

Red List of Estonian lichens: revision in 2019

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Abstract: The second assessment of the threat status of Estonian lichens based on IUCN system was performed in 2019. The main basis for choosing the species to be currently assessed was the list of legally protected lichens and the list of species assigned to the Red List Categories RE–DD in 2008. Species that had been assessed as Least Concern (LC) in 2008 were not evaluated. Altogether, threat status of 229 lichen species was assessed, among them 181 were assigned to the threatened categories (CR, EN, VU), while no species were assigned to the LC category. Compared to the previous red list, category was deteriorated for 58% and remained the same for 32% of species. In Estonia, threatened lichens inhabit mainly forests (particularly dry boreal and nemoral deciduous stands), alvar grasslands, sand dunes and various saxicolous habitats. Therefore, the most frequent threat factors were forest cutting and overgrowing of alvars and dunes (main threat factor for 96 and 70 species, respectively).

Kokkuvõte: 2019. aastal viidi läbi teistkordne IUCN süsteemil põhinev Eesti samblike ohustatuse hindamine. Hinnati liike, mis on riiklikult kaitstud ning liike, mis 2008. aasta hindamise järgi olid Eestis kas regionaalselt välja surnud, kriitilises seisundis, väljasuremisohus, ohualtid, ohulähedased või puuduliku andmestikuga (kategooriad RE–DD). 2008. a-l kategooriasse Soodsas seisundis (LC) kuulunud liike ei kaasatud uude hindamisse. Kokku hinnati 229 samblikuliigi ohustatust, nendest 181 kuulusid ohustatud kategooriatesse (CR, EN või VU); ükski hinnatud liik ei sobinud kategooriasse LC. Võrreldes eelmise punase nimestikuga tõusis kategooria 58% liikidel ning jäi samaks 32%-l. Ohustatud samblikuliigid asustavad Eestis peamiselt metsi (eriti palu- ja salumetsi), loopealseid, liivikuid ning erinevaid kivi-kasvupindu. Seetõttu on sagedasemad ohutegurid metsaraie ning loodude ja liivikute kinnikasvamine (oluline tegur vastavalt 96 ja 70 liigile).

Keywords: IUCN, regional red-listing, status deterioration, threat factors

INTRODUCTION

Since 1979, five Red Lists have been compiled in Estonia: in 1979, 1988, 1998, 2008 and 2018–2019. Lichens (40 species) were included for the first time into the second Red List in 1988 (Anonymous, 1993). Conventional system of threat categories and intuitive-emotional criteria for defining these categories were used in three earlier Red Lists. IUCN categories and strictly established criteria (Standards and Petitions Working Group, 2006) were applied for the first time in the fourth Red List (Tartes, 2010). The according part of the Estonian Red List containing lichens was prepared between 2006 and 2008 (Randlane et al., 2008). At that time, the checklist of Estonian lichens – basis for the assessments – included 1,019 species (Randlane et al., 2006). Out of them, 45.5%, mainly macrolichens, were evaluated. Among evaluated species,

213 were assigned to one of the following IUCN categories: Regionally Extinct (RE), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD); assessment results are publicly available (Table 2 in Randlane et al., 2008). The second assessment of the threat status of Estonian lichens based on IUCN system was performed in 2019. The aim of this article is to present the data of the revised Red List of lichens in Estonia, to discuss the changes compared to the previous red list and to summarize the information about threat factors and habitats of threatened lichens.

MATERIAL AND METHODS

The main basis for choosing the species to be currently assessed was the list of legally pro-

tected lichens in Estonia (Keskkonnaministri määrus nr 51, 2004; Vabariigi Valitsuse määrus nr 195, 2004) and the list of species assigned to the IUCN categories RE, CR, EN, VU, NT and DD in 2008 (Table 2, Randle et al., 2008). In addition to these 215 species, 25 macrolichen species were evaluated for the first time: 12 species which were not assessed in 2008 because of identification difficulties and/or limited data (e.g., species of the *Cladonia chlorophaea* group, some taxa from the former genera *Collema* and *Leptogium*) and 13 species that were recorded in Estonia for the first time within 2008–2018. The species that had been assessed as Least Concern in 2008 (251, except for two protected species) were not evaluated during the current assessment process because of financial and time limitations.

The first author (PL) passed the IUCN Red List Assessor Training Workshop (2015 in Tallinn) and, prior to the project, she introduced the criteria and how they should be applied to the group of lichen experts. The latest IUCN guidelines (ver. 13) for using the Red List categories and criteria (IUCN Standards and Petitions Subcommittee, 2017) were applied, but also supplementary guidelines for applying IUCN criteria for fungi (Dahlberg & Mueller, 2011) were used. Down-listing of the category (because immigration from outside the region will tend to decrease extinction risk within the region) was not done since there are no data about the immigration possibilities of lichen species from neighbouring countries (see also explanation in Ingerpuu et al., 2018).

The following IUCN categories were used: Regionally Extinct (RE), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD), Least Concern (LC), Not Applicable (NA) and Not Evaluated (NE). Of them, CR, EN and VU are ‘threatened categories’ according to the IUCN guidelines. Similarly to the previous assessment in 2008, the species that had not been reliably reported from Estonia after 1950 were considered to be RE. During the evaluation process, applicability of IUCN criteria A (Population Size Reduction; only A2–A4 were considered while criterion A1 was not intendedly used), B (Geographic Range), C (Small Population Size and Decline) and D (Very Small or Restricted Population) was assessed for

each species and the according category was assigned to the species. Criterion E (Quantitative Analysis) was not used due to the insufficiency of data. Threshold levels of categories for criteria B and D were not modified. If useful, experts applied quantitative threshold level for category NT provided in Dahlberg & Mueller (2011).

