

## D1.1 Raised bog

### Summary

Raised bogs, developed as rain-fed mire systems on flat or gently-sloping ground, with deep saturated acid peat are widely distributed across Europe but especially characteristic of the hemi-boreal and south boreal zones, occurring sometimes as part of wider raised bog or Aapa mire complexes, in other cases isolated in different landscapes. Surface patterning with hummocks, lawns, carpets and hollows is typical and there can also be secondary pools. *Sphagna* are typically dominant on the mire surface with distinctive contingents of dwarf-shrubs on the drier hummocks. Trees are scarce and confined to drier areas, though marginal bog woodland occurs in many sites. The main threat to raised bogs is posed by hydrological alteration by different drainage activities and peat extraction still threatens the habitat in some countries. Atmospheric pollution and nitrogen enrichment cause changes in the nutrient regime and vegetation. Long-term historic losses have been enormous and the decline in quantity and quality continues in most countries, though restoration efforts by blocking ditches and restoring the rain-fed water table have often been locally successful.

### Synthesis

Raised bog habitats have declined markedly in area in recent and historical past. Taking into account probable effects of deficiencies and time-scales of data provided, this habitat type results in the assessment Endangered (EN) under the criterion A3 in EU28 and in Vulnerable (VU) under the criteria A1 and A3 in EU28+. In the case of Raised bogs, historic reduction in area is relevant even today, although area reduction is generally considered to have ceased. Many populations of bog biota are nevertheless continuing to decline partly due to the historic legacy. Also, quality decline is widely reported but the C/D1 criterion only indicates Near Threatened (NT) status. Data were insufficient for separation between the C and D criteria, which are difficult to assess separately because they are strongly interlinked. Main abiotic threats include altered water level/hydrology and nitrogen deposition that affect biotic structures like abundance of trees.

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	A3	Vulnerable	A1, A3

### Sub-habitat types that may require further examination

There are sub-types characteristic of different climate zones that require further examination. These include habitat types of plateau bog, concentric bog, excentric bog and northern reticulate bog complexes. Species composition of vegetation and microrelief structures vary among raised bog subtypes.

### Habitat Type

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#### Code and name

D1.1 Raised bog



A view over Viirusuo bog in SE Finland, an eccentric (sloping) bog complex where hollows with *Sphagnum balticum* have an intermediate water level and open water pools are characteristically missing, hummocks strings (kermis) with *Sphagnum fuscum* and dwarfshrubs, including the eastern *Chamaedaphne calyculata*. (Photo: Teemu Tahvanainen).



Old cranked pine on a raised bog with abundant *Sphagnum magellanicum* and a typical secondary bog pool in early spring at Riisu Raba bog, Estonia. (Photo: Teemu Tahvanainen).

## Habitat description

In raised bogs, the water table level is elevated by a few centimeters to metres above that of mineral rich ground water of surrounding areas and consequently there is an ombrotrophic (rain-fed) nutrient regime. The peat layer is often several metres thick and mainly composed of *Sphagnum* remains, highly water saturated with the water table close to the surface. High acidity (pH < 4.5) and low mineral content characterize the peat and pore water. Typically there is a pattern of alternation between micro habitats (hummocks, lawns, carpets, hollows) that relate to topography, hydrology and peat formation. Hummock-hollow patterning can be irregular in flat plateau bogs, where hummocks remain low. In concentric and eccentric raised bog complexes, hummock-hollow patterning shows a distinct orientation perpendicular to the slope and water flow. Open water pools of secondary origin, i.e. developed on the peat after hummock ridge formation, are often found and provide important aquatic microhabitats. Raised bog habitats are most typical in central parts of raised bog complexes (EUNIS habitat X04) but they are also found in mixed complexes with D3.2 Aapa mires. Mire complex patterns may also be completely missing and often raised bog habitats are found as small undrained remnants of historically degraded bog complexes. Raised bogs differ from D1.2 Blanket bogs by being restricted to basins rather than blanketing over variable terrain. The lagg zones of raised bog complexes are considered under D2.2a Poor Fens.

