OPAL – Exploring Nature Together

Findings and Lessons Learnt

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Welcome

The generous support of the Big Lottery's "Supporting UK-wide Great Ideas" programme has enabled people from across the UK to enjoy the benefits of nature by participating in an OPAL activity.

It would be easy to define OPAL as a success by looking solely at the numbers. In the last two years over 100,000 people, 22,000 from disadvantaged communities, have learnt new skills and knowledge and through their efforts over 6,000 places have been explored and recorded. Over 800 organisations have been involved. An astonishing 3,500 teachers have been trained and through them nearly 20,000 hard-to-reach children have been taught outdoors. People's efforts have also made a real contribution to science, enabling academic papers and reports to be produced on their environmental findings, their motivations, and the challenges and barriers to making citizen science activities a success for all involved.

However, neither the numbers nor the science outputs do true justice to all the face-to-face experiences our wonderful network of Community Scientists has provided to an equally amazing range of participants, from all sectors of society, many of whom have never explored the wonders of nature before. It is the stories of these people that truly brings OPAL to life and helps us achieve our vision of "citizen science for everyone".

We are working hard to sustain OPAL into 2017 and beyond, with the aim to continue putting people at the heart of citizen science. In doing so, we expect very soon to exceed the magic number of one million people who have participated in OPAL since we first started in 2007.

David Slawson
OPAL Director

What is OPAL?

OPAL is about giving everyone, whatever their age, background, or level of ability, the opportunity to explore and better understand their local environment.

Through citizen science (public participation in science) OPAL supports communities across the UK to carry out studies of the natural world, either working directly in partnership with scientists or by providing resources to work independently. From looking at the water quality of the UK's lakes and ponds, to maintaining a watchful eye for new invasive species, OPAL's citizen scientists have contributed to a wide variety of scientific inquiry.

OPAL has provided communities across the UK with opportunities to get outside and closer to their local environment, all while contributing to important national scientific research.

Research centres

Soil:	Imperial College London	■
Air:	Imperial College London	■
	University of York	●
Water:	University College London	■
Climate:	UK Met Office	■
Biodiversity:	Natural History Museum	■
	Open University	■
Trees:	FERA	▲
	Forest Research	▲

Support services

National Biodiversity Network	■
Natural History Museum	■
Field Studies Council	▲
The Royal Parks	■

Table 1: *Leading national research centres and other essential supporting services, 2007-2016*

The OPAL Network

OPAL is a partnership of universities, charities, museums and other prominent environmental organisations led by Imperial College London. Since 2007, 22 funded partners, originally across England and latterly across the UK, have each brought their particular expertise to the network (Figure 1, Table 1). OPAL's pioneering 'Community Scientists', a network of enthusiastic and engaging science educators and researchers who work directly with the public, have developed relationships with thousands of schools, and community and voluntary organisations. Over 950,000 people have had environmental experiences through OPAL.

OPAL is committed to bringing about stronger partnerships between the community, voluntary and statutory sectors and has associate partners representing UK government, including the Environment Agency and DEFRA. National committees coordinate and guide OPAL activities in each country.

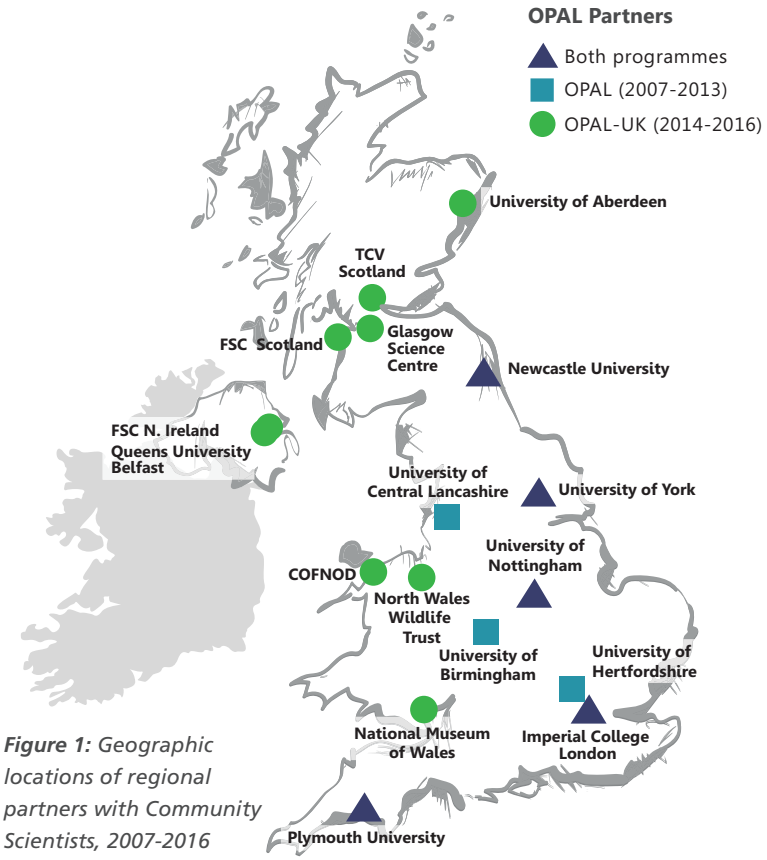


Figure 1: *Geographic locations of regional partners with Community Scientists, 2007-2016*

Citizen Science and OPAL

The term 'citizen science' was only coined in the mid-1990s, but the practice of volunteers partnering with professional scientists has been around for much longer than that. The Audubon Christmas Bird Count is widely regarded as the first example of mass public participation in science in the field of natural history, starting in 1900 and continuing through to the present day.[1]

Professionals work with the public to formulate new knowledge and make informed decisions.

