The OPAL **Air Survey** Booklet

OPAL EXPLORE NATURE

Please note: Online data entry for the OPAL Air Survey is now closed. However, you can still use the Air Survey to investigate air quality in your local area.

Introduction

Good air quality is important. It is essential for our health and for the health of the natural environment. Although air quality in the UK is better today than it has been for many decades, air pollutants can still reach levels which can cause harm to human health, crop yields, water quality and biodiversity.

About the Air Survey

OPAL is running activities that will help us learn more about how the natural environment is affected by air pollution. By getting involved in the OPAL Air Survey, and submitting your results to **www.opalexplorenature.org**, you will be helping us to understand the impact of air quality both in your local area and across the country. The first stage of the OPAL Air Survey was based almost entirely in England; we are now extending the survey to build up a more detailed picture of air quality across the whole of the UK.



The OPAL Air Survey uses biological indicators (or 'bioindicators'); species whose presence or performance is sensitive to changes in environmental conditions. OPAL has developed two new bioindicator methods that anyone can use to investigate nitrogen-containing air pollutants.

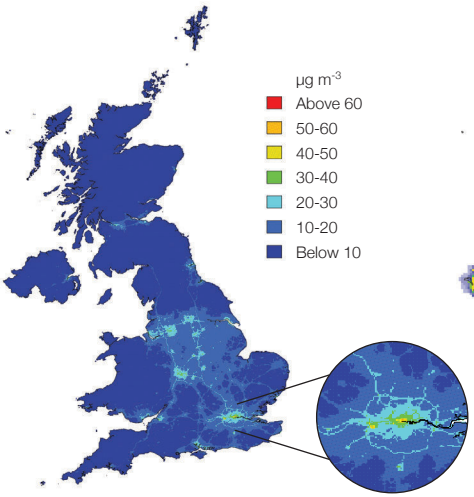
Nitrogen oxides and ammonia

The OPAL Air Survey focuses on the two main nitrogen-containing air pollutants in the UK: ammonia and nitrogen oxides (nitric oxide and nitrogen dioxide). Although moderate levels of nitrogen stimulate the growth of most plants and fungi, high levels of ammonia and nitrogen oxides can reduce the growth of sensitive species, thereby changing the natural world around us.

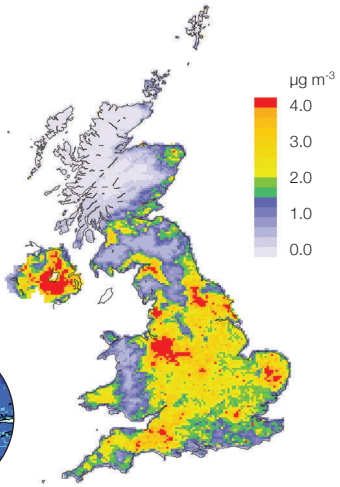
Nitrogen oxides are mainly produced from burning of fossil fuels associated with power generation and transport. Large urban areas and places close to busy roads have the highest concentrations of nitrogen dioxide. In contrast, the highest ammonia concentrations are found in the countryside. High levels of ammonia are

found in areas of livestock farming, and close to intensive chicken and pig units, as ammonia is released in animal wastes.

Maps 1 and 2 show the national distributions of nitrogen dioxide and ammonia. These maps show average concentrations over quite large grid squares (1km for nitrogen dioxide and 5km for ammonia) and they are based on computer models rather than measurements in every grid square. The OPAL Air Survey bioindicators may therefore provide valuable additional information about levels of nitrogen-containing air pollutants at specific locations.