Trees (*Pinus sylvestris*, *Betula pubescens*) are found only sparsely on hummocks and *Sphagnum* mosses dominate the ground layer of vegetation. In hummocks, *Sphagnum fuscum* is the most characteristic species, especially in boreal and continental areas. Other typical hummock species are *S. rubellum*, *S. magellanicum*, *S. capillifolium*, *S. angustifolium*, *Dicranum bergeri* and *Polytrichum strictum*. Dwarf-shrub species *Andromeda polifolia*, *Betula nana*, *Calluna vulgaris*, *Empetrum nigrum*, *Erica tetralix*, *Ledum palustre*, *Vaccinium microcarpon*, *V. oxycoccos*, *V. uliginosum* are characteristic on hummocks, while only few herbs (*Drosera rotundifolia*, *Rubus chamaemorus*) and sedges (*Carex pauciflora*, *Eriophorum vaginatum*) are found. The wet hollows may have continuous carpets of *Sphagnum* or sometimes muddy peat surfaces void of mosses or with some cover of hepatics or *Warnstorffia fluitans*. Typical species include *Sphagnum cuspidatum*, *S. balticum*, *S. jensenii*, *S. majus*, *S. tenellum* among mosses and *Carex limosa*, *Scheuchzeria palustris*, *Rhynchospora alba* among vascular plants. Also forest mosses like *Pleurozium schreberi*, *Hylocomium splendens*, *Dicranum polysetum* and lichens like *Cladonia spp.* and *Certraria islandica* are found on hummocks.

Raised bogs are widely distributed from central European mountain areas to north-boreal regions, being most prominent in the hemi-boreal to south-boreal zones. The pattern of dominance and features of micro-habitat patterning vary over different climatic zonation belts.

Indicators of good quality:

- Under natural conditions, the water table is close to surface in hollows and it can be readily observed in small pit dug in peat surface except during prolonged drought.
- There is a gradual and logical continuum between dominant vegetation and the composition of recently (decades to centennial) formed peat, indicating that modern vegetation is forming typical *Sphagnum* peat.
- Species composition differs between hummocks and hollows in a regionally characteristic way and there are no large patches of lichens or hummock mosses such as *Polytrichum strictum* in the hollows.
- Ombrotrophic and acidophilic *Sphagnum* mosses and other characteristic species comprise substantial elements in vegetation.
- Number of species or diversity indices of vegetation are not good indicators since raised bogs are naturally species poor habitats, while harboring unique species assemblages.
- Occurrence of trees is limited to scattered individuals on hummocks. Drainage ditches are one main factor to cause decline of quality of raised bogs but their occurrence alone does not always indicate poor quality.

Characteristic species:

Flora: Vascular plants: *Andromeda polifolia*, *Betula nana*, *Calluna vulgaris*, *Carex limosa*, *Carex pauciflora*, *Drosera rotundifolia*, *Empetrum nigrum*, *Erica tetralix*, *Eriophorum vaginatum*, *Ledum palustre*, *Melampyrum pratense*, *Pinus sylvestris*, *Rhynchospora alba*, *Rubus chamaemorus*, *Scheuchzeria palustris*, *Trichophorum cespitosum*, *Vaccinium microcarpon*, *Vaccinium oxycoccos*, *V. uliginosum*, *V. vitis-idaea*

