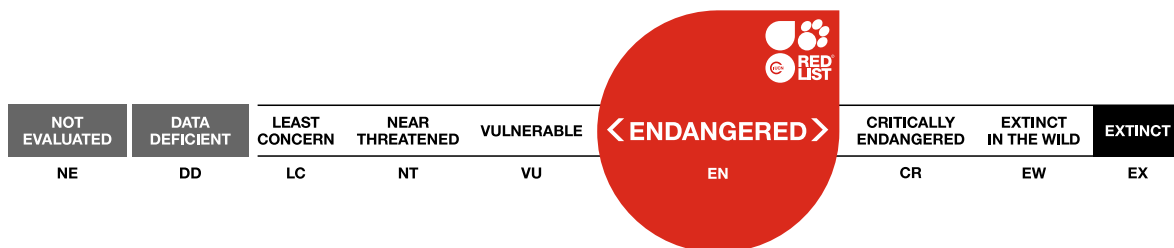


Cladonia submitis, Mid-Atlantic Comb-over

Assessment by: Hoffman, J., Ohmura, Y. & Lendemer, J.



View on www.iucnredlist.org

Citation: Hoffman, J., Ohmura, Y. & Lendemer, J. 2021. *Cladonia submitis*. *The IUCN Red List of Threatened Species* 2021: e.T183335302A183335414. <https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T183335302A183335414.en>

Copyright: © 2021 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [Arizona State University](#); [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae

Scientific Name: *Cladonia submitis* A. Evans

Synonym(s):

- *Cladina submitis* (A. Evans) Hale & W.L. Culb.

Common Name(s):

- English: Mid-Atlantic Comb-over

Taxonomic Source(s):

Index Fungorum Partnership. 2020. Index Fungorum. Available at: <http://www.indexfungorum.org>.

Taxonomic Notes:

This species was included within *Cladonia mitis* until Evans (1943) separated it on the basis that *C. submitis* occupies a different habitat, produces unique secondary compounds, and has shorter, more robust podetia. Four subspecies of *C. submitis* were also recognized by Evans (1943), and while they have not been subsequently investigated in detail, they are not presently recognized as taxonomically distinct (Hoffman *et al.* 2020).

The reported occurrences of this species in east Asia are very likely ascribable to a different taxon. While the individuals do share some characteristics (e.g. production of usnic acid and pseudonorrangiformic acid), there are notable morphological differences. The podetia of North American individuals are thicker and coarser than Asian individuals (Ahti 1961). Furthermore, the North American populations occur in coastal sandy habitats while the Asian populations occur on rocky outcrops at higher elevations (Hoffman *et al.* 2020). Thus, the Asian occurrences are treated as a distinct taxon, and *C. submitis* is considered endemic to eastern North America.

Assessment Information

Red List Category & Criteria: Endangered A2c; B2ab(i,ii,iii,iv,v) [ver 3.1](#)

Year Published: 2021

Date Assessed: August 30, 2020

Justification:

Cladonia submitis is an endemic macrolichen native to the Mid-Atlantic coast of North America, inhabiting primarily pine barren and sand dune habitat. It has a restricted area of occupancy (AOO = 196 km²), and is considered to be severely fragmented. The species shows evidence of decline due to habitat loss resulting from land use changes and development. Based on recent large-scale surveys, there has been a 59.3% decline in AOO and a 39.3% decline in extent of occurrence (EOO) in the past century (Hoffman *et al.* 2020). A similar range of decline in the population size is inferred based on the reduction in EOO and AOO. Overall, therefore, the species is listed as Endangered under criteria A2c; B2ab(i,ii,ii,iv).

Geographic Range

Range Description:

Cladonia submitis is endemic to eastern North America, with occurrences as far north as southern Maine and as far south as central North Carolina, from the coastline to eastern West Virginia (Brodo *et al.* 2001, Hoffman *et al.* 2020). However, occurrences in the western extent of its range are presumed no longer to be extant. The species has also been recorded from Honshu and Hokkaido, Japan, and Sakhalin Island, Russia, but the taxonomic identity of these collections is unlikely to be *C. submitis*. The morphology and habitat differences are notable enough to suggest that the East Asian collections are not *C. submitis* (Ahti 1961, Hoffman *et al.* 2020), and thus are not included here.