Map 1. Nitrogen dioxide in the UK
(average concentrations for 2012)
Supplied by Defa © Crown copyright 2013



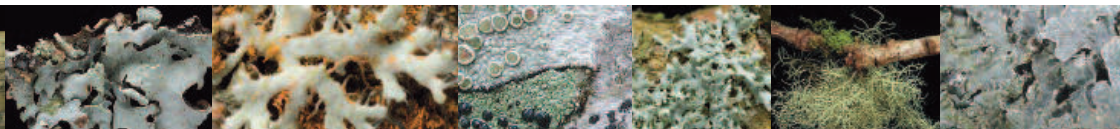
Map 2. Ammonia in the UK
(average concentrations for 2010)
Supplied by Defra © Crown copyright 2013

Bioindicators of ammonia and nitrogen oxides

In this survey we are looking for lichens that are known to grow particularly well when they are close to sources of ammonia and nitrogen oxides, as well as lichens that do not like excessive nitrogen in any form. Lichens are well known indicators of air quality. We are also looking for a fungus, commonly known as tar spot, that we believe is sensitive to nitrogen oxides.

(a) Lichens

Lichens will grow on almost any surface including trees, rocks, soil and artificial surfaces such as concrete and tarmac. In this survey we are looking for lichens on trees. Lichens grow best in light and where they are not competing with tall grass, shrubs or climbing plants.



(b) Tar spot of Sycamore

You may have seen 'tar spots' on the leaves of Sycamore trees. These black spots are caused by the fungus *Rhytisma acerinum*, which is widely distributed across the UK. The fungus spends the winter in infected leaf litter on the ground. In the spring, it produces spores which are transported to newly emerging leaves by the wind and small insects. After infection, large, easily identified 'tar spots', develop on the leaves by July and August. Despite these spots, the fungus is not thought to have a large effect on the health of infected trees.

How is air pollution changing?

In contrast to the visible smogs that affected cities in the past, much of the air pollution in the UK today is largely invisible and so more difficult to detect, although you may be able to smell the pollutants from car exhausts, farmyards and heavy industry. The levels of all the major air pollutants are measured regularly at sites across the UK. We know from these results that the chemical composition of the air has changed considerably over recent decades. Policies to reduce air pollutants and the availability of 'clean technology' have led to a sharp reduction in levels of some pollutants such as sulphur dioxide. However, there has been much less of a fall in the levels of nitrogen-containing pollutants, and these are the focus of the OPAL Air Survey. You can read more about air quality where you live by visiting **http://uk-air.defra.gov.uk**

Survey preparation

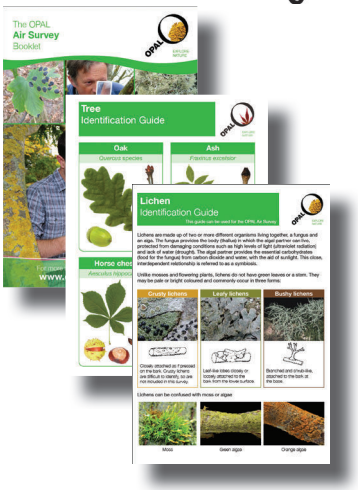
The OPAL Air Survey has two parts, using two different bioindicators:

Activity 1: Lichens on trees (pages 5-10)
Activity 2: Tar spot on sycamore (pages 11-13)

These two activities do not need to be carried out at the same place or at the same time. This booklet contains instructions for carrying out both parts of the OPAL Air Survey and tables in which to enter your results. You will also need the **Lichen Identification Guide** to identify the indicator lichens and the **Tree Identification Guide** to identify the trees on which they grow.

Essential equipment to take outside with you

- The OPAL Air Survey pack which contains this survey **Booklet***, **Lichen Identification Guide**, **Tree Identification Guide** and OPAL **magnifier**
- A **tape measure** (or use the tape measure on the **Lichen Identification Guide**)
- A **pencil** or waterproof pen



Useful items to take outside (if you have them)

- A map or GPS device
- A mobile phone (in case of emergencies)
- A camera

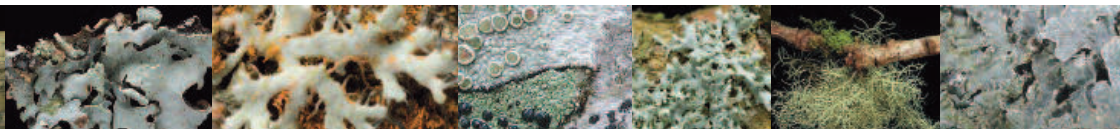
Try to carry out the survey when the weather is dry (as some lichens change colour in the rain) and try to do the tarspot survey between July and October (when the spots are most developed).