The length of a generation was considered 17 years for most of species except 7 years for ephemeric species *Scytinium schraderi*. The term “mature individual of a lichen” follows the concept of „functional individual“ sensu Hallingbäck (2007). The number of mature individuals (used in criteria C and D1) was estimated only if suitable data were available, for example, when lichen thalli had systematically been counted or estimated during the methodical surveys. The population was considered to be severely fragmented if the distance between species localities was more than 50 or 100 km (for vegetatively or spore-dispersed species, respectively). Applying criteria A2 and A3, we estimated, inferred or suspected decline of populations within the time length of three generations (i.e. 51 years); applying criterion A4, in some cases (e.g. *Cladonia foliacea* and *Enchylium tenax*), the time length was up to 100 years. The species which taxonomy has been changed (for example, they had been synonymized) since the last Red List, were either evaluated in the usual way within the current species (like *Vulpicida tubulosus* within *V. juniperinus*; Saag et al., 2014) or they were not evaluated in this project as the current species belonged to LC in 2008 (like *Usnea diplo-typus* within *U. dasopoga*; Mark et al., 2016).

The main data source for species occurrence records was the PlutoF biodiversity database (<https://plutof.ut.ee/>; Abarenkov et al., 2010), that incorporates the data of specimens from all main Estonian herbaria (TALL, TAM and TU), numerous literature records and the data of protected lichen species from the Estonian Nature Information System (<http://www.eelis.ee>). In addition, the datasets of 26 published and unpublished lichen research projects or inventories in Estonia during 2008–2018 were uploaded to the PlutoF database and made available for the expert group. Species assessment sheets together with supporting documentation are available to the registered users of the Estonian Nature Information System.

RESULTS AND DISCUSSION

During the recent evaluation in Estonia, the threat status of 229 species was assessed (Table 1). These form 19.4% of the 1,179 species of the lichenized, lichenicolous and saprophytic fungi (i.e. species traditionally treated by lichenologists) that are currently known in Estonia (Randlane et al., 2018). However, the majority of evaluated species represented lichens, and only one saprotrophic fungus (*Arthopyrenia cinereopruinosa*) belonged to the list of assessed taxa; no lichenicolous fungi were evaluated. Among the assessed species, 181 were assigned to the threatened categories (CR, EN, VU) while no species were assigned to the LC category (Table 1 and Supplement 1). All legally protected lichen species in Estonia (51 taxa) belong either to the threatened categories or they were assessed as NT.

Table 1. Number of lichen species in the IUCN Red List categories according to the assessments in 2008 and 2019. For abbreviations of categories see Material and Methods.

Category	2008	2019
RE	29	22
CR	13	64
EN	32	74
VU	68	43
NT	42	20
DD	29	6
LC	251	0
Total	464	229
NA	not applied	7
NE	555	943
Total number of recorded species	1019*	1179**

* Randlane et al., 2006

** Randlane et al., 2018

Out of 213 species that were evaluated in 2008 to the categories RE–DD and planned to be newly evaluated in 2019, eleven taxa appeared not applicable for the new assessment against criteria or, in some cases, it was intentionally decided not to re-evaluate them (Figure 1; see Supplement 2 for explanations). For the rest of the species, the red-listed category deteriorated for 58% and remained the same for 32% of the species during the second assessment (Figure 1). The reason of deterioration of the category

(mainly from VU to EN or CR, and from NT to VU or EN) was, in some extent, related to the wider usage of the criteria C and D during this evaluation process; furthermore, the application of the criterium D2 was refined during the current evaluation by considering the risk of taxa to become highly threatened within a very short time. However, the small population size and decline of these species was mainly caused by the degradation of their natural habitats. This was also the reason for several other species whose status has deteriorated. For example, *Flavocetraria nivalis* that inhabits mainly alvar grasslands in Estonia, has moved from NT category in 2008 to CR in 2019 due to the cessation of traditional land use practices, but also environmental stress and natural disturbances (Leppik et al., 2013). Extensive encroachment of alvar grasslands with tall herbs and shrubs is the main threat also for other epigeic lichens (Leppik et al., 2013, 2015) and hence, for example, 20% decline of the population within two generations was projected for *Solorina saccata* (i.e. change of threat category from NT in 2008 to EN in 2019). The status of many old-growth forest specialists (e.g. *Alectoria sarmentosa*, *Leptogium saturninum*, *Lobaria pulmonaria*, *Menegazzia terebrata* and *Megalaria grossa*) changed from NT category in 2008 to a threat category in 2019, mainly because of estimated or projected decline of populations caused by continuous destructive forest management with clear cutting and shortened rotation periods. The decline in

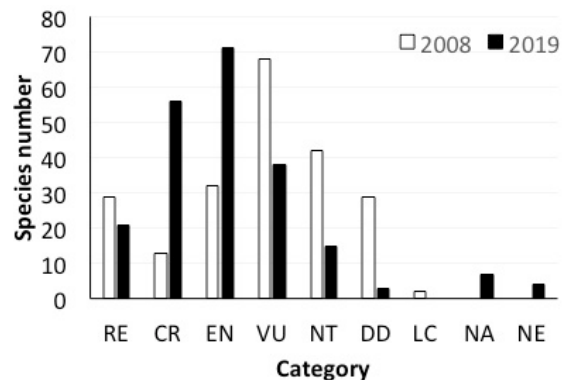


Fig. 1. Distribution of the lichen species that were evaluated both in 2008 and 2019 (n=215) among the IUCN categories. For abbreviations of categories see Material and Methods.

quantity and quality of forest habitats has been demonstrated in detail particularly for *Lobaria pulmonaria* (Jüriado & Liira, 2009, 2010).

The number of RE species is now lower, compared to the previous assessment, as seven species (*Diplotomma lutosum*, *Lecanora epibryon*, *Peltigera elisabethae*, *Ramalina elegans*, *Rostania occultata*, *Thelidium pyrenophorum* and *Verrucaria maculiformis*) have been re-found within the last ten years. However, there are 14 species that are candidates to be assessed as RE in the near future, as their last documented occurrence falls to the period of 50–62 years ago (Supplement 1).

