | x | |
| *Phleum pratense* | | | | | x |
| *Picea abies* | | | x | x | x |
| *Pilosella cymosa* coll. | | | | x | |
| *Pilosella officinarum* | | | x | | x |
| *Pilosella* sp. | | | | x | x |
| *Pimpinella saxifraga* | | | | x | x |
| *Pinus sylvestris* | | | x | x | x |
| *Plantago lanceolata* | NT | • | | x | x |
| *Plantago major* | | | | x | |
| *Platanthera bifolia* | | | x | | x |
| *Poa nemoralis* | | | | x | |
| *Poa pratensis* | | – | x | x | x |
| *Poa* sp. | | | x | | |
| *Poa trivialis* | | | x | | |
| *Polygala vulgaris* | VU | • | | | x |
| *Polypodium vulgare* | | | x | | |
| *Populus tremula* | | | x | | |
| *Potentilla anserina* ssp. *anserina* | | | | x | |
| *Potentilla erecta* | | | x | x | x |
| *Primula veris* | | • | x | | x |
| *Prunella vulgaris* | | | x | x | x |
| *Pteridium aquilinum* | | | x | x | x |
| *Quercus robur* | | ▲ | x | | x |
| *Ranunculus acris* | | | x | x | x |
| *Ranunculus auricomus* | | | | | x |
| *Ranunculus repens* | | | x | x | x |
| *Ribes alpinum* | | | | | x |
| *Rosa* sp. | | | | x | x |
| *Rubus idaeus* | | | x | x | x |
| *Rubus saxatilis* | | | x | | x |
| *Rumex acetosa* | | | x | x | x |
| *Rumex acetosella* | | | x | x | x |
| *Rumex acetosella* ssp. *tenuifolius* | | | x | | |
| *Rumex longifolius* | | – | | x | |
| *Satureja vulgaris* | | • | x | | |
| *Senecio* sp. | | | x | | |

| VASCULAR PLANTS Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Silene dioica* | | | x | x | |
| *Sorbus aucuparia* | | | x | x | x |
| *Stellaria graminea* | | | x | x | x |
| *Stellaria media* | | | x | x | x |
| *Sylvatica-ryhmä* | | | x | | x |
| *Taraxacum* spp. | | – | x | x | x |
| *Thalictrum aquilegiifolium* | VU | | | | x |
| *Tilia cordata* | | ▲ | | x | x |
| *Trientalis europaea* | | | x | x | x |
| *Trifolium pratense* | | | x | x | x |
| *Trifolium repens* | | | x | x | x |
| *Trifolium* sp. | | | x | | |
| *Tripleurospermum inodorum* | | | | x | |
| *Urtica dioica* | | – | x | x | x |
| *Vaccinium myrtillus* | | | x | x | x |
| *Vaccinium vitis-idaea* | | | x | x | x |
| *Valeriana sambucifolia* | | | | x | |
| *Veronica chamaedrys* | | | x | x | x |
| *Veronica officinalis* | | | x | x | x |
| *Veronica serpyllifolia* | | | x | x | x |
| *Vicia cracca* | | | | | x |
| *Vicia sepium* | | | x | | |
| *Viola canina* | | | x | | x |
| *Viola palustris* | | | x | x | x |
| *Vulgata*-group | | | | x | x |

## References

**Nomenclature** according to:

Hämet-Ahti, L., Suominen, J., Ulvinen, T. & Uotila, P. 1998: Retkeilykasvio (Field Flora of Finland). — 4th ed. Finnish Museum of Natural History, Botanical Museum, Helsinki, 656 p. (in Finnish with English summary)

**Red-list status** according to:

Rassi P., Hyvärinen E., Juslén A. & Mannerkoski I. (eds.) 2010: The 2010 Red List of Finnish Species. — Ministry of the Environment & Finnish Environment Institute, Helsinki, 685 p.