Safe fieldwork

We don't advise you to work on your own. Take a responsible friend who can help with your survey and in case things go wrong. Make sure that you know what to do in an emergency. Ensure that you have performed a risk assessment where applicable.

Be aware and avoid hazards around trees such as roots, low-hanging branches and falling branches. Cover any cuts or open wounds before starting the activity. Take special care when working around trees to avoid getting twigs in the eye.

Do not damage any tree, its twigs or branches. Be careful not to disturb other plants and local wildlife. Ensure that you have permission from the landowner to survey lichens and trees on their land. This survey is designed for use in the UK. Check local conditions if you intend to use it elsewhere. More general safety information is available from Royal Society for the Prevention of Accidents **www.rospa.com/leisuresafety**



The survey starts here

Activity 1: Lichens on trees

Look for a site with deciduous trees and lots of light. We suggest **Oak**, **Ash** or **Sycamore** (use the Tree Identification Guide to help you). Avoid coniferous trees and trees which are heavily shaded (e.g. Beech and Horse Chestnut) or covered in ivy. Choose 2-4 trees with a single trunk. If sampling in woodland, use trees at the edge rather than the centre.

Record your results on pages 5–10 as you carry out your survey, and remember to enter them on the OPAL website at the end.

Date of survey _____

1. Who are you doing the Air Survey with today?

- ☐ Primary school
- ☐ Secondary school
- ☐ Youth group
- ☐ Adult volunteer group
- ☐ Friends or family
- ☐ College / university
- ☐ Other

2. Have you carried out a field survey before? yes | no | not sure

3. Could you identify a lichen before you did the survey? yes | no | not sure

4. Are you interested in air quality where you live? yes | no | not sure

A Site characteristics

5. Record the location of your site (postcode / OS grid reference / GPS reading).
Further help is available on the OPAL website if you are unsure of the exact location.

_____

6. Which of these best describes your site?

☐ Street ☐ Playing field/park ☐ Churchyard ☐ Farmland ☐ Garden ☐ Wasteland ☐ Upland ☐ Woodland edge

7. Can you see any of the following near to any of the trees that you are sampling?

☐ Busy road ☐ Sewage treatment works ☐ Industry/ factory ☐ Building site or quarry ☐ Farmland/ manure heap ☐ Playing field/park ☐ None of these

B Tree characteristics

8. Record for each tree:

- the type (species) of tree, or answer 'unknown' if you are not sure

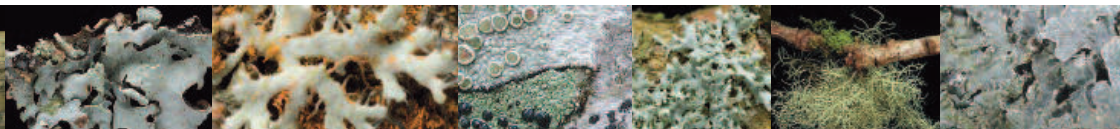
  use the **Tree Identification Guide** to help you

- the girth (circumference) of the trunk (in centimetres) at 1.3 metres above the ground

Measuring girth

Tree 1	**Tree 2**
Species: _____	Species: _____
Trunk girth: _____ cm	Trunk girth: _____ cm

Tree 3	**Tree 4**
Species: _____	Species: _____
Trunk girth: _____ cm	Trunk girth: _____ cm