Mosses: *Aulacomnium palustre*, *Cladopodiella fluitans*, *Calypogeia sphagnicola*, *Dicranum bergeri*, *Dicranum leioneuron*, *Dicranum polysetum*, *Dicranum scoparium*, *Gymnocolea inflata*, *Hylocomium splendens*, *Leucobryum glaucum*, *Mylia anomala*, *Odontochisma sphagni*, *Pleurozium schreberi*, *Polytrichum strictum*, *Sphagnum angustifolium*, *Sphagnum balticum*, *Sphagnum capillifolium*, *Sphagnum compactum*, *Sphagnum cuspidatum*, *Sphagnum rubellum*, *Sphagnum lindbergii*, *Sphagnum magellanicum*, *Sphagnum papillosum*, *Sphagnum fuscum*, *Sphagnum majus*, *Sphagnum jensenii*, *Sphagnum tenellum*, *Warnstorfia fluitans*

Lichens: *Cetraria islandica*, *Cladonia rangiferina*, *Cladonia arbuscula*, *Cladonia stellaris*, *Cladonia stygia*.

Fauna: Birds: *Pluvialis apricaria*, *Grus grus*, *Tringa glareola*, *Tringa nebularia*, *Numenius arquata*, *Anthus pratensis*, *Motacilla flava*, *Tetrao tetrix*, *Vanellus vanellus*

Insects: *Boloria* spp., *Carsia sororiata*, *Coenonympha tullia*, *Colias palaeno*, *Pyrgus centaureae*

### **Classification**

This habitat may be equivalent to, or broader than, or narrower than the habitats or ecosystems in the following typologies.

EUNIS:

D1 Raised and blanket bogs

EuroVegChecklist:

*Oxycocco microcarpi-Empetrion hermaphroditi* Nordhagen ex Du Rietz 1954

*Sphagnion medii* Kästner et Flössner 1933

*Scheuchzerion palustris* Nordhagen ex Tx. 1937 (hollows)

*Oxycocco palustris-Ericion tetralicis* Nordhagen ex Tx. 19

Annex I:

7110 Active raised bogs

(may include small parts of 7120 Degraded raised bogs still capable of natural regeneration)

Emerald:

X04 Raised bog complexes (partly)

MAES:

Wetlands

IUCN:

5.4. Bogs, Marshes, Swamps, Fens, Peatlands

**Does the habitat type present an outstanding example of typical characteristics of one or more biogeographic regions?**

Yes

Regions

Atlantic

Boreal

Justification

Although relatively widespread, raised bogs have clear climate zonality with their main area in the hemi-boreal and south-boreal zones, while large parts of the distribution cover the Atlantic region as well. In addition, raised bogs occur in temperate mountain areas where boreal climate conditions prevail. Extra-zonal raised bogs are found only in specific local hydrological conditions. Furthermore, raised bogs have subtypes with climate-zonal distribution patterns.

**Geographic occurrence and trends**

EU 28	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
<i>Austria</i>	Present	30 Km <sup>2</sup>	Decreasing	Decreasing
<i>Belgium</i>	Present	1.6 Km <sup>2</sup>	Stable	Decreasing
<i>Croatia</i>	Present	0.01 Km <sup>2</sup>	Unknown	Unknown
<i>Czech Republic</i>	Present	25 Km <sup>2</sup>	Decreasing	Decreasing
<i>Denmark</i>	Present	73 Km <sup>2</sup>	Decreasing	Decreasing
<i>Estonia</i>	Present	1500 Km <sup>2</sup>	Decreasing	Decreasing
<i>Finland</i>	Åland Islands: Present Finland mainland: Present	5600 Km <sup>2</sup>	Decreasing	Decreasing
<i>France</i>	France mainland: Present	145 Km <sup>2</sup>	Decreasing	Decreasing
<i>Germany</i>	Present	460 Km <sup>2</sup>	Decreasing	Decreasing
<i>Hungary</i>	Present	0.03 Km <sup>2</sup>	Decreasing	Decreasing
<i>Ireland</i>	Present	499 Km <sup>2</sup>	Decreasing	Decreasing
<i>Italy</i>	Italy mainland: Present	8.9 Km <sup>2</sup>	Decreasing	Decreasing
<i>Latvia</i>	Present	2979 Km <sup>2</sup>	Decreasing	Decreasing
<i>Lithuania</i>	Present	125 Km <sup>2</sup>	Decreasing	Decreasing