In Estonia, threatened lichens inhabit mainly forests (particularly dry boreal and nemoral deciduous stands), alvar grasslands and various saxicolous habitats, but also wooded meadows, parks and limestone quarries and dunes (Figure 2). The wooded habitats provide several specific microhabitats for epiphytic and wood-dwelling lichens, like rough bark of coniferous and deciduous trees, wood of standing and laying tree trunks, charred wood, etc. (e.g. Jüriado et al., 2003; Lõhmus & Kruustük, 2010; Lõhmus & Lõhmus, 2011; Degtjarenko et al., 2016; Marmor et al., 2017; Jüriado & Paal, 2019), while dry alvar grasslands with very thin soil layer and sand dunes are suitable for ground layer community taxa (e.g. Leppik et al. 2013, 2015; Jüriado et al., 2016). Therefore, the main threat factors of Estonian lichens tend to be forest cutting (important factor for 96 species) and overgrowing of dunes and alvars due to the cessation of traditional management (important for 70 species). Furthermore, the air pollution, expansion of urban areas and tourism activity also have negative impact for several lichen species.

The current paper reveals the results of the second assessment of the threat status of Estonian lichens based on IUCN system performed in 2019. However, the species that were assessed as LC in 2008 were not re-evaluated this time (except two protected species), and 59% of lichens and related fungi currently known in Estonia have not been evaluated with IUCN system at all. Thus, the evaluation process to define the threat status of lichens in Estonia is continuing. Forest microlichens (ca 350 species) will be assessed according to the IUCN categories

and criteria during the project “Conservation status of forest lichens in Estonia” in 2020. For this purpose, additional systematic lichen surveys (following method by Lõhmus et al., 2018) will be performed in old-growth stands in less studied regions (islands Saare- and Hiiumaa) and forest site types (alvar forests). Another project, “Contemporary state and threat evaluation of common lichens in Estonia”, will provide the assessment of 165 widely distributed lichen species according to IUCN system in 2021.

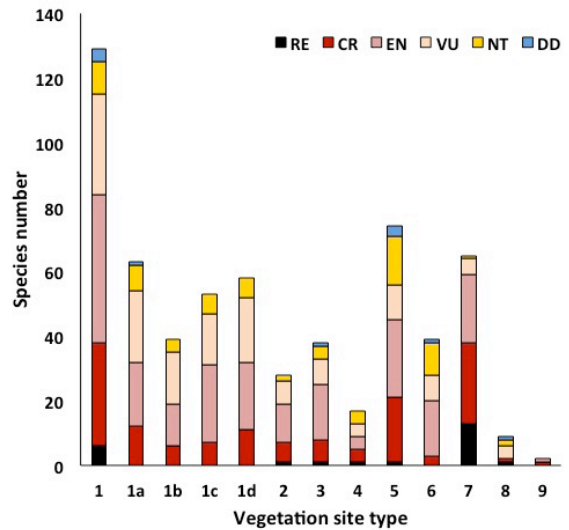


Fig. 2. Distribution of evaluated lichen species (categories RE–DD) among inhabited habitats, based on vegetation site type classification by Paal (1997): 1 – forests (all site types together and more specifically forest of 1a – alvar, boreal heath and dry boreal; 1b – fresh boreal and dry boreo-nemoral; 1c – fresh boreo-nemoral; 1d – floodplain, paludified and drained peatland); 2 – wooded meadows; 3 – parks; 4 – yards, roadsides, waste grounds; 5 – eutrophic alvar grasslands; 6 – quarries (mainly limestone) and dunes; 7 – outcrops (lime- and sandstone) and erratic boulders; 8 – mires; 9 – fresh waterbodies. Note that one species can inhabit several suitable habitats.

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Supplement 1. Red-listed lichens according to the evaluation in 2019 together with the IUCN categories and applied criteria; details of the previous assessment (incl. species older names used in Table 2, Randlane et al., 2008) are also given. For abbreviations of categories and criteria see Material and Methods. Comment field provides information about the protection category (I–III) and the year of the last documented record for the species that were assessed as RE or being very close to it. The taxonomy of the species follows Randlane et al. (2018).