**Indicator status** according to:

Pykälä, J. 2009: Appendix 12. Huomion arvoiset putkilokasvit perinnebiotoopeilla. In: Raatikainen K. (ed.), Perinnebiotooppien seurantaohje. — Metsähallituksen luonnonsuojelujulkaisuja B 117: 103–109. (in Finnish)

Helle, I. & Mussaari, M. 2004: Etelä- ja Keski-Suomen perinnebiotooppien (niityt, kedot ja hakamaat) lajistoa, species list.

| BRYOPHYTES Species | Red-list status | Indicator status | Plot A | B | C |
|---|---|---|---|---|---|
| *Amblystegium serpens* | | | | x | x |
| *Aulacomnium androgynum* | | | x | x | |
| *Aulacomnium palustre* | | | x | | x |
| *Brachytheciastrum velutinum* | | | x | | |
| *Brachythecium albicans* | | | | x | |
| *Brachythecium mildeanum* | | | x | | |
| *Brachythecium rutabulum* | | | x | x | x |
| *Brachythecium salebrosum* | | | | x | |
| *Bryum caespiticium* | | | | | x |
| *Bryum capillare* | | | | x | |
| *Calliergon cordifolium* | | | x | | |
| *Ceratodon purpureus* | | | | x | x |
| *Climacium dendroides* | | | x | x | x |
| *Dicranum polysetum* | | | x | | x |
| *Dicranum scoparium* | | | x | x | x |
| *Grimmia sp.* | | | x | | |
| *Hedwigia ciliata* | | | x | x | x |
| *Herzogiella seligeri* | | • | x | | |
| *Hylocomium splendens* | | | x | x | x |
| *Hypnum cupressiforme* | | | x | x | x |
| *Leptodictyum riparium* | | | x | x | |
| *Leskea polycarpa* | | • | | x | |
| *Lophocolea heterophylla* | | | x | | x |
| *Mnium hornum* | | | x | x | x |
| *Orthotrichum speciosum* | | | | x | x |
| *Orthotricum obtusifolium* | | | | | x |
| *Plagiomnium affine* | | | | x | x |
| *Plagiomnium cuspidatum* | | | | x | |
| *Plagiomnium medium* | | | x | | x |
| *Plagiomnium undulatum* | | • | | | x |
| *Plagiothecium curvifolium* | | | | | x |
| *Plagiothecium denticulatum* | | | x | | |
| *Pleurozium schreberi* | | | x | x | x |
| *Pohlia nutans* | | | | x | |
| *Polytrichastrum formosum* | | | x | | |
| *Polytrichum commune* | | | x | x | |
| *Polytrichum juniperinum* | | | x | | x |
| *Ptilidium pulcherrimum* | | | x | x | |
| *Ptilium crista-castrensis* | | | | | x |
| *Racomitrium heterostichum* | | | x | | |
| *Racomitrium microcarpon* | | | | x | x |
| *Radula complanata* | | | x | | |
| *Rhodobryum roseum* | | | x | x | |
| *Rhyncostegium sp.* | | | x | | |
| *Rhytidiadelphus squarrosus* | | | x | x | x |
| *Rhytidiadelphus triquetrus* | | | x | | |
| *Sanionia uncinata* | | | x | x | |
| *Sciuro-hypnum oedipodium* | | | x | x | x |
| *Sciuro-hypnum populeum* | | | x | | |
| *Sciuro-hypnum reflexum* | | | x | x | |
| *Sciuro-hypnum starkei* | | | | | x |
| *Sphagnum squarrosum* | | | x | | |
| *Sphagnum teres* | | • | x | | |
| *Tetraphis pellucida* | | | x | | |
| *Thuidium tamariscinum* | | • | x | | |

## References

**Nomenclature** according to:

Sammaltyöryhmä 2015: Suomen sammalien levinneisyys metsäkasvillisuusvyöhykkeissä ja ELY-keskuksissa. — Suomen ympäristökeskus, Tampere. 335 p. (in Finnish)

**Red-list status** according to:

Rassi P., Hyvärinen E., Juslén A. & Mannerkoski I. (eds.) 2010: The 2010 Red List of Finnish Species. — Ministry of the Environment & Finnish Environment Institute, Helsinki, 685 p.