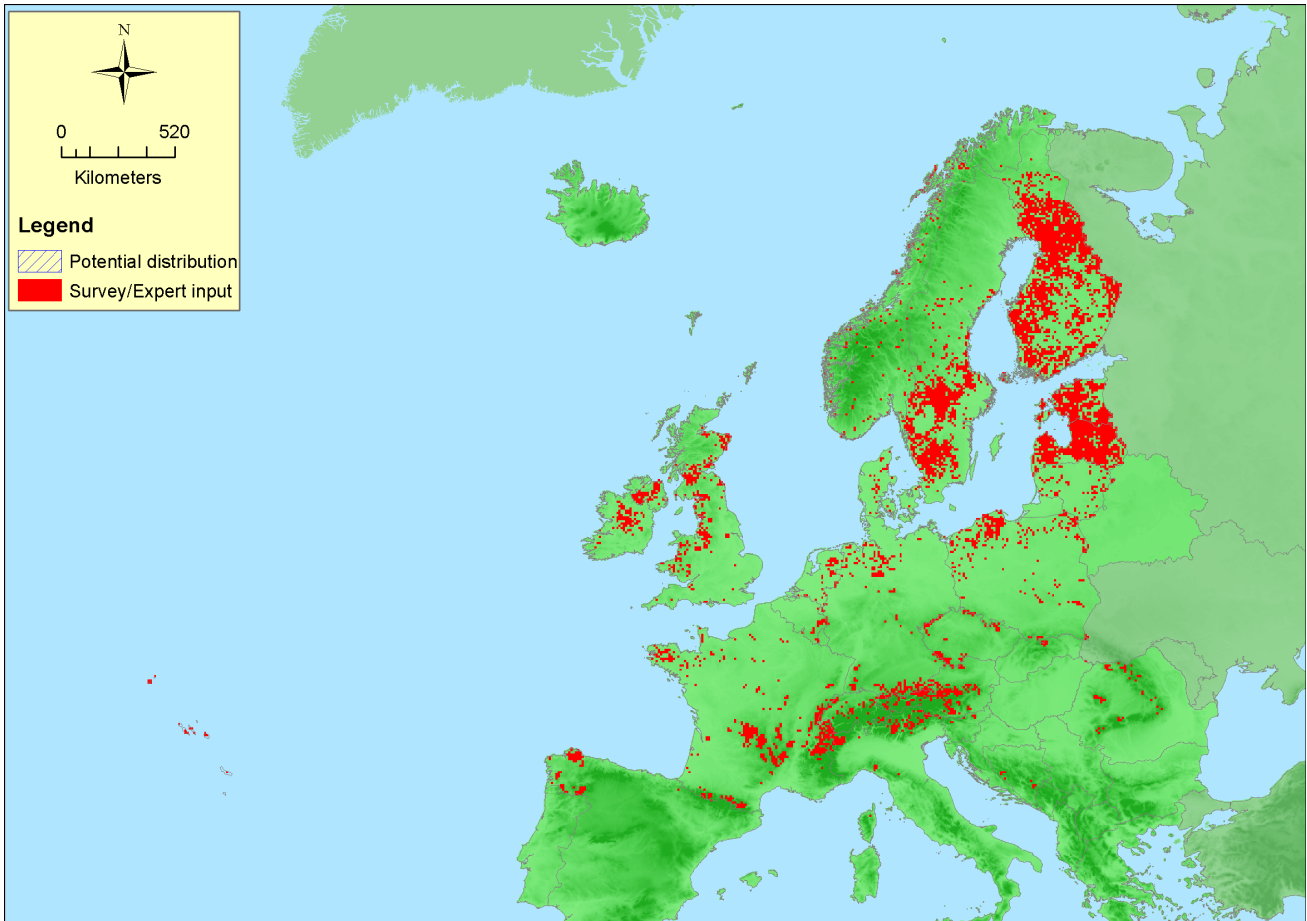
EU 28	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
<i>Netherlands</i>	Present	53 Km <sup>2</sup>	Decreasing	Decreasing
<i>Poland</i>	Present	610 Km <sup>2</sup>	Decreasing	Decreasing
<i>Portugal</i>	Portugal Azores: Present Portugal mainland: Present	0.2 Km <sup>2</sup>	Decreasing	Decreasing
<i>Romania</i>	Present	20 Km <sup>2</sup>	Stable	Decreasing
<i>Slovakia</i>	Present	0.8 Km <sup>2</sup>	Decreasing	Decreasing
<i>Slovenia</i>	Present	0.6 Km <sup>2</sup>	Stable	Stable
<i>Spain</i>	Spain mainland: Present	68 Km <sup>2</sup>	Decreasing	Decreasing
<i>Sweden</i>	Present	8000 Km <sup>2</sup>	Decreasing	Decreasing
<i>UK</i>	Northern Island: Present United Kingdom: Present	625 Km <sup>2</sup>	Decreasing	Decreasing