Species name	Species name used in 2008	Category 2019	Criteria 2019	Category 2008	Criteria 2008	Comment
<i>Acarospora oligospora</i> (Nyl.) Arnold		RE		RE		<1890
<i>Alectoria sarmentosa</i> (Ach.) Ach.		VU	C1; D1	NT		II
<i>Alyxoria culmigena</i> (Lib.) Ertz	<i>Opegrapha herbarum</i>	EN	D	DD		
<i>Alyxoria ochrocheila</i> (Nyl.) Ertz & Tehler	<i>Opegrapha ochrocheila</i>	NT	A2c; B2ab(iii)	VU	D2	
<i>Amygdalaria panaeola</i> (Ach.) Hertel & Brodo		RE		RE		<1890
<i>Anaptychia runcinata</i> (With.) J. R. Laundon		CR	D	VU	D2	
<i>Arctoparmelia centrifuga</i> (L.) Hale		VU	A2c; B1ab(i,iii,iv)	EN	B1ab(i,iv)	
<i>Arctoparmelia incurva</i> (Pers.) Hale		EN	A2c; B2ab(ii,iii,iv)	EN	A2c; B1ab(i,iv)	
<i>Arthonia apatetica</i> (A. Massal.) Th. Fr.		VU	D1	VU	D2	
<i>Arthonia atra</i> (Pers.) A. Schneid.	<i>Opegrapha atra</i>	VU	C1+2a(i); D1	NT		
<i>Arthonia byssacea</i> (Weigel) Almq.		VU	C1; D1	NT		III
<i>Arthonia didyma</i> Körb.		NT	A2c+3c; C1	NT		
<i>Arthonia lapidicola</i> (Taylor) Branth. & Rostr.		VU	D1	VU	D2	
<i>Arthopyrenia cinereopruinosa</i> (Schaer.) A. Massal.		RE		RE		<1890
<i>Arthothelium spectabile</i> Flot. ex A. Massal.		CR	D	VU	D2	
<i>Aspicilia zonata</i> (Ach.) R. Sant.	<i>Aspicilia xyloxena</i>	RE		RE		1945
<i>Bacidia biatorina</i> (Körb.) Vain.		VU	B1ab(iii)+2ab(iii); C1; D1	EN	B2ab(iii)	II
<i>Bacidia fuscoviridis</i> (Anzi) Lettau		RE		RE		1929
<i>Bacidia laurocerasi</i> (Delise ex Duby) Zahlbr.		VU	C1; D1	NT		II
<i>Baeomyces carneus</i> Flörke		EN	C2a(i); D	VU	D2	II
<i>Biatoridium monasteriense</i> J. Lahm ex Körb.		VU	A2c	NT		II
<i>Bilimbia lobulata</i> (Sommerf.) Hafellner & Coppins		EN	C2a(i); D	VU	B2ab(iii)	
<i>Bryoria chalybeiformis</i> (L.) Brodo & D. Hawksw.		EN	D	VU	D2	
<i>Bryoria furcellata</i> (Fr.) Brodo & D. Hawksw.		EN	D	VU	B1ab(iii)	II
<i>Bryoria simplicior</i> (Vain.) Brodo & D. Hawksw.		CR	D	DD		1963
<i>Calogaya biatorina</i> (A. Massal.) Arup, Frödén & Söchting	<i>Caloplaca biatorina</i>	EN	D	VU	D2	
<i>Caloplaca atroflava</i> (Turner) Mong.		RE		RE		<1890
<i>Caloplaca chalybaea</i> (Fr.) Müll. Arg.		RE		RE		1908
<i>Caloplaca lucifuga</i> G. Thor		EN	D	NT		
<i>Caloplaca ulcerosa</i> Coppins & P. James		VU	D1	VU	D2	
<i>Carbonicola anthracophila</i> (Nyl.) Bendiksbj & Timdal	<i>Hypoceno- myce an- thracophila</i>	VU	A3c	LC		II

Species name	Species name used in 2008	Category 2019	Criteria 2019	Category 2008	Criteria 2008	Comment
<i>Carbonicola myrmecina</i> (Ach.) Bendiksby & Timdal		CR	C2a(i); D	-		
<i>Catapyrenium cinereum</i> (Pers.) Körb.		EN	B1ab(iii)+2ab(iii); D	EN	B2ab(iii)	
<i>Cetrelia cetrarioides</i> (Delise ex Duby) W. L. Culb. & C. F. Culb.		EN	C1+C2a(i)	VU	B1ab(iii)	
<i>Cetrelia monachorum</i> (Zahlbr.) W.L. Culb. & C.F. Culb.		CR	C2a(i)	-		
<i>Cetrelia olivetorum</i> (Nyl.) W. L. Culb. & C. F. Culb.		EN	B2ab(iii); C1+C2a(i)	VU	B1ab(iii)	II
<i>Chaenotheca cinerea</i> (Pers.) Tibell		CR	C2a(i)	EN	B2ab(iii)	II
<i>Chaenotheca gracilentia</i> (Ach.) J. Mattsson & Middelb.		EN	C2a(i)	VU	B2ab(iii)	II
<i>Circinaria gibbosa</i> (Ach.) A. Nordin, Savić & Tibell	<i>Aspicilia gibbosa</i>	RE		RE		1931
<i>Cladonia borealis</i> S. Stenroos		VU	A2c; C1+2a(i); D1	EN	A2bc	
<i>Cladonia brevis</i> (Sandst.) Sandst.		CR	D	EN	B2ab(iii)	1958
<i>Cladonia caespiticia</i> (Pers.) Flörke		CR	D	VU	D2	
<i>Cladonia carneola</i> (Fr.) Vain.		VU	A2c; C1; D1	EN	A2bc	
<i>Cladonia cervicornis</i> (Ach.) Flot.		EN	C2a(i); D	DD		
<i>Cladonia coccifera</i> (L.) Willd.		EN	D	EN	A2bc	
<i>Cladonia cryptochlorophaea</i> Asahina		DD		NE		
<i>Cladonia decorticata</i> (Flörke) Spreng.		EN	B2ab(iii); D	VU	D2	
<i>Cladonia foliacea</i> (Huds.) Willd.		NT	A2c+4c; D	NT		
<i>Cladonia grayi</i> G. Merr. ex Sandst.		NT	D	NE		
<i>Cladonia humilis</i> (With.) J.R. Laundon		VU	C1; D1	-		
<i>Cladonia incrassata</i> Flörke		VU	D1	NT		
<i>Cladonia macroceras</i> (Delise) Hav.		VU	A2c; C1+C2a(i); D1	NT		
<i>Cladonia macrophylla</i> (Schaer.) Stenh.		EN	A2c; B2ab(i,ii,iii); C1+2a(i); D	EN	A2bc; B2ab(iii)	
<i>Cladonia magyarica</i> Vain. ex Gyeln.		VU	B2ab(iii); D1	-		
<i>Cladonia merochlorophaea</i> Asahina		DD		NE		
<i>Cladonia novochlorophaea</i> (Sipman) Brodo & Ahti		VU	B2ab(iii); C1; D1	NE		
<i>Cladonia parasitica</i> (Hoffm.) Hoffm.		VU	C1	NT		
<i>Cladonia pocillum</i> (Ach.) Grognot		NT	C1	NT		
<i>Cladonia portentosa</i> (Dufour) Follmann		NT	D	NT		
<i>Cladonia ramulosa</i> (With.) J.R. Laundon		EN	D	-		
<i>Cladonia scabriuscula</i> (Delise) Nyl.		VU	D1	VU	A2bc	
<i>Cladonia straminea</i> (Sommerf.) Flörke	<i>Cladonia metacorallifera</i>	CR	D	VU	D2	
<i>Coenogonium luteum</i> (Dicks.) Kalb & Lücking	<i>Dimerella lutea</i>	EN	A2c; C2a(i); D	VU	B2ab(iii)	II
<i>Collema flaccidum</i> (Ach.) Ach.		EN	D	NE		