**Indicator status** according to:

Sammaltyöryhmä 2015: Suomen sammalien levinneisyys metsäkasvillisuusvyöhykkeissä ja ELY-keskuksissa. — Suomen ympäristökeskus, Tampere. 335 p. (in Finnish)

**Explanations**

**TRB = traditional rural biotope is the species main habitat**

**▲ = traditional rural biotope is the species one habitat, but not the main one**

**• = indicator species**

**x/xx / xxx = the number of separate occurrences with the maximum of three**

| STIPITATE MACROFUNGI Species | Red-list status | Indicator status | Plot A | B | C |
|---|---|---|---|---|---|
| *Amanita muscaria* var. *muscaria* | | | | x | x |
| *Auriscalpium vulgare* | | | xx | x | xx |
| *Baespora myosura* | | | xxx | xxx | xxx |
| *Bolbitius titubans* | | | | x | |
| *Calocera viscosa* | | | x | x | |
| *Cantharellus cibarius* | | ▲ | x | | |
| *Clavulina cinerea* | | | | | x |
| *Clitocybe odora* var. *odora* | | | | x | |
| *Clitocybe* sp. | | | x | | x |
| *Clitopilus prunulus* | | | x | x | x |
| *Conocybe* aff. *tenera* | | | | x | |
| *Conocybe brunneidisca* | | TRB | | | x |
| *Coprinus comatus* | | | | x | |
| *Cortinarius flexipes* coll. | | | x | | x |

| STIPITATE MACROFUNGI Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Cortinarius raphanoides* | | | x | | |
| *Cortinarius spilomeus* | | | x | | |
| *Cortinarius triumphans* | | | | | x |
| *Crepidotus versutus* | | | x | | |
| *Cystoderma jasonis* var. *jasonis* | | | | | x |
| *Deconica crobula* | NE | | x | | |
| *Deconica merdaria* coll. | | | x | | |
| *Entoloma cetratum* | | | x | | |
| *Entoloma* sp. | | | | x | |
| *Galerina atkinsoniana* | | ▲ | x | | x |
| *Galerina clavata* | | ●▲ | x | | |
| *Galerina marginata* | | | xxx | | xx |
| *Galerina perplexa* | 'new' | | | | xx |
| *Galerina pumila* var. *pumila* | | ▲ | x | | |
| *Galerina vittiformis* var. *vittiformis f. tetraspora* | | ▲ | x | | |
| *Gymnopilus penetrans* | | | xx | | |
| *Gymnopilus picreus* | | | | | x |
| *Gymnopus androsaceus* | | ▲ | xxx | | xxx |
| *Hebeloma birrus* | | ▲ | xx | x | x |
| *Hebeloma* sp. | | | | x | xx |
| *Hygrophoropsis aurantiaca* | | ▲ | xx | xx | x |
| *Hypholoma capnoides* | | | x | | |
| *Inocybe geophylla* | | | xx | | |
| *Inocybe lilacina* | | | x | | |
| *Laccaria laccata* | | | xx | | x |
| *Lactarius aurantiacus* | | | x | | xx |
| *Lactarius helvus* | | | x | | |
| *Lactarius tabidus* | | | | x | |
| *Lentinellus micheneri* | | | | | x |
| *Lepista gilva* | | | x | | |
| *Lycoperdon perlatum* | | | | | x |
| *Lycoperdon* sp. | | | | x | |
| *Macrolepiota procera* | | ●▲ | x | | xxx |
| *Macrotyphula fistulosa* | | | xx | | |
| *Marasmiellus ramealis* | | | | x | |
| *Marasmius epiphyllus* | | | | x | |
| *Marasmius setosus* | NE | | x | | |
| *Mycena amicta* | | | x | | |
| *Mycena* cf. *pura* | | ▲ | | x | |
| *Mycena citrinomarginata* | | | | | xx |
| *Mycena epipterygia* coll. | | | xxx | x | |
| *Mycena filopes* | | | x | xxx | |
| *Mycena flavoalba* | | ▲ | xxx | x | xxx |
| *Mycena floridula* | | | xx | | xx |
| *Mycena galericulata* | | | xxx | xxx | xxx |
| *Mycena galopus* | | | xxx | x | xxx |
| *Mycena leptocephala* | | ▲ | xxx | xxx | xxx |
| *Mycena metata* | | | | | x |
| *Mycena polygramma* | | ● | xxx | xxx | xxx |

