## Supplementary Information

The pattern of sensitive species being increasingly found in isolated populations vulnerable to local extinction can also be seen in data from the Swedish Species Information Centre (Artdatabanken, 2020), a database of species observations contributed by both professionals and the public (Fig. S1). An illustrative example is the sensitive species *L. pulmonaria*, which is rather distinctive and therefore often reported (as well as being the subject of numerous studies). The decline and fragmentation in in the southern half of Sweden is clear even at the coarse scale of the map. We can also assume that *L. pulmonaria* was more abundant prior to 1990 (studies from the 1980’s already reported steep declines in southern Sweden attributed to air pollution e.g. Hallingbäck & Olsson (1987)), but there are too few comparable observations for this period in the Species Information Centre database. Recent research (Ronnås et al., 2017) indicates that spore dispersal for this species can occur over longer distances (up to several kilometres) and that it may therefore be largely establishment limitation that results in the observed poor effective dispersal already mentioned in the discussion section. However, this study was performed in an area of old growth forest, and the authors note that in heavily managed forest short distance dispersal is the dominant process, as explored in Belinchón et al. (2017).   
We note that the Swedish Species Information Centre data are not based (only) on rigorous systematic resampling, but also have a citizen science component, and are potentially affected by variations in sampling effort. However, there is no indication that a consistent decrease in sampling effort in southern Sweden has occurred which could account for the decline seen there, and the species has changed Red List classification in Sweden from “LC- Least Concern” in 2000 to “NT- Near Threatened” in 2005 and remained at NT since then.

Map

Description automatically generated

**Fig. S1.** Recorded observations of *L. pulmonaria* in the Swedish Species Information Centre database in the periods 1990–2000 and 2010–2020.

**Site Information**

DEIMS-SDR (Dynamic Ecological Information Management System - Site and dataset registry), which can be found at deims.org, is a database of long-term ecosystem research sites, with information about sites, parameters measured and contact information. The sites featured in this study have the following permanent identifiers.

Aneboda <https://deims.org/9dd45aa6-ed7a-49d2-bea4-7750351c55d0>

Kindla <https://deims.org/9aa88bb6-b4a9-4569-8520-3d26643e6de9>

Gårdsjön <https://deims.org/9abbb750-8325-4a00-a801-db9cf3a2df13>

Gammtratten <https://deims.org/27415652-8de8-40e7-92c1-f82526116a2d>

A presence/absence epiphytic lichen species list for the monitored sites is found in Table S1.

**Table S1.** Species list.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Gårdsjön | Aneboda | Kindla | Gammtratten |
| *Alectoria sarmentosa* (Ach.) Ach. |  |  |  | x |
| *Arthonia leucopellaea* (Ach.) Almq. |  | x |  |  |
| *Bacidia arceutina* (Ach.) Rehm & Arnold |  |  |  | x |
| *Biatora efflorescens* (Hedl.) Räsänen |  |  | x | x |
| *B. carneoalbida* (Müll. Arg.) Coppins |  |  |  | x |
| *Bryoria capillaris (Ach.) Brodo & D.Hawksw.* | x | x | x | x |
| *B. furcellata* (Fr.) Brodo & D.Hawksw. |  |  |  | x |
| *B. fuscescens* (Gyeln.) Brodo & D.Hawksw. |  |  |  | x |
| *Bryoria* sp. |  | x |  |  |
| *Calicium parvum* Tibell | x |  |  |  |
| *C. viride* Tuck. |  |  |  | x |
| *Caloplaca flavorubescens* (Huds.) J.R.Laundon |  |  |  | x |
| *Cetraria chlorophylla* (Willd.) Vain. |  |  |  | x |
| *C. pinastri* (Scop.) Gray |  |  |  | x |
| *Chaenotheca chrysocephala* (Turner ex Ach.) Th.Fr. | x | x | x | x |
| *C. ferruginea* (Turner ex Sm.) Mig. | x |  |  | x |
| *C. subroscida* (Eitner) Zahlbr. |  |  |  | x |
| *C. trichialis* (Ach.) Th.Fr. | x |  |  |  |
| *Cladonia coniocraea* (Flk.) Sandst. | x | x | x |  |
| *C. digitata* (L.) Hoffm*.* | x |  |  |  |
| *C. pyxidata* (L.) Hoffm*.* | x |  | x |  |
| *Cladonia* sp*.* | x | x | x | x |
| *C. squamosa* Rabenh. | x |  |  |  |
| *Dimerella pineti* (Schrad.) Vezda | x |  |  |  |
| *Fuscidea pusilla* Tønsberg | x |  |  |  |
| *Hypogymnia physodes* (L.) Nyl. | x | x | x | x |
| *Hypocenomyce scalaris* (Ach. ex Lilj.) M.Choisy | x | x |  | x |
| *Hypogymnia tubulosa* (Schaer.) Hav. |  | x |  | x |
| *Imshaugia Aleurites* (Ach.) S.L.F.Mey. | x |  |  | x |
| *Japewia subaurifera* Muhr & Tønsberg |  |  | x | x |
| *Lecanactis abietina* (Ach.) Körb. | x | x |  |  |
| *Lecanora conizaeoides* Nyl*.* | x |  |  |  |
| *Lecidea nylanderi* (Anzi) Th.Fr. |  |  | x | x |
| *Lepraria incana* (L.) Ach. | x | x | x |  |
| *Lepidozia reptans* (L.) Dumort. | x |  |  |  |
| *Lobaria pulmonaria* (L.) Hoffm*.* |  |  |  | x |
| *Loxospora elatina* (Ach.) A.Massal. | x | x | x |  |
| *Micarea prasine* Fr. | x |  |  |  |
| *Mycoblastus sanguinarius* (L.) Norman |  | x |  | x |
| *Ochrolechia androgyna* C |  |  | x | x |
| *O. microstictoides* Räsänen |  |  | x |  |
| *Ochrolechia* sp. |  |  | x | x |
| *Parmelia saxatilis* (L.) Ach. |  |  | x |  |
| *P. sulcate* Taylor | x |  |  | x |
| *Parmeliopsis ambigua* (Wulfen) Nyl. | x | x | x | x |
| *P. hyperopta* (Ach.) Arnold |  | x | x | x |
| *Phlyctis argena* (Ach.) Flot. | x | x |  | x |
| *Physcia stellaris* (L.) Nyl. |  |  |  | x |
| *Platismatia glauca* (L.) W. L. Culb. & C. F. Culb. | x | x | x | x |
| *Pseudevernia furfuracea* (L.) Zopf | x |  | x |  |
| *Sphaerophorus globosus* (Huds.) Vain. |  | x |  |  |
| *Thelotrema lepadinum* (Ach.) Ach. |  | x |  |  |
| *Trapeliopsis pseudogranulosa* Coppins & P. James | x |  |  |  |
| *Usnea filipendula* Stirt*.* | x |  | x | x |
| *U. subfloridana* Stirt*.* |  |  |  | x |

**References**

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