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<i>Collema nigrescens</i> (Huds.) DC.		EN	C2a(i)	VU	B2ab(iii); C1	II
<i>Collema subnigrescens</i> Degel.		EN	C2a(i)	NT		
<i>Cyphelium inquinans</i> (Sm.) Trevis.		EN	D	NT		III
<i>Dermatocarpon luridum</i> (With.) J. R. Laundon		CR	B2ab(i,ii); C2a(i)	DD		
<i>Dermatocarpon minutum</i> (L.) W. Mann		EN	D	DD		
<i>Dibaeis baeomyces</i> (L. f.) Rambold & Hertel		EN	C2a(i); D	NT		
<i>Diplotomma lutosum</i> (Ach.) Arnold		CR	D	RE		
<i>Enchylium bachmanianum</i> (Fink) Otálora, P.M. Jørg. & Wedin	<i>Collema bachmani-anum</i>	EN	D	DD		
<i>Enchylium limosum</i> (Ach.) Otálora, P.M. Jørg. & Wedin	<i>Collema limosum</i>	VU	B2ab(iii); D1	DD		
<i>Enchylium tenax</i> (Sw.) Gray		NT	A2c+4c; D	NE		
<i>Endocarpon psorodeum</i> (Nyl.) Blomb. & Forssell		EN	D	EN	D	
<i>Endocarpon pusillum</i> Hedw.		EN	C2a(i); D	EN	B2ab(iii)	
<i>Eopyrenula leucoplaca</i> (Wallr.) R. C. Harris		EN	D	EN	B2ab(iii)	
<i>Evernia divaricata</i> (L.) Ach.		VU	A2c; C1	VU	A4bc	III
<i>Evernia mesomorpha</i> Nyl.		VU	C1; D1	NT		
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & A. Thell		CR	A2a; B1ab(i,ii,iii)+ 2ab(i,ii,iii)	CR	B1ab(iii)+ 2ab(iii)	I
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & A. Thell		CR	A2ac	NT		
<i>Flavoparmelia caperata</i> (L.) Hale		EN	D	EN	B1ab(iii)	II
<i>Fuscidea cyathoides</i> (Ach.) V. Wirth & Vězda		RE		RE		<1890
<i>Gyalecta ulmi</i> (Sw.) Zahlbr.		EN	A2c; C1+2a(i); D	VU	B2ab(iii)	II
<i>Gyalolechia bracteata</i> (Hoffm.) A. Massal.	<i>Fulgensia bracteata</i>	NT	A2c+4c; C1	NT		III
<i>Gyalolechia fulgens</i> (Sw.) Søchting, Frödén & Arup	<i>Fulgensia fulgens</i>	CR	D	DD		
<i>Hypogymnia vittata</i> (Ach.) Parrique		CR	D	CR	B2ab(iii)	1965
<i>Lasallia pustulata</i> (L.) Mérat		EN	A2c; D	VU	A2c+3c	III
<i>Lathagrium cristatum</i> (L.) Otálora, P.M. Jørg. & Wedin		VU	D1	NE		
<i>Lathagrium undulatum</i> (Flot.) Otálora, P.M. Jørg. & Wedin	<i>Collema undulatum</i>	CR	D	VU	D2	
<i>Lecanora bicincta</i> Ramond		CR	D	VU	D2	
<i>Lecanora caesiosora</i> Poelt		CR	B1ab(iii); D	VU	D2	
<i>Lecanora epibryon</i> (Ach.) Ach.		CR	B1ab(iii)+2ab(iii); D	RE		
<i>Lecanora impudens</i> Degel.		EN	B2ab(iii); D	VU	D2	
<i>Lecanora intumescens</i> (Rebent.) Rabenh.		EN	C2a(i)	VU	B2ab(iii)	
<i>Lecidea erythrophaea</i> Flörke ex Sommerf.		NT	A3c	NT		III
<i>Lempholemma isidiodes</i> (Nyl. ex Arnold) H. Magn.		CR	D	VU	D2	
<i>Lempholemma polyanthes</i> (Bernh.) Malme		RE		RE		1929
<i>Leptogium rivulare</i> (Ach.) Mont.		CR	D	CR	D	1957