| STIPITATE MACROFUNGI Species | Red-list status | Indicator status | Plot A | Plot B | Plot C |
|---|---|---|---|---|---|
| *Mycena purpureofusca* | | ● | | | x |
| *Mycena rosella* | | | x | | |
| *Mycena rubromarginata* | | | | | x |
| *Mycena sanguinolenta* | | | | | x |
| *Mycena stylobates* | | | x | | |
| *Mycena vitilis* | | | xxx | | x |
| *Mycena vulgaris* | | | x | | x |
| *Mycetinis scorodonius* | | | | | xxx |
| *Naucoria escharioides* | | | x | xx | xxx |
| *Naucoria scolecina* | | | x | | xx |
| *Panaeolus olivaceus* | | ▲ | x | | |
| *Panaeolus papilionaceus* var. *papilionaceus* | | ▲ | x | xxx | x |
| *Paxillus involutus* | | | xx | xxx | xxx |
| *Pholiota flammans* | | | | | x |
| *Pluteus cervinus* | | | xx | xx | |
| *Polyporus brumalis* | | | x | | |
| *Psathyrella rostellata* | | | | x | |
| *Psathyrella senex* | | | | | x |
| *Psathyrellaceae* | | | xx | x | |
| *Psilocybe medullosa* | | | x | | |
| *Rhodocollybia buturacea* f. *asema* | | | x | | |
| *Rickenella fibula* | | | | | x |
| *Rickenella schwartzii* | | ▲ | | | x |
| *Russula* (cf.) *olivascens* | | | x | | |
| *Russula aeruginea* | | | | x | |
| *Russula* aff. *olivobrunnea* | | | | | x |
| *Russula cessans* | | | x | | x |
| *Russula nitida* | | ▲ | | | xx |
| *Russula pelargonia* coll. | | | xx | | x |
| *Russula puellaris* var. *cupreovinosa* | | | x | | |
| *Strobilurus esculentus* | | | x | | xx |
| *Stropharia aeruginosa* | | | xx | | |
| *Stropharia semiglobata* | | ▲ | | xxx | xxx |
| *Tapinella atrotomentosa* | | | | | x |
| *Tricholomopsis decora* | | | x | | |
| *Tubaria conspersa* | | | xxx | | |
| *Typhula* sp. | | | | | x |
| *Xeromphalina* sp. | | | x | | x |

## References

**Nomenclature** according to:

Knudsen, H., & Vesterholt, J., (eds.) 2012: Funga Nordica. Agaricoid, boletoid, clavarioid, cyphelloid and gasteroid genera. — Nordsvamp, Copenhagen. 1083 p.

**Red-list status** according to:

von Bonsdorff, T., 2012: Sent table: Species list of NE and LC fungi species. Outcome from 2010 Red List evaluation.

von Bonsdorff, T. 2016: Bulletin by e-mail.

**Indicator status** according to:

von Bonsdorff, T., Kytövuori, I., Vauras, J., Huhtinen, S., Halme, P., Rämä, T., Kosonen, L. & Jakobsson, S. 2014: Indicator fungi. — Norrlinia 27: 1–272. [in Finnish with English summary]

Kytövuori I., Nummela-Salo U., Ohenoja E., Salo P. & Vauras J. 2005: Distribution table of agarics and boletes in Finland. — In: Salo P., Niemelä T., Nummela-Salo U. & Ohenoja E. (eds.), Suomen helttasienten ja tattien ekologia, levinneisyys ja uhanalaisuus. Suomen ympäristökeskus, Helsinki. Suomen ympäristö 769, pp. 225–426.