Country Occurrence:

Native, Extant (resident): United States (Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania)

Native, Possibly Extinct: United States (West Virginia)

Population

Across most of its range, the population of *Cladonia submitis* is naturally patchily distributed, occurring primarily in exposed patches among forested habitats. However, the species is typically locally abundant where it occurs. The current population size is estimated to exceed 4,200 individuals based on counts at each site until the number exceeded 100 distinct thalli (Hoffman *et al.* 2020). As population size estimates were made only at a subset of occurrences for the species, and at most of these sites the number of individuals was considerably greater than the maximum count recorded, this estimate of population size is most likely highly conservative. However, the conversion of habitat to commercial and residential land has extirpated the species at 14 of its historical occurrences. All of the known disjunct occurrences in mountainous regions consist of small numbers of individuals in spatially restricted rock outcrop habitats, and some of these have not been relocated in 30 years or longer. These declines have caused a notable reduction to the area of occupancy (AOO) and extent of occurrence (EOO). Hence, we infer a population decline for the species due to these anthropogenic effects within the last 3 generations. As the processes that have caused past declines in the core area of the population along the coast have not ceased, and are ongoing, we infer that there is also a continuing decline in the AOO and EOO, as well as in overall habitat quality due to increased fragmentation and habitat loss.

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

Cladonia submitis is primarily restricted to exposed sections of sand and sparse grass or shrubs among pine barren and sand dune habitat. In pine barrens, the species occurs along roadsides or in exposed areas with reduced canopy coverage, among pitch pine (*Pinus rigida*) and oaks (*Quercus marilandica*, *Q. berberidifolia*). On dune habitat, the species typically inhabits the inter dune, with beach plum (*Prunus maritima*) beach heather (*Hudsonia tomentosa*) and occasional pitch pine. In both habitat types, the species grows in a large assemblage among other *Cladonia* species, including *C. subtenuis*, *C. rangiferina*, *C. uncialis*, *C. atlantica* and *C. boryi*. *Cladonia submitis* has also historically been reported from a small number of scattered locations on exposed rock outcrops in the Piedmont and Appalachian Mountains, in assemblage with other *Cladonia* species.

Systems: Terrestrial

Use and Trade

Cladonia submitis is collected by scientists for research purposes, and likely by sellers of *Cladonia* lichens as decorations, as soil cover for potted plants, and as prop in model-making. No notable records of *C. submitis* specifically harvested for non-scientific purposes exist as of yet, but several co-occurring, morphologically similar species such as *C. subtenuis*, *C. arbuscula* and *C. rangiferina* are often collected for this purpose, usually to be ambiguously labeled “reindeer moss” for sale (pers. obs). Thus it is likely that collectors harvesting *Cladonia* lichens indiscriminately in areas where *C. submitis* is found will also collect *C. submitis*.

Threats (see Appendix for additional information)

The most immediate threat that *Cladonia submitis* faces is that of habitat loss and degradation (historical and ongoing) from land use changes and development. In the majority of its range, *C.*

submitis inhabits land around a metropolitan area which has grown and developed considerably over the last century. Many places where the species had been collected in the past were recently found to be transformed into residential or commercial land (Hoffman *et al.* 2020). While the species can occasionally be found on sandy roadsides, creating small pockets where the species can occur, the overall trend of land development threatens the species in the majority of its range, leading to more than a 50% decline in its area of occupancy.