C Record indicator lichens on the trunk

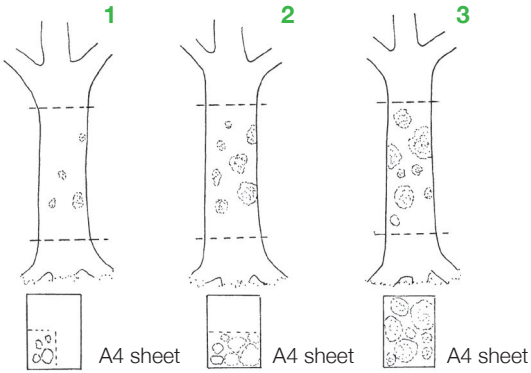
Choose the side of the trunk with the most lichens. Focus just on the lichens between 50–150cm above ground level.

Although there may be many different types of lichen growing on the trunk, we are only interested in the nine indicator lichens shown in the **Lichen Identification Guide**. Don't spend more than about 10 minutes on each tree trunk.

Examining lichens 50-150cm above the ground

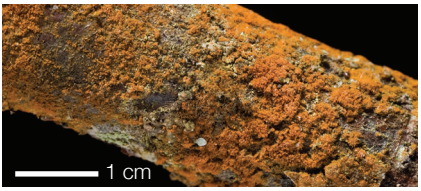
9. In the table on page 8 record the total amount of each indicator lichen you see on the side of the trunk you have chosen as follows:

- **0** None (this is an important result)
- **1** Small amount overall (amounting to less than ¼ of an A4 sheet of paper in total)
- **2** Medium amount overall (amounting to between ¼ up to one A4 sheet in total)
- **3** Large amount overall (more than one A4 sheet in total)

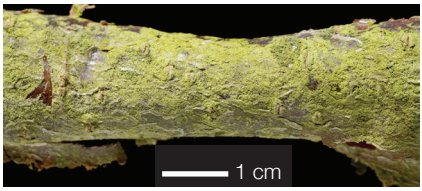


10. Did you find lichens that were different from the indicator lichens in the **Lichen Identification Guide**? If so, count how many other types of lichen there are. Record this number in the table (page 8).

11. Look for green or orange algae on the trunk. Place a tick in the table (page 8) if you find orange or green algae or no signs of algae.



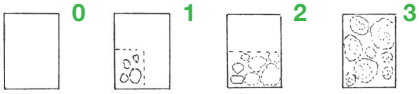
Orange alga



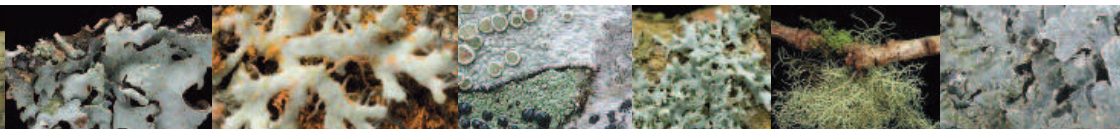
Green alga

Table to record results for Questions **9**-**11**

Amount of each indicator lichen (0, 1, 2 or 3)



	Amount of each indicator lichen on the trunk of each tree (0, 1, 2 or 3)				
	Example	**Tree 1**	**Tree 2**	**Tree 3**	**Tree 4**
Nitrogen-sensitive					
1. *Usnea*	0				
2. *Evernia*	0				
3. *Hypogymnia*	1				
Intermediate					
4. *Melanelixia*	1				
5. *Flavoparmelia*	2				
6. *Parmelia*	1				
Nitrogen-loving					
7. Leafy *Xanthoria*	2				
8. Cushion *Xanthoria*	1				
9. *Physcia*	3				
How many other types of lichen?	4				
Type(s) of algae tick (✓)	Green ☐ Orange ✓ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐



D Record lichens on twigs

Can you reach the twigs? If so, check if any of the indicator lichens are present. Don't spend more than 5 minutes looking.

- Avoid dead or fallen twigs
- Only record from twigs under 2 cm in diameter up to a length of 1 metre

Take care to avoid twigs in the eye!