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<i>Leptogium saturninum</i> (Dicks.) Nyl.		VU	A2c+3c; C1	NT		III
<i>Lobaria pulmonaria</i> (L.) Hoffm.		VU	A2bc+4bc; C1+2a(i)	NT		III
<i>Lobaria scrobiculata</i> (Scop.) DC.		CR	B2ab(iii); D	CR	B2ab(iii)	
<i>Lobothallia radiosa</i> (Hoffm.) Hafellner		EN	B1ab(iii)+2ab(iii); D	NT		
<i>Megalaria grossa</i> (Pers. ex Nyl.) Hafellner		VU	C1	NT		III
<i>Megaspora verrucosa</i> (Ach.) Hafellner & V. Wirth		CR	B1ab(iii)+2ab(iii); C2a(i); D	EN	B2ab(iii)	
<i>Melanelia commixta</i> (Nyl.) A. Thell		CR	D	CR	B2ab(iv); C1+2a(i)	
<i>Melanelia disjuncta</i> (Erichsen) Essl.		EN	A2c	DD		
<i>Melanelia hepatizon</i> (Ach.) A. Thell		EN	D	EN	B1ab(iii,iv)	
<i>Melanelia panniformis</i> (Nyl.) Essl.		CR	D	-		
<i>Melanelia sorediata</i> (Ach.) Goward & Ahti		EN	A2c; D	DD		
<i>Melanelia stygia</i> (L.) Essl.		EN	D	VU	A2c	
<i>Melanelixia glabra</i> (Schaer.) O. Blanco, A. Crespo, Divakar, Ëssl., D. Hawksw. & Lumbsch	<i>Melanelia glabra</i>	CR	B1ab(iii)+2ab(iii); D	CR	B2ab(iii)	1958
<i>Melanelixia glabratula</i> (Lamy) Sandler & Arup		NT	A2c	-		
<i>Melanohalea elegantula</i> (Zahlbr.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	<i>Melanelia elegantula</i>	CR	B1ab(iii)+2ab(iii); D	EN	B1ab(iii,iv)	
<i>Melanohalea septentrionalis</i> (Lynge) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	<i>Melanelia septentrionalis</i>	EN	D	NT		
<i>Melaspilea gibberulosa</i> (Ach.) Zwackh		RE		RE		1929
<i>Menegazzia terebrata</i> (Hoffm.) A. Massal.		VU	C1+2a(i); D1	NT		III
<i>Micarea bedlundii</i> Coppins		VU	A2c+3c	VU	B2ab(iii)	II
<i>Micarea turfosa</i> (A. Massal.) Du Rietz		RE		RE		1929
<i>Multiclavula mucida</i> (Pers.) R. H. Petersen		VU	A2c; C1; D1	VU	B2ab(iii)	
<i>Multiclavula vernalis</i> (Schwein.) R. H. Petersen		EN	D	CR	A2a; D	
<i>Nephroma arcticum</i> (L.) Torss.		RE		RE		1882
<i>Nephroma bellum</i> (Spreng.) Tuck.		CR	B1ab(iii)+2ab(iii); D	CR	B2ab(iii)	
<i>Nephroma isidiosum</i> (Nyl.) Gyeln.		CR	B1ab(iii)+2ab(iii); D	DD		1961
<i>Nephroma laevigatum</i> Ach.		EN	C1+C2a(i)	VU	A4bc	III
<i>Nephroma parile</i> (Ach.) Ach.		EN	A2bc; C1+C2a(i)	VU	A2bc	III
<i>Nephroma resupinatum</i> (L.) Ach.		CR	C2a(i)	EN	A2bc	II
<i>Ochrolechia frigida</i> (Sw.) Lynge		VU	D1	VU	B1ab(iii)	II
<i>Parmelia fraudans</i> (Nyl.) Nyl.		CR	B1ab(iii)+2ab(iii); D	EN	B1ab(i,iv)	
<i>Parmelia omphalodes</i> (L.) Ach.		VU	A2c; C1; D1	NT		
<i>Parmelia submontana</i> Nád. ex Hale		CR	D	-		
<i>Parmeliella triptophylla</i> (Ach.) Müll. Arg.		VU	C1+2a(i); D1	VU	A2bc; B2ab(iii)	II
<i>Parmelina tiliacea</i> (Hoffm.) Hale		VU	C1; D1	NT		

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<i>Peltigera castanea</i> Goward, Goffinet & Miadlikowska		CR	B1ab(iii)+2ab(iii); D	-		
<i>Peltigera collina</i> (Ach.) Schrad.		CR	C2a(i)	CR	D	II
<i>Peltigera degenii</i> Gyeln.		EN	B2ab(iii); D	VU	D2	
<i>Peltigera elisabethae</i> Gyeln.		CR	C2a(i); D	RE		
<i>Peltigera horizontalis</i> (Huds.) Baumg.		EN		NT		
<i>Peltigera hymenina</i> (Ach.) Delise		NT	B2ab(iii)	NT		
<i>Peltigera islandica</i> Goward & Manoharan-Basil		CR	D	-		
<i>Peltigera lepidophora</i> (Nyl. ex Vain.) Bitter		VU	A2bc; B2ab(iii); C1+2a(i)	DD		
<i>Peltigera occidentalis</i> (E. Dahl) Kristinsson		CR	B1ab(iii)+2ab(iii); D	-		
<i>Peltigera ponojensis</i> Gyeln.		NT	B1ab(iii)+2ab(iii); C1	DD		
<i>Peltigera scabrosa</i> Th. Fr.		CR	D	EN	B2ab(iii)	
<i>Peltigera venosa</i> (L.) Hoffm.		CR	D	EN	B2ab(iv)	1961
<i>Pertusaria carneopallida</i> (Nyl.) Anzi		RE		RE		1946
<i>Phaeophyscia chloantha</i> (Ach.) Moberg		RE		RE		1927
<i>Phaeophyscia endophoenicea</i> (Harm.) Moberg		EN	B2ab(iii); D	DD		
<i>Physcia leptalea</i> (Ach.) DC.		EN	D	VU	A4c	
<i>Physcia magnussonii</i> Frey		CR	D	VU	D2	
<i>Physconia detersa</i> (Nyl.) Poelt		VU	D1	NT		
<i>Physconia grisea</i> (Lam.) Poelt		EN	A2c; B2ab(iii)	NT		
<i>Pilophorus cereolus</i> (Ach.) Th. Fr.		CR	D	EN	B2ab(iii)	1969
<i>Placidium pilosellum</i> (Breuss) Breuss		EN	C2a(i)	EN	B2ab(iii)	
<i>Placidium squamulosum</i> (Ach.) Breuss		NT	A2c+3c; C1	EN	B2ab(iii)	
<i>Polycauliona verruculifera</i> (Vain.) Arup, Frödén & Söchting	<i>Caloplaca verruculifera</i>	EN	D	NT		II
<i>Polychidium muscicola</i> (Sw.) Gray		EN	D	DD		
<i>Protopannaria pezizoides</i> (Weber) P. M. Jørg. & S. Ekman		CR	D	DD		1965
<i>Protoparmeliopsis achariana</i> (A. L. Sm.) Moberg & R. Sant.		CR	D	VU	D2	1964
<i>Protoparmeliopsis macrocyclos</i> (H. Magn.) Moberg & R. Sant.		NT	B1ab(iii)	NT		
<i>Psora decipiens</i> (Hedw.) Hoffm.		NT	A2c+3c; C1	NT		III
<i>Punctelia subrudecta</i> (Nyl.) Krog		RE		RE		1947
<i>Pycnora praestabilis</i> (Nyl.) Hafellner		CR	A2a; B2ab(iii); D	CR	B2ab(i,ii,iii,iv); D	
<i>Pycnothelia papillaria</i> Dufour		EN	B2ab(iii)	EN	A2	
<i>Pyrenula laevigata</i> (Pers.) Arnold		EN	C1+2a(i); D	VU	B2ab(iii)	II
<i>Pyrenula nitidella</i> (Schaer.) Müll. Arg.		EN	C1+2a(i); D	VU	B2ab(iii)	II
<i>Ramalina calicaris</i> (L.) Fr.		EN	D	VU	A1b	
<i>Ramalina dilacerata</i> (Hoffm.) Hoffm.		CR	D	DD		
<i>Ramalina elegans</i> (Bagl. & Carestia) Jatta		DD		RE		