Cladonia submitis also faces threats from climate change, particularly in the form of modified fire regimes and sea level rise. The species primarily occupies pine barren and sand dune habitats. Pine barrens, once influenced by a natural fire regime, are an at-risk habitat due both to fire-suppression and because fire disturbances are projected to become more frequent and intense under climate change (Keeley and Sypard 2016). Suppression of the natural fire regime can result in overgrowth of vegetation which can overshadow and exclude *C. submitis*. This overgrowth also leads to increased fuel loads, which leads to more intense fires, that will also impact remnant individuals (Ray *et al.* 2020). This forecasted change in the fire regime poses a risk to *C. submitis* inhabiting pine barrens. Sand dunes on the other hand, are threatened by erosion caused by sea level rise, projected to become more significant under climate change (Sweet *et al.* 2017). The species appears to have been lost from inter dune habitat along Cape May, New Jersey following a significant storm in 1962, in which the majority of the dunes were destroyed (see Jordan 2003, Hoffman *et al.* 2020).

Conservation Actions (see Appendix for additional information)

Cladonia submitis inhabits a range of public and protected land. While the species is more protected from urbanization and land use changes in state and federal protected areas, such as Island Beach State Park and Wharton State Forest in New Jersey, it is threatened by those effects outside of such boundaries. An increase in the public awareness and education about the species, and particularly its threatened habitat (pine barrens and sand dunes), is needed. Additionally, further research that will aid in the conservation of this species includes population assessments and monitoring, population genetics studies, and ecological studies that incorporate threats to the species. Additionally, a species recovery plan needs to be written. Studies into the true identity of specimens collected in Japan and Russia should also be conducted.

Credits

Assessor(s): Hoffman, J., Ohmura, Y. & Lendemer, J.

Reviewer(s): Yahr, R.

Facilitator(s) and Compiler(s): Chandler, A. & Allen, J.

Bibliography

Ahti, T. 1961. Taxonomic studies on reindeer lichens (*Cladonia*, subgenus *Cladina*). *Annales Botanici Societatis Zoologicae-Botanicae Fennicae Vanamo* 32(1): 1-160.

Ahti, T., and Oksanen, J. 1990. Epigeic lichen communities of taiga and tundra regions. *Vegetation* 86: 39-70.

Bachman, S., Moat, J., Hill, A.W., de la Torre, J. and Scott, B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: V. Smith and L. Penev (eds) e-Infrastructures for data publishing in biodiversity science. *Zookeys* 150: 117–126.

Brodo, I.M., S.D. Sharnoff, and S. Sharnoff. 2001. *Lichens of North America*. Yale University Press, New Haven and London.

Evans, A.W. 1943. Microchemical studies on the genus *Cladonia*, subgenus *Cladina*. *Rhodora* 45(539): 417-438.

Hoffman, J.R., Ohmura, Y. and Lendemer, J.C. 2020. Combing for Beach Broccoli: surveys of the endemic macrolichen *Cladonia submitis* determines endangered status under IUCN guidelines. *Biodiversity and Conservation* 29: 2439–2456.

IUCN. 2021. The IUCN Red List of Threatened Species. Version 2021-1. Available at: www.iucnredlist.org. (Accessed: 25 March 2021).

Jordan, J.J. 2003. *Cape May Point: The Illustrated History: 1875 to the Present*. Schiffler Books, Atglen, Pennsylvania.

Keeley, J. and Syphard, A. 2016. Climate change and future fire regimes: examples from California. *Geosciences* 6(3): 37.

Maikawa, E. and Kershaw, K.A. 1976. Studies on lichen-dominated systems. XIX. The postfire recovery sequence of Black Spruce–lichen woodland in the Abitau Lake region, NWT. *Canadian Journal of Botany* 54(23): 2679-2687.

Morneau, C., and Payette, S. 1989. Postfire lichen-spruce woodland recovery at the limit of the boreal forest in northern Quebec. *Canadian Journal of Botany* 67: 2770-2782.

Nimis, P.L., Scheidegger, C. and Wolseley, P.A. 2002. Monitoring with Lichens - Monitoring Lichens. In: Nimis, P.L., Scheidegger, C. and Wolseley, P.A. (eds), *Monitoring with Lichens - Monitoring Lichens*, pp. 1-4. Springer, Dordrecht, Netherlands.