EU 28 +	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
<i>Bosnia and Herzegovina</i>	Present	0.2 Km <sup>2</sup>	Decreasing	Decreasing
<i>Norway</i>	Norway Mainland: Present	7100 Km <sup>2</sup>	Decreasing	Decreasing
<i>Switzerland</i>	Present	17 Km <sup>2</sup>	Decreasing	Decreasing

### Extent of Occurrence, Area of Occupancy and habitat area

	Extent of Occurrence (EOO)	Area of Occupancy (AOO)	Current estimated Total Area	Comment
<i>EU 28</i>	8260850 Km <sup>2</sup>	4951	20660 Km <sup>2</sup>	
<i>EU 28+</i>	8750700 Km <sup>2</sup>	5129	27760 Km <sup>2</sup>	

### Distribution map



The distribution centre of Raised bogs lies in Scandinavia, the Baltic and Atlantic regions, in the latter occurring together with Blanket and Valley bogs. In temperate mountains the habitat covers smaller areas, requiring high precipitation and flat relief (flat summits of Hercynian mountains, intermountain basins and surroundings of alpine lakes). In southern Europe it is virtually absent - individual reports often represents transitions to poor fens and wooded peatlands. The map is rather complete for EU28, except for northern Sweden, but with data gaps in Norway and the Balkan. Data sources: ART17, EVA, NAT.

### **How much of the current distribution of the habitat type lies within the EU 28?**

Raised bog habitats are widely distributed over boreal region e.g. in Russia, Canada, Alaska. In a coarse estimate, about 5-10 % of worldwide distribution may lie within the EU28.

### **Trends in quantity**

The long-term historic trend in Central Europe has been devastating, the area is estimated to have declined by 90% within ca. 150 years in many countries, but losses have been less dramatic in Fennoscandia, where the major part of the existing extent is located. Recent past (50 years) reduction has been extensive everywhere, usually reported as between 30-50 %. A decrease of 5-10 % of the remaining area is most often projected for the future due mainly to peat extraction, while in some areas an increase is anticipated from restoration work.

- Average current trend in quantity (extent)  
EU 28: Decreasing  
EU 28+: Decreasing
- Does the habitat type have a small natural range following regression?

No

#### *Justification*

The habitat has a wide distribution and despite the trend of decline in quantity, the EOO remains very

wide.

- Does the habitat have a small natural range by reason of its intrinsically restricted area?

No

*Justification*

The habitat has a wide distribution occurring where the necessary conditions are met.

## **Trends in quality**

Habitat quality is decreasing in almost all countries with a European extent of degradation of 65% and calculated severity 42%. Some countries, however, indicate potential increase in future thanks to restoration activities.