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<i>Ramalina obtusata</i> (Arnold) Bitter		EN	B2ab(iii); D	DD		
<i>Ramalina siliquosa</i> (Huds.) A. L. Sm.		VU	D1+2	VU	D2	
<i>Ramalina sinensis</i> Jatta		CR	D	EN	A2	1960
<i>Ramalina thrausta</i> (Ach.) Nyl.		EN	A2c	NT		III
<i>Rhizocarpon badioatrum</i> (Flörke ex Spreng.) Th. Fr.		RE		RE		1932
<i>Rhizocarpon oederi</i> (Weber) Körb.		RE		RE		<1890
<i>Rinodina interpolata</i> (Stirt.) Sheard		RE		RE		1929
<i>Rostania occultata</i> (Bagl.) Otálora, P.M. Jørg. & Wedin	<i>Collema occultatum</i>	CR	D	RE		
<i>Rusavskia sorediata</i> (Vain.) S.Y. Kondr. & Kärnefelt	<i>Xanthoria sorediata</i>	CR	D	VU	D2	
<i>Sclerophora coniophaea</i> (Norman) J. Mattsson & Middelb.		EN	D	NT		II
<i>Sclerophora farinacea</i> (Chevall.) Chevall.		EN	D	VU	A3c; B2ab(iii)	II
<i>Sclerophora pallida</i> (Pers.) Y. I. Yao & Spooner		NT	C1	LC		III
<i>Sclerophora peronella</i> (Ach.) Tibell		EN	D	VU	B2ab(iii)	II
<i>Scytinium aragonii</i> (Otálora) Otálora, P.M. Jørg. & Wedin		RE		NE		1935
<i>Scytinium gelatinosum</i> (With.) Otálora, P.M. Jørg. & Wedin	<i>Leptogium gelatinosum</i>	EN	C2a(i); D	DD		
<i>Scytinium imbricatum</i> (P.M. Jørg.) Otálora, P.M. Jørg. & Wedin		NT	A2c+4c; C1; D	NE		
<i>Scytinium intermedium</i> (Arnold) Otálora, P.M. Jørg. & Wedin		EN	C2a(i); D	NE		
<i>Scytinium parvum</i> (Degel.) Otálora, P.M. Jørg. & Wedin	<i>Collema parvum</i>	CR	D	VU	D2	
<i>Scytinium pulvinatum</i> (Hoffm.) Otálora, P.M. Jørg. & Wedin		NT	A2c+4c; C1; D	NE		
<i>Scytinium schraderi</i> (Bernh.) Otálora, P.M. Jørg. & Wedin	<i>Leptogium schraderi</i>	EN	C2a(i); D	VU	D2	
<i>Scytinium subtile</i> (Schrad.) Otálora, P.M. Jørg. & Wedin	<i>Leptogium subtile</i>	CR	C2a(i); D	VU	D2	
<i>Scytinium tenuissimum</i> (Dicks.) Otálora, P.M. Jørg. & Wedin	<i>Leptogium tenuissimum</i>	EN	C2a(i); D	DD		
<i>Scytinium teretiusculum</i> (Wallr.) Otálora, P.M. Jørg. & Wedin	<i>Leptogium teretiusculum</i>	VU	C1; D1	VU	B2ab(iii)	II
<i>Solorina bispora</i> Nyl.		CR	B1ab(iii)+2ab(iii); D	VU	D2	
<i>Solorina saccata</i> (L.) Ach.		EN	C1	NT		II
<i>Solorina spongiosa</i> (Ach.) Anzi		EN	A2bc; B1ab(iii)+2ab(iii); D	EN	B1ab(iii)	II
<i>Sphaerophorus globosus</i> (Huds.) Vain.		CR	D	CR	B2ab(iii,iv)	
<i>Squamarina lentigera</i> (Weber) Poelt		CR	C2a(i); D	EN	B1ab(iii)	II
<i>Stereocaulon condensatum</i> Hoffm.		EN	A2c	VU	A2c	III