Ray, D.G., Calahan, G.D. and Lendemer, J.C. 2020. Factors influencing the persistence of reindeer lichens (*Cladonia* subgenus *Cladina*) within frequent-fire environments of the Mid-Atlantic Coastal Plain, USA. *Fire Ecology* 16(1): 1-18.

Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R. and Zervas, C. 2017. Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report NOS CO-OPS 083. National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce, Silver Spring, Maryland.

Citation

Hoffman, J., Ohmura, Y. & Lendemer, J. 2021. *Cladonia submitis*. *The IUCN Red List of Threatened Species* 2021: e.T183335302A183335414. <https://dx.doi.org/10.2305/IUCN.UK.2021-1>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Supplementary Material](#), and for [Images and External Links to Additional Information](#), please see the Red List website.

Appendix

Habitats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Habitat	Season	Suitability	Major Importance?
1. Forest -> 1.4. Forest - Temperate	Resident	Suitable	Yes
13. Marine Coastal/Supratidal -> 13.3. Marine Coastal/Supratidal - Coastal Sand Dunes	Resident	Suitable	Yes

Plant Growth Forms

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Plant Growth Form
LC. Lichen

Use and Trade

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

End Use	Local	National	International
Research	No	No	No
Other household goods	No	No	No

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
1. Residential & commercial development -> 1.1. Housing & urban areas	Ongoing	Whole (>90%)	Rapid declines	High impact: 8
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
1. Residential & commercial development -> 1.2. Commercial & industrial areas	Ongoing	Whole (>90%)	Rapid declines	High impact: 8
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
1. Residential & commercial development -> 1.3. Tourism & recreation areas	Ongoing	Whole (>90%)	Slow, significant declines	Medium impact: 7
	Stresses:	2. Species Stresses -> 2.2. Species disturbance		

7. Natural system modifications -> 7.1. Fire & fire suppression -> 7.1.1. Increase in fire frequency/intensity	Ongoing	Majority (50-90%)	Slow, significant declines	Medium impact: 6
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality		
11. Climate change & severe weather -> 11.4. Storms & flooding	Future	Whole (>90%)	Slow, significant declines	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		

Conservation Actions in Place

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Action in Place
In-place research and monitoring
Action Recovery Plan: No
Systematic monitoring scheme: No
In-place land/water protection
Conservation sites identified: No
Area based regional management plan: No
Occurs in at least one protected area: Yes
Invasive species control or prevention: Not Applicable
In-place education
Subject to recent education and awareness programmes: No

Conservation Actions Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Action Needed
1. Land/water protection -> 1.1. Site/area protection
1. Land/water protection -> 1.2. Resource & habitat protection
4. Education & awareness -> 4.3. Awareness & communications
5. Law & policy -> 5.1. Legislation -> 5.1.2. National level
5. Law & policy -> 5.1. Legislation -> 5.1.3. Sub-national level

Research Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Research Needed
1. Research -> 1.1. Taxonomy
1. Research -> 1.2. Population size, distribution & trends
1. Research -> 1.3. Life history & ecology
1. Research -> 1.5. Threats
2. Conservation Planning -> 2.2. Area-based Management Plan
3. Monitoring -> 3.1. Population trends

Additional Data Fields

Distribution
Estimated area of occupancy (AOO) (km ²): 196
Continuing decline in area of occupancy (AOO): Yes
Extreme fluctuations in area of occupancy (AOO): No
Estimated extent of occurrence (EOO) (km ²): 170452
Continuing decline in extent of occurrence (EOO): Yes
Extreme fluctuations in extent of occurrence (EOO): No
Number of Locations: 27
Continuing decline in number of locations: Yes
Extreme fluctuations in the number of locations: No
Population
Number of mature individuals: 4,200
Continuing decline of mature individuals: Yes
Extreme fluctuations: No
Population severely fragmented: Yes
No. of subpopulations: 13
Continuing decline in subpopulations: Yes
Extreme fluctuations in subpopulations: No
All individuals in one subpopulation: No
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes

Habitats and Ecology
Generation Length (years): 30

The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#).

The IUCN Red List Partners are: [Arizona State University](#); [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); and [Zoological Society of London](#).