**Explanations**

**Column FESA = Found elsewhere in the study area**

| POLYPORES Species | Red-list status | Indicator status | Plot A | Plot B | Plot C | FESA |
|---|---|---|---|---|---|---|
| *Albatrellus confluens* | | | | | | x |
| *Anomoporia kamtschatica* | | • | | | | x |
| *Antrodia serialis* | | | | | x | |
| *Antrodia sinuosa* | | | | x | x | |
| *Antrodiella romellii* | | | | | | x |
| *Antrodiella serpula* | | | x | | | |
| *Bjerkandera adusta* | | | | | | x |
| *Ceriporia reticulata* | | | x | | | |
| *Cerrena unicolor* | | | x | x | | |
| *Datronia mollis* | | | | | x | |
| *Fomes fomentarius* | | | x | | x | |
| *Fomitopsis pinicola* | | | x | | | |
| *Ganoderma lucidum* | | | | | | x |
| *Gloeophyllum sepiarium* | | | | | x | |
| *Heterobasidion parviporum* | | | | | | x |
| *Hyphodontia paradoxa* | | | x | | | |
| *Inonotus obliquus* | | | x | | | |
| *Inonotus radiatus* | | | x | | x | |
| *Ischnoderma benzoinum* | | | | | | x |
| *Lenzites betulinus* | | | | | x | |
| *Meruliopsis taxicola* | | • | | | | x |
| *Oligoporus fragilis* | | | x | | | |
| *Oligoporus rennyi* | | | x | | | |
| *Oligoporus stipticus* | | | | | x | |
| *Phellinus pini* | | • | | | | x |
| *Phellinus punctatus* | | | x | | x | |
| *Phellinus tremulae* | | | | | | x |
| *Piptoporus betulinus* | | | | | | x |
| *Polyporus brumalis* | | | x | | | |
| *Postia alni* | | | | | x | |
| *Postia caesia* | | | x | | | |
| *Postia leucomallella* | | • | | | | x |
| *Postia tephroleuca* | | | | | | x |
| *Pycnoporus cinnabarinus* | | | | | | x |
| *Trametes hirsuta* | | | x | x | x | |
| *Trichaptum abietinum* | | | x | x | x | |
| *Trichaptum fuscoviolaceum* | | | x | | x | |

| CORTICIOIDS AND WOOD-INHABITING HYDNACEOUS FUNGI Species | Red-list status | Indicator status | Plot A | Plot B | Plot C | FESA |
|---|---|---|---|---|---|---|
| *Basidioradulum radula* | | | | | x | |
| *Botryobasidium botryosum* (*vagum*) | | | | x | | |
| *Botryobasidium subcoronatum* | | | | | | x |
| *Chondrostereum purpureum* | | | x | | | |
| *Hymenochaete tabacina* | | | x | | | |
| *Hyphoderma roseocremeum* | | | | | | x |
| *Hyphoderma setigerum*-coll. | | | | | | x |
| *Leucogyrophana mollusca* | | | x | | | |
| *Mucronella calva* | | | | | x | |
| *Peniophora* sp. | | | | | | x |
| *Peniophorella guttulifera* | | | | | x | |
| *Peniophorella pallida* | | | | x | | |
| *Peniophorella praetermissa* | | | | | x | |
| *Peniophorella pubera* | | | | | | x |
| *Phanerochaete laevis* | | | | | | x |
| *Phanerochaete sanguinea* | | | x | | | |
| *Phanerochaete sordida* | | | | x | | |
| *Phanerochaete velutina* | | | x | | | |
| *Phlebia gigantea* | | | | | | x |
| *Phlebia radiata* | | | x | | | |
| *Phlebia tremellosa* | | | | | | x |
| *Piloderma fallax* | | | | | | x |
| *Pseudohydnum gelatinosum* | | | | | | x |
| *Steccherinum fimbriatum* | | | x | | | |
| *Stereum hirsutum* | | | | x | x | |
| *Stereum rugosum* | | | x | x | x | |
| *Stereum sanguinolentum* | | | x | | x | |
| *Stereum subtomentosum* | | | | | | x |
| *Tomentella* sp. | | | | | | x |
| *Tubulicrinis subulatus* | | | | | | x |
| *Vesiculomyces citrinus* | | | | | x | |
| *Xylodon brevisetus* | | | | x | | |
| *Xylodon pruni* | | | | | | x |

## References

**Nomenclature** according to:

Kotiranta, H., Saarenoksa, R. & Kytövuori, I. 2009: Aphyllophoroid fungi of Finland. A check-list with ecology, distribution, and threat categories. — Norrlinia 19: 1–223.

**Red-list status** according to:

Rassi P., Hyvärinen E., Juslén A. & Mannerkoski I. (eds.) 2010: The 2010 Red List of Finnish Species. — Ministry of the Environment & Finnish Environment Institute, Helsinki, 685 p.