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<i>Stereocaulon evolutum</i> Graewe ex Th. Fr.		RE		RE		1908
<i>Stereocaulon incrustatum</i> Flörke		CR	C1+2a(i); D	DD		
<i>Stereocaulon vesuvianum</i> Pers.		RE		RE		1912
<i>Zwackhia soređiifera</i> (P. James) Ertz	<i>Opegrapha soređiifera</i>	CR	C2a(i); D	VU	D2	
<i>Zwackhia viridis</i> (Ach.) Poetsch & Schied.	<i>Opegrapha viridis</i>	VU	C1; D1	VU	A3c	
<i>Thelidium pyrenophorum</i> (Ach.) Mudd		DD		RE		
<i>Thelotrema lepadinum</i> (Ach.) Ach.		VU	C1	NT		III
<i>Toninia physaroides</i> (Opiz) Zahlbr.		VU	C1; D1	-		
<i>Toninia sedifolia</i> (Scop.) Timdal		EN	B1ab(iii)+2ab(iii); C1; D	VU	B2ab(iii)	
<i>Toninia verrucarioides</i> (Nyl.) Timdal		CR	B1ab(iii)+2ab(iii); D	DD		
<i>Umbilicaria cinerascens</i> (Arnold) Frey		CR	D	VU	D2	
<i>Umbilicaria cylindrica</i> (L.) Delise ex Duby		CR	D	DD		1959
<i>Umbilicaria decussata</i> (Vill.) Zahlbr.		CR	B2ab(iv); C2a(i); D	VU	D2	
<i>Umbilicaria hirsuta</i> (Sw. ex Westr.) Hoffm.		CR	D	-		
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm.		EN	D	VU	D2	
<i>Umbilicaria nyländeriana</i> (Zahlbr.) H. Magn.		CR	C2a(i); D	VU	D2	
<i>Umbilicaria polyrhiza</i> (L.) Fr.		EN	D	CR	A2bc	
<i>Umbilicaria proboscidea</i> (L.) Schrad.		CR	D	DD		
<i>Usnea barbata</i> (L.) Weber ex F.H. Wigg		NT	A2c+3c+4c; C1	NT		III
<i>Usnea chaetophora</i> Stirt.		EN	B1ab(iii); D	EN	B1ab(iii)	
<i>Usnea fulvovirens</i> (Räsänen) Räsänen		VU	A2c; C1; D1	EN	A2bc+3bc	
<i>Usnea glabrata</i> (Ach.) Vain.		CR	A2c; C2a(i)	CR	A2bc+3bc	1959
<i>Usnea wasmuthii</i> Räsänen		VU	A3c; B2ab(iii)	VU	A2bc+3bc	
<i>Vahlia leucophaea</i> (Vahl) P.M. Jørg.	<i>Fuscopannaria leucophaea</i>	CR	A2bc; B1ab(i,ii)+2ab(i,ii); D	DD		1961
<i>Variospora thallincola</i> (Wedd.) Arup, Frödén & Söchtng	<i>Caloplaca thallincola</i>	EN	D	VU	D2	
<i>Verrucaria maculiformis</i> Kremp.		DD		RE		
<i>Vulpicida juniperinus</i> (L.) J.-E. Mattsson & M. J. Lai		NT	A2c+3c+4c; B1ab(iii)	DD		
<i>Xanthomendoza fallax</i> (Hepp) Arnold		EN	D	VU	B1ab(i,iv)	
<i>Xanthoparmelia mougeotii</i> (Schaer. ex D. Dietr.) Hale		EN	C2a(i)	EN	B2ab(iii)	II
<i>Xanthoria calcicola</i> Oxner		EN	D	VU	D2	
* <i>Xanthoria oregana</i> Gyeln.		DD		-		

* as *Gallowayella poeltii* in Estonian Nature Information System

Supplement 2. The list of lichen species which were red-listed in 2008, but considered as Not Evaluated (NE) or Not Applicable (NA) in 2019. Explanation why the species was not assessed in 2019 is given in the Comment.

Species name in 2008	Red list category		Comment
	2008	2019	
<i>Bryoria intricans</i> (Vain.) Brodo & D. Hawksw.	DD	NA	has been included in <i>Bryoria chalybeiformis</i> (L.) Brodo & D. Hawksw. and was assessed within this species in 2019
<i>Caloplaca coronata</i> (Kremp. ex Körb.) J. Steiner	VU	NE	Estonian material needs re-identification and therefore the species was not assessed in 2019
<i>Cladonia convoluta</i> (Lam.) Anders	VU	NA	has been included in <i>Cladonia foliacea</i> (Huds.) Willd. and was assessed within this species in 2019
<i>Dermatocarpon leptophyllum</i> (Ach.) K.G.W. Lång	DD	NA	has been included in <i>Dermatocarpon minutum</i> (L.) W. Mann and was assessed within this species in 2019
<i>Hyperphyscia adglutinata</i> H. Mayrhofer & Poelt	RE	NA	considered doubtful (included in the checklist based on literature data, herbarium samples are not available) and therefore the species was not assessed in 2019
<i>Lecanora swartzii</i> (Ach.) Ach.	VU	NE	lack of data for the assessment (only one collection known from Mohni island, 2005)
<i>Leptogium cyanescens</i> (Räbenh.) Körb.	DD	NA	considered doubtful (included in the checklist based on literature data, herbarium samples are not available) and therefore the species was not assessed in 2019
<i>Opegrapha rupestris</i> Pers.	VU	NA	Estonian material needs re-identification and therefore the species was not assessed in 2019
<i>Vulpicida tubulosus</i> (Schaer.) J.-E. Mattsson & M.J. Lai	NT	NA	has been included in <i>V. juniperinus</i> (L.) J.-E. Mattsson & M.J. Lai (Saag et al. 2014) and was assessed within this species in 2019
<i>Usnea diplotypus</i> Vain.	NT	NE	has been included in <i>U. dasopoga</i> Vain. (Clerc 2011), the species which was assessed as LC in 2008
<i>Usnea substerilis</i> Motyka	EN	NE	has been included in <i>U. lapponica</i> Vain. (Mark et al. 2016), the species which was assessed as LC in 2008