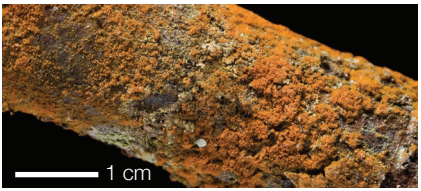
If you cannot reach the twigs, just move onto Section E.

Nitrogen-sensitive lichens

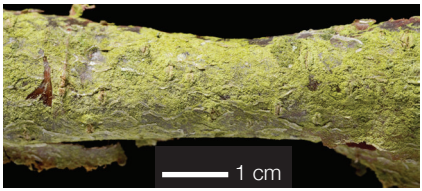
Nitrogen-loving lichens

12. Record the presence of indicator lichens with a tick (✓) in the table on page 10. Enter zero (0) for each indicator species which was not present when you looked.

13. If there are green or orange algae on the twigs enter a tick in the box.



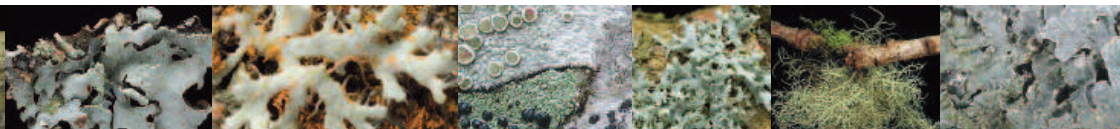
Orange alga



Green alga

Table to record results for Questions **12**-**13**

	Indicator lichen on the twigs of each tree (✓ if present, 0 if not present) Leave the columns blank for the trees where you could not reach the twigs safely				
	Example	**Tree 1**	**Tree 2**	**Tree 3**	**Tree 4**
Nitrogen-sensitive					
1. *Usnea*	0				
2. *Evernia*	0				
3. *Hypogymnia*	✓				
Intermediate					
4. Melanelixia	✓				
5. *Flavoparmelia*	0				
6. *Parmelia*	0				
Nitrogen-loving					
7. Leafy *Xanthoria*	✓				
8. Cushion *Xanthoria*	✓				
9. Physcia	✓				
How many other types of lichen?	4				
Type(s) of algae tick (✓)	Green ☐ Orange ✓ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐	Green ☐ Orange ☐ None ☐

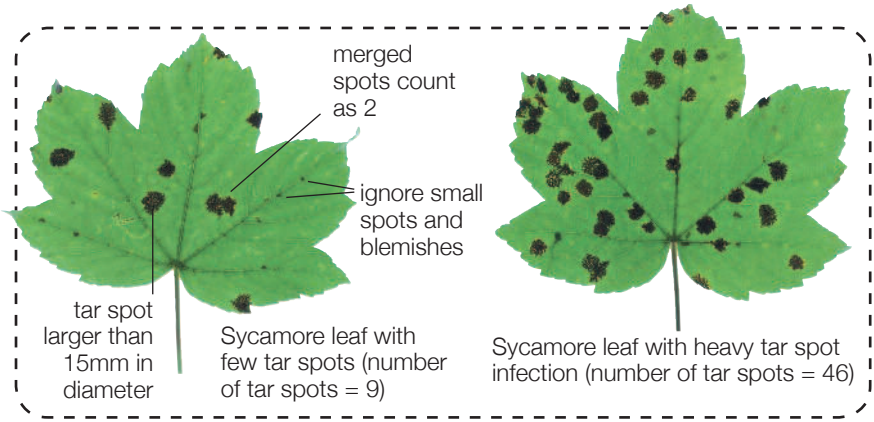


Activity 2: Tar spot of Sycamore

Choose 2-4 **Sycamore** trees. Use the Tree Identification Guide to help you. You do not have to carry out the tar spot survey at the same time or in the same place as the lichen survey.

Choose 10 leaves from each tree. Try to select leaves from different positions within the tree, and avoid taking all 10 leaves from the same branch or same position.