- Average current trend in quality

EU 28: Decreasing

EU 28+: Decreasing

## **Pressures and threats**

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Alteration of hydrology by ditching, canalization or water abstraction are the most common threats to raised bogs, with peat extraction and airborne pollution, specifically Nitrogen deposition next. Succession of communities and droughts imposed by climate warming also pose a threat. Minor factors reported were tourism, fragmentation and changes of grazing regime.

### **List of pressures and threats**

#### **Sylviculture, forestry**

Forest planting on open ground

Forest planting on open ground (native trees)

Artificial planting on open ground (non-native trees)

#### **Mining, extraction of materials and energy production**

Peat extraction

Mechanical removal of peat

#### **Human intrusions and disturbances**

Other human intrusions and disturbances

#### **Pollution**

Air pollution, air-borne pollutants

Nitrogen-input

other air pollution

#### **Natural System modifications**

Human induced changes in hydraulic conditions

Canalisation & water deviation

Canalisation

Modification of hydrographic functioning, general

Reservoirs

Water abstractions from groundwater

Other human induced changes in hydraulic conditions

Other ecosystem modifications

Anthropogenic reduction of habitat connectivity

## **Natural biotic and abiotic processes (without catastrophes)**

- Biocenotic evolution, succession
  - Species composition change (succession)
  - Eutrophication (natural)

## **Climate change**

- Changes in abiotic conditions
  - Droughts and less precipitations

## **Conservation and management**

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Raised bogs are widely represented in conservation areas but many valuable sites are still without protection. Restoration of degraded bogs by blocking ditches and restoring the rain-fed water-table, has been conducted in many countries but upscaling of restoration activities is needed in order to gain more than marginal area and quality effects at the European scale. Peat extraction should be stopped in habitats that still have the natural defining features of raised bogs, in order to halt the reduction in extent.

## **List of conservation and management needs**

### **Measures related to wetland, freshwater and coastal habitats**

- Restoring/Improving the hydrological regime
- Managing water abstraction

### **Measures related to spatial planning**

- Establish protected areas/sites
- Establishing wilderness areas/allowing succession
- Legal protection of habitats and species
- Manage landscape features

### **Measures related to hunting, taking and fishing and species management**

- Regulation/Management of hunting and taking

### **Measures related to urban areas, industry, energy and transport**

- Specific management of traffic and energy transport systems

### **Measures related to special resource use**

- Other resource use measures

## **Conservation status**

Annex I:

7110: ALP U1, ATL U2, BOR U2, CON U2, MAC U2, MED U2, PAN U2

## **When severely damaged, does the habitat retain the capacity to recover its typical character and functionality?**

There are good experiences of restoration by blocking drainage ditches. Importantly, *Sphagnum* mosses recover quickly and peat accumulation can start within about ten years if water levels are kept high. Natural recovery without intervention is slow. In high-domed Raised bogs sufficient blocking or damming of ditches can be especially difficult.

## **Effort required**



10 years	20 years	50+ years	200+ years
Through intervention	Through intervention	Through intervention	Naturally

## Red List Assessment

### Criterion A: Reduction in quantity

Criterion A	A1	A2a	A2b	A3
EU 28	-47 %	-10 %	unknown %	-63 %
EU 28+	-42 %	-10 %	unknown %	-56 %

Estimated limits of loss for the criterion A1 were 35-60% and for the criterion A3 58-69%. However, A3 is governed by Finland and Sweden where historic decline was estimated as 50% which is only a very coarse estimate (set a bit higher than recent decline) and the upper limit comes from assuming 60% loss, as more precise data was not provided. Without these two countries, the average A3 value would be 90%. Furthermore, data are missing from Belgium, Ireland and UK which have much bigger historic area losses than Nordic countries. Data from all Baltic countries are missing as well, which probably also have substantial historic losses. Historic trends were estimated on average for a 156 year period. Extending the same trend to the period after 1750 would indicate 75% historic decline of area. Therefore, historic losses in EU28 are probably more than 70% and assessment of Endangered (EN) status is given for the criterion A3. Data for historic decline was missing for Norway but it was probably similar to other Nordic countries and therefore EU28+ historical decline must be less than EU28. Assuming that the decline was slightly higher (10%) in historical times compared to recent times in Norway, the EU28+ historical decline amounts 56%, i.e. clearly below the EN threshold and, thus, Vulnerable (VU) status is assessed for EU28+.

