Ecological Indicators 20 (2012) 196–203

Contents lists available at SciVerse ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Terricolous lichens as indicators of nitrogen deposition: Evidence from national records

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ARTICLE INFO

Article history:
Received 18 October 2011
Received in revised form 2 February 2012
Accepted 21 February 2012

Keywords:
Acid grassland
Air pollution
Bog
Calcareous grassland
Determinants of plant community diversity and structure
Generalised additive models
Heathland
Terricolous lichens

ABSTRACT

Large areas of Great Britain currently receive nitrogen (N) deposition at rates which exceed the thresholds above which there is risk of damage to sensitive components of the ecosystem (critical loads for nutrient nitrogen and critical levels for ammonia), and are predicted to continue to do so. Excess N can damage semi-natural ecosystems. Lichens are potentially sensitive to air quality because they directly utilise nutrients deposited from the atmosphere thus may be good indicators of air quality. We used data from the British Lichen Society (BLS) database, which records the presence of all lichen taxa growing in Britain at 10 km resolution. The probability of presence of a taxa at a given level of N deposition was analysed together with driver data for climate, change in sulphur deposition, land-use and N deposition using generalised additive models (GAMs). Many taxa showed negative responses to N deposition with reductions in the probability of presence as N deposition increased. In all of the habitats, there were a mix of terricolous taxa which showed negative or no significant relationship with N deposition. Most of the taxa with negative relationships with N deposition started to decline in prevalence at the lowest levels of deposition found in this study. Levels of deposition over which a negative response apparently occurs are lower than those at which critical loads have been set for some habitats. These findings suggest that some terricolous lichen taxa are sensitive to atmospheric N deposition and even low levels of nitrogen deposition could be damaging terricolous lichen communities making then potentially good indicators of N deposition.

1. Introduction

Atmospheric nitrogen (N) deposition poses a serious threat to sensitive semi-natural habitats in the United Kingdom (UK) (Hall et al., 2006; NEGTAP, 2001). Large areas of the country have nitrogen (N) deposition at rates which exceed thresholds above which there is risk of damage to sensitive components of the ecosystem. These thresholds or critical loads and levels are exceeded for total loads of nitrogen as a nutrient which builds up in the ecosystem causing long term chronic effects. Hallsworth et al. (2010) estimated that 20% of the area of Special Areas of Conservation in the UK exceeded the 1 $\mu g\,m^{-3}$ critical level for ammonia concentration in air assigned to lichens and bryophytes.

Lichens are potentially very sensitive to air quality and they have been widely used for biomonitoring of air pollutants, especially sulphur dioxide (Hawksworth and Rose, 1970). Lichens directly uptake nutrients deposited from the atmosphere through their thallus surface making them vulnerable to changes in atmospheric chemistry (Hauck, 2010). They are therefore sensitive components of the ecosystem and may also act as valuable early indicators of N deposition damage. Both changes in species composition and community structure have been observed in relation to N deposition (Davies et al., 2007; Welch et al., 2006). In a regional survey, Mitchell et al. (2005) examined epiphytic moss, liverwort and lichen communities in Atlantic Oak woodlands in Scotland and the north of England. They were able to identify a number of species that were either

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doi:10.1016/j.ecolind.2012.02.027