There is no need to remove any of the leaves. Either choose leaves still attached to the tree or collect fallen leaves from under the tree. Answer Questions **1**-**5** for each tree (pages 11-13).



Date of survey _____

A Site characteristics

1. Record the location of your site (postcode / OS grid reference / GPS reading).
Further help is available on the OPAL website if you are unsure of the exact location.

_____

2. Which of these best describes your site?

Street	Playing field/park	Churchyard	Farmland	Garden	Wasteland	Upland	Woodland edge
☐	☐	☐	☐	☐	☐	☐	☐

3. Can you see any of the following near to any of the trees that you are sampling?

Busy road	Sewage treatment works	Industry/ factory	Building site or quarry	Farmland/ manure heap	Playing field/park	None of these
☐	☐	☐	☐	☐	☐	☐

B Tree characteristics

4. Record for each Sycamore tree:

- the girth (circumference) of each trunk (in centimetres) at 1.3 metres above the ground
- the amount of fallen leaves lying under each tree (0 = no fallen leaves, 1 = a small amount of fallen leaves, 2 = lots of fallen leaves)

Tree 1

Trunk girth: _____ cm

Fallen leaves*: _____

Tree 2

Trunk girth: _____ cm

Fallen leaves*: _____

Tree 3

Trunk girth: _____ cm

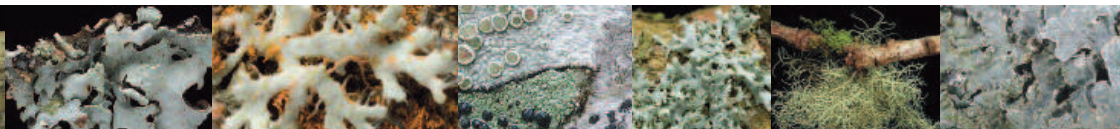
Fallen leaves*: _____

Tree 4

Trunk girth: _____ cm

Fallen leaves*: _____

* **0** = no fallen leaves **1** = a small amount of fallen leaves **2** = lots of fallen leaves

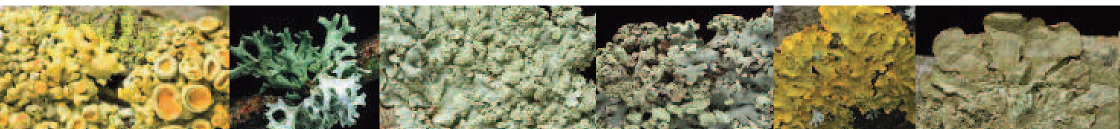


C Record leaf information

5. Choose 10 leaves randomly from each tree. Record for each leaf:

- the number of tar spots (which are larger than 15mm wide), including any partial (or merged) spots (ignore any small marks and blemishes)
- the width of the leaf (in cm) at its widest point

	Tree 1		Tree 2		Tree 3		Tree 4	
Leaf number	**Number of tar spots**	**Leaf width (cm)**	**Number of tar spots**	**Leaf width (cm)**	**Number of tar spots**	**Leaf width (cm)**	**Number of tar spots**	**Leaf width (cm)**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								



What do your results mean?
Lichens and air quality

The lichens in the OPAL survey are known to respond to the levels of nitrogen-containing air pollution. If your trees are dominated by nitrogen sensitive species (like *Usnea* and *Evernia*), the air is likely to be relatively unpolluted. However, if they are dominated by nitrogen loving species (like *Xanthoria* and *Physcia*), the air is likely to have high levels of nitrogen oxides or ammonia.