### Criterion B: Restricted geographic distribution

Criterion B	B1			B2			B3	
	EOO	a	b	c	AOO	a		b
EU 28	>50000 Km <sup>2</sup>	Yes	Yes		>50	Yes	Yes	
EU 28+	>50000 Km <sup>2</sup>	Yes	Yes		>50	Yes	Yes	

This is a widespread habitat type with both EOO and AOO. Therefore the B criterion is assessed as Least Concern (LC) despite the reported continuing decline and threatening processes.

### Criterion C and D: Reduction in abiotic and/or biotic quality

Criteria C/D	C/D1		C/D2		C/D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	65 %	42 %	unknown %	unknown %	unknown %	unknown %
EU 28+	65 %	42 %	unknown %	unknown %	unknown %	unknown %

Criterion C	C1		C2		C3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %
EU 28+	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %

Criterion D	D1		D2		D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%
EU 28+	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%

Reduction in quality was always reported as according to C/D rather than biotic and abiotic separately. Few countries indicated specific biotic quality effects, but they also indicated climate change as a threat, which includes abiotic aspects. C/D1 values are close to VU thresholds and Nordic countries estimates dominate the assessment. There were very few data entries on future and historic quality decline, so they could not be assessed. Most degradation is recent and historic quality changes are not likely to be critical. For EU28+ assessment, trends in Finland and Sweden were applied for Norwegian raised bog area, as data was not available for Norway. This results in closely the same figures and correspondingly the assessment Near Threatened (NT) is made for both EU28 and EU28+ by the criterion C/D1.

### Criterion E: Quantitative analysis to evaluate risk of habitat collapse

Criterion E	Probability of collapse
EU 28	unknown
EU 28+	unknown

There are many studies on raised bog ecology and recent changes, but assessment of the E criterion was not considered possible because of great ambiguity of possible collapse thresholds.

### Overall assessment "Balance sheet" for EU 28 and EU 28+

	A1	A2a	A2b	A3	B1	B2	B3	C/D1	C/D2	C/D3	C1	C2	C3	D1	D2	D3	E
EU28	VU	LC	DD	EN	LC	LC	LC	NT	DD	DD	DD	DD	DD	DD	DD	DD	DD
EU28+	VU	LC	DD	VU	LC	LC	LC	NT	DD	DD	DD	DD	DD	DD	DD	DD	DD

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	A3	Vulnerable	A1, A3

### Confidence in the assessment

Medium (evenly split between quantitative data/literature and uncertain data sources and assured expert knowledge)

### Assessors

T. Tahvanainen

### Contributors

Type description: T. Tahvanainen

Territorial data: Alegro, L. Aunina, R. Bijlsma, C. Bită-Nicolae, J. Capelo, A. Čarni, R. Delarze, I. Diack, D. Espírito-Santo, P. Finck, P. Frankard, M. Hájek, B. Hamill, J. Janssen, P. Jones, N. Juvan, Z. Kački, T. Kontula, E. Leibak, A. Mikołajczak, Đ. Milanović, J.A. Molina, Zs. Molnár, B. Nygaard, J. Paal, D. Paternoster, P. Perrin, V. Rašomavičius, U. Raths, U. Riecken, J. Šibík, Ž. Škvorc, D. Spray, A. Ssymank

Working Group Mires & bogs: C. Bită-Nicolae, M. Hájek, F. Jansen, T. Tahvanainen

## Reviewers

J. Rodwell

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