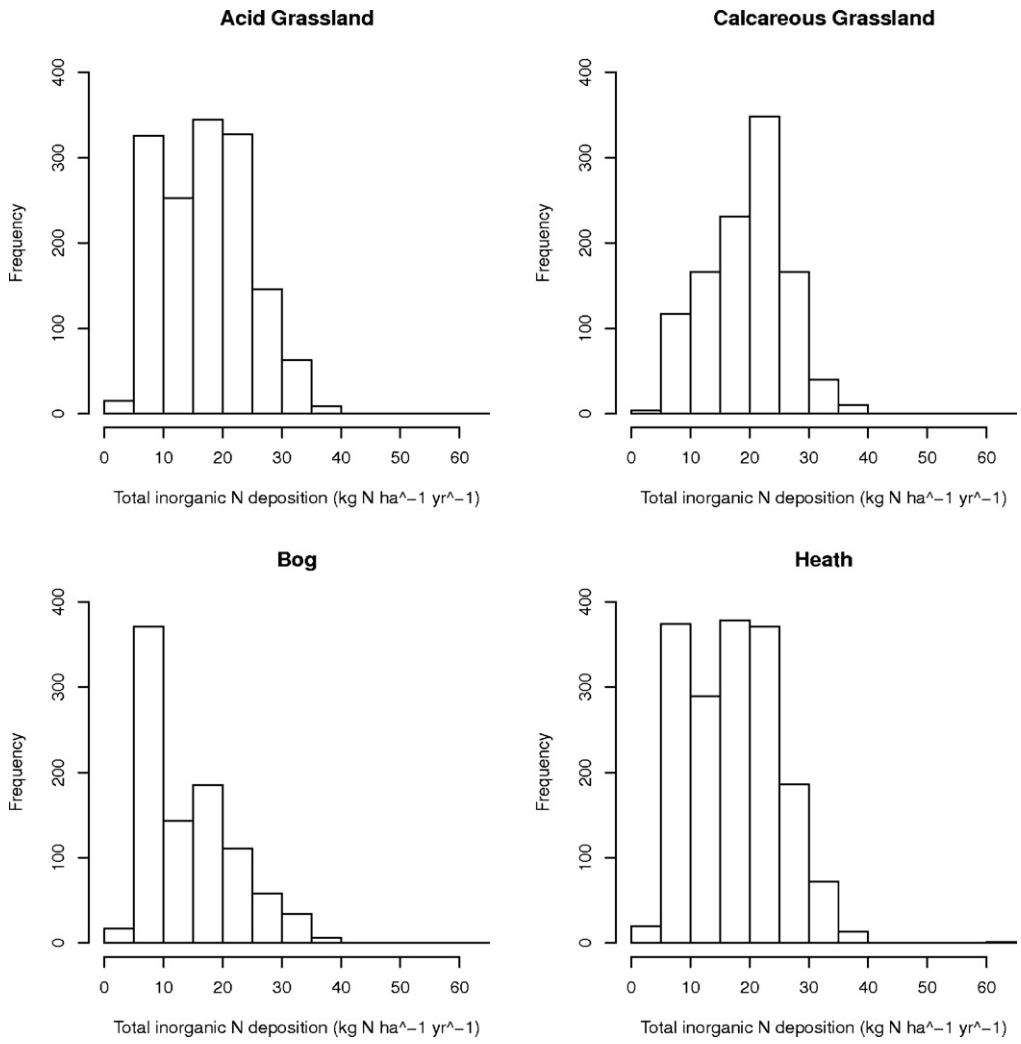

Fig. 1. Range of nitrogen deposition for habitats investigated. Hectad frequency histograms of N deposition ($kg\,N\,ha^{-1}\,yr^{-1}$) for each of the habitats for acid grassland, calcareous grassland, bog and heathland.

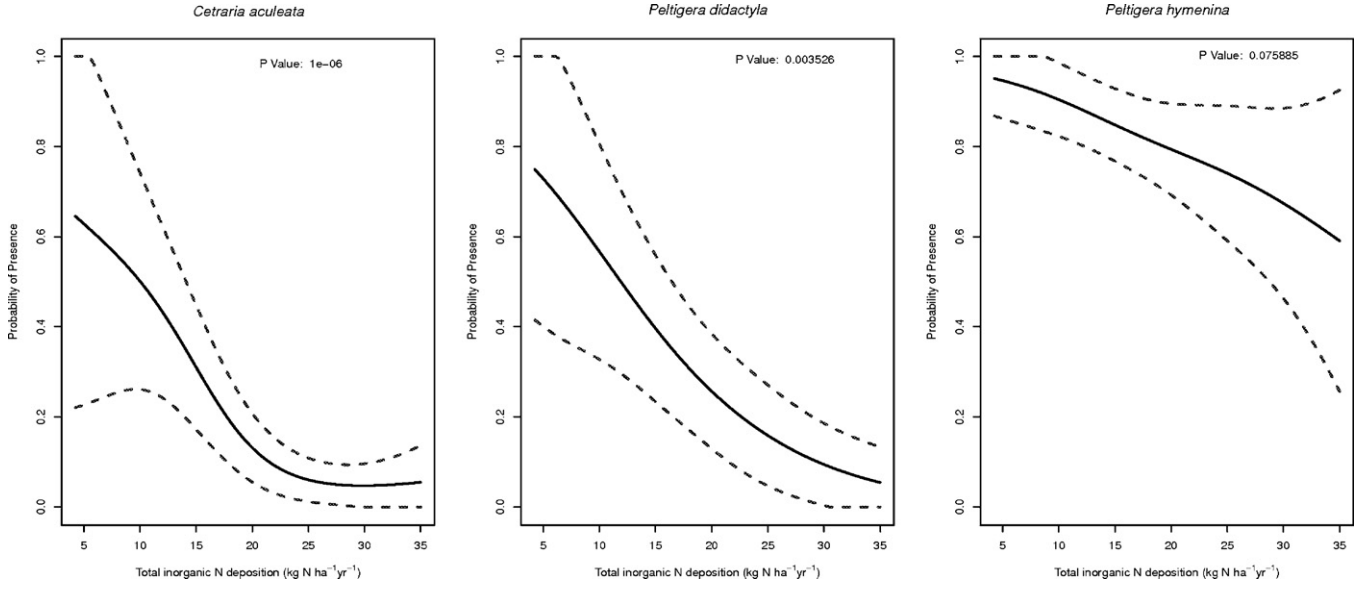

Fig. 2. Spatial change in probability of presence of lichen taxa in acid grassland. Modelled spatial change in probability of presence of *Cetraria aculeata*, *Peltigera didactyla* and *P. hymenina* in acid grassland hectads with increasing total inorganic N deposition ($kg\,N\,ha^{-1}\,yr^{-1}$).