Tree trunk at the edge of a field fertilised by cow manure. Nitrogen-containing pollutants from the manure have increased the abundance of nitrogen-loving species

Tree trunk on the edge of woodland away from sources of nitrogen, where the air is relatively clean. Nitrogen-sensitive species of lichen are abundant

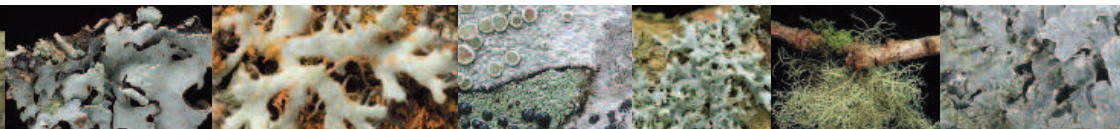
Tar spot and air quality

Tar spot numbers can be reduced by air pollution. If you find few tar spots on your leaves, it may indicate that there are high levels of nitrogen oxides. However, it may also indicate an absence of fungal spores from fallen leaves to cause the infection.

How will the new results help us to learn more?

The data collected by participants so far has helped us to understand how the OPAL Air Survey bioindicators respond to different levels of nitrogen oxides and ammonia across England. You can learn more about these findings on the OPAL website (**www.opalexplorenature.org**). However, we are still unsure about the effects of other factors, such as climate, tree species, and other air pollutants.

We therefore need your help to gather more data. As Maps 1 and 2 show (page 2), the levels of nitrogen oxides and ammonia are quite different in Scotland, Wales and Northern Ireland. More survey results from these parts of the UK, as well as for the many parts of England for which we had few results, will allow us to understand much more clearly the effects of both nitrogen oxides and ammonia pollution on lichens and tar spot across the whole country.



Further information

Lichens: An Illustrated Guide to the British and Irish Species. Dobson (2005).

Lichens on Twigs. Wolseley, James & Alexander (2003). Field Studies Council.

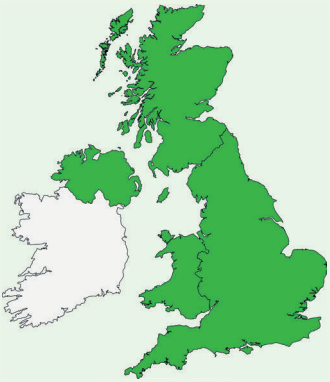
www.nhm.ac.uk/jdsml/nature-online/lichen-id-guide

British Lichen Society **www.britishlichensociety.org.uk**

Additional photographs of lichens at **www.opalexplorenature.org** and at **www.ispotnature.org**

iSpot
Your place to share nature

This activity is one of a series of nature surveys developed by the Open Air Laboratories (OPAL) programme to help you get closer to your local environment while collecting important scientific data. With funding from the Big Lottery Fund, our network of leading universities, museums and wildlife organisations has been developing citizen science activities since 2007 and our resources are available throughout the UK.



If you've enjoyed this survey, why not try another? You can find everything you need to get involved at **www.opalexplorenature.org/surveys**

You can also see what your data has revealed so far and discover a range of ways to get more involved in studying the environment on our website: **www.opalexplorenature.org**

www.facebook.com/opalexplorenature **@OPALnature**

Imperial College London · The University of York · British Lichen Society · Natural History Museum

FSC Bringing Environmental Understanding To All · Environment Agency · defra Department for Environment Food and Rural Affairs · Big Lottery Fund · LOTTERY FUNDED

This pack has been developed by Sally Power[1], Pat Wolseley[2,3], Barbara Hilton[3], Linda Davies[1,3], Nigel Bell[1], Nathan Callaghan[1], Emma Green[1], Simon Norman[4], Mike Ashmore[5]. Photographs by: William Purvis[2,3], Barbara Hilton[3], Ann Allen[3], Heidi Döring[3], James Cook[1], Harry Taylor[2], Emma Green[1]. Editing by: Roger Fradera[1], Laura Gosling[1], Poppy Lakeman Fraser[1], Kate Martin[1] and David Slawson[1]. [1]Imperial College London. [2]Natural History Museum. [3]British Lichen Society. [4]Field Studies Council, [5]University of York.

FSC MIX From responsible sources FSC® C022289

WORLD LAND TRUST™