**Indicator status** according to:

Niemelä, T. 2005: Käävät, puiden sienet [Polypores, lignicolous fungi]. — Norrlinia 13: 1–319. (in Finnish with English summary)

| BIRDS Species | Red-list status | Notes |
|---|---|---|
| *Cygnus olor* | | |
| *Anser anser* | | |
| *Branta canadensis* | NA | One pair, invasive species in Finland |
| *Anas platyrhynchos* | | |
| *Anas clypeata* | | One pair |
| *Aythya fuligula* | EN | |
| *Bucephala clangula* | | |
| *Podiceps auritus* | EN | Three pairs |
| *Podiceps cristatus* | NT | |
| *Ardea cinerea* | | Not observed in 2013, but possibly has bred in previous years |
| *Buteo buteo* | VU | Not observed in 2013, but has bred in previous years |
| *Fulica atra* | EN | Two pairs |
| *Grus grus* | | One pair |
| *Haematopus ostralegus* | | |
| *Tringa ochropus* | | |
| *Actitis hypoleucos* | | |
| *Tringa totanus* | VU | |
| *Scolopax rusticola* | | |
| *Gallinago gallinago* | VU | |
| *Larus ridibundus* | VU | |
| *Larus canus* | | |
| *Sterna paradisaea* | | |
| *Columba oenas* | | |
| *Columba palumbus* | | |
| *Cuculus canorus* | | |
| *Aegolius funereus* | NT | Not observed in 2013, but in previous years 3 territories |
| *Apus apus* | VU | |
| *Dryocopus martius* | | Two pairs |
| *Picus canus* | | One pair |
| *Dendrocopos major* | | Five pairs |
| *Dendrocopos minor* | | Two pairs |
| *Jynx torquilla* | | |
| *Alauda arvensis* | | |
| *Hirundo rustica* | NT | |
| *Delichon urbicum* | EN | |
| *Anthus trivialis* | | |
| *Motacilla alba* | | |
| *Erithacus rubecula* | | |
| *Luscinia luscinia* | | |
| *Phoenicurus phoenicurus* | | |
| *Oenanthe oenanthe* | NT | |
| *Turdus philomelos* | | |
| *Turdus iliacus* | | |
| *Turdus viscivorus* | | |
| *Turdus merula* | | |
| *Sylvia borin* | | |
| *Sylvia atricapilla* | | |
| *Sylvia communis* | | |
| *Sylvia curruca* | | |
| *Sylvia nisoria* | VU | Not observed in 2013, but bred in 2008 |
| *Acrocephalus schoenobaenus* | | |
| *Hippolais icterina* | | |
| *Phylloscopus trochilus* | | |
| *Phylloscopus collybita* | | |
| *Phylloscopus sibilatrix* | | |
| *Muscicapa striata* | | |
| *Ficedula hypoleuca* | | |
| *Parus major* | | |
| *Parus caeruleus* | | |
| *Parus cristatus* | VU | |
| *Parus ater* | | |
| *Certhia familiaris* | | |
| *Lanius collurio* | | Two pairs |
| *Pica pica* | | |
| *Nucifraga caryocatactes* | | Not observed in 2013, but has bred in previous years |
| *Garrulus glandarius* | | |
| *Corvus monedula* | | |
| *Corvus corone cornix* | | |
| *Corvus corax* | | |
| *Sturnus vulgaris* | | |
| *Passer domesticus* | VU | |
| *Passer montanus* | | |
| *Fringilla coelebs* | | |
| *Carduelis cannabina* | | |
| *Carduelis chloris* | VU | |
| *Carduelis spinus* | | |
| *Loxia pytyopsittacus* | | |
| *Carpodacus erythrinus* | NT | |
| *Emberiza citrinella* | | |

## References

**Nomenclature** according to

Mullarney, K., Svensson, L., Zetterström, D. 1999: Lintuopas – Euroopan ja Välimeren alueen linnut. — Otava, Trento, 400 p.

**Red-list status** according to:

Tiainen, J., Mikkola-Roos, M., Below, A., Jukarainen, A., Lehikoinen, A., Lehtiniemi, T., Pessa, J., Rajasärkkä, A., Rintala, J., Sirkiä, P. & Valkama, J. 2016: Suomen lintujen uhanalaisuus 2015 – The 2015 Red List of Finnish Bird Species. — Ministry of the Environment & Finnish Environment Institute, 49 p.