Citizen science today means anything from wearable technology that measures air quality or background radiation, to classifying galaxies or the calls of whales while sat at a computer, to participants donating their surplus computer power towards complex climate modelling or even to aid the search for extra-terrestrial life.

For OPAL, citizen science means going outside and getting hands-on with nature to investigate local spaces and explore topics of national environmental importance.

OPAL reflects the ethos of its primary funder, the Big Lottery Fund, by seeking to engage a wide audience, particularly people from disadvantaged sectors of society, and people not previously engaged with nature.

The OPAL objectives:

1. **Supporting a change of lifestyle, a purpose to spend time outdoors, observing and recording the local environment**
2. **Developing an exciting and innovative educational programme that can be accessed and enjoyed by all ages and abilities**
3. **Inspiring a new generation of environmentalists**
4. **Gaining a much greater understanding of the state of the natural environment for research and policy purposes**
5. **Building stronger partnerships between community, voluntary and statutory sectors**

OPAL Timeline

2017

2016

May 2016
OPAL Polli:Nation Survey launched

June 2015
OPAL New Zealand Flatworm Survey launched

May 2015
OPAL surveys refreshed and produced in Welsh

February 2015
Polli:Nation grant awarded

2015

2014

January 2014
OPAL-UK Begins

September 2013
OPAL-UK Grant Awarded

June 2013
European Citizen Science Association formed

January 2013
Community Environment Report launched

2013

May 2013
OPAL Tree Health Survey launched

Sept 2011
Bugs Count app launched

2012

June 2011
OPAL Bugs Count Survey launched

March 2011
OPAL Climate Survey launched

2011

September 2010
OPAL Biodiversity Survey launched

March 2010
OPAL Water Survey launched

2010

October 2009
Indicia roll out

July 2009
iSpot released

March 2009
Launch of **OPAL website**

2009

September 2009
OPAL Air Survey launched

March 2009
OPAL Soil and Earthworm Survey launched

November 2008
Official OPAL launch

2008

August 2007
1st BLF Grant Awarded

2007

OPAL

LOTTERY FUNDED

OPAL-UK Outcome

Exploring and Studying Outdoors

People most in need spend more time outdoors exploring and studying local green spaces, with benefits for their well-being and the environment.

965,000

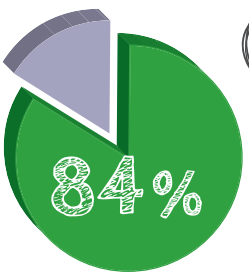
Over 965,000 OPAL beneficiaries since the programme began in December 2007.

113,000

Over 113,000 beneficiaries involved in OPAL-UK since January 2014.

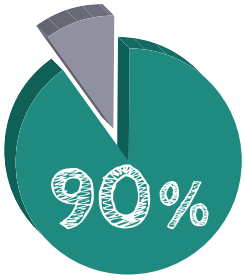
23%

23% of beneficiaries under OPAL-UK come from disadvantaged communities.



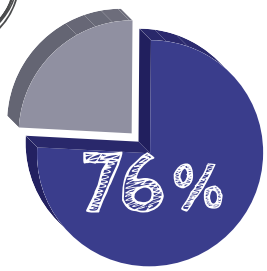
"Would you recommend OPAL to your family and friends?"[2]

84% answered "Yes".



"Will you sign up for the next OPAL survey?"[3]

90% answered "Yes".



"Would you like to do an OPAL survey again?"[4]

76% answered "Yes".

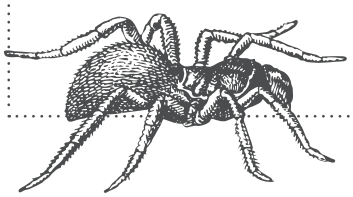
51% of those who took part in an OPAL survey and submitted data had never done a field survey before.[5]

Whether taking part in an OPAL activity with family or being led by an OPAL Community Scientist, people across the country have headed into their local green spaces to play, learn and investigate nature. As an insight into this activity, two case studies demonstrate the breadth of this experience.

Case Study 1

OPAL support homeless to get hands on with nature

OPAL Community Scientists in Nottingham developed an outdoor event with Framework, a charity and housing association dedicated to helping homeless, vulnerable and excluded people. The event's theme was 'Spiders', and people learnt about the habitat needs, adaptations and lifecycle of these animals. They even got the chance to handle the spiders that were found. Those individuals that were reluctant to handle spiders at first were pleased that they had overcome their concerns and said they felt they could do it again if necessary. Through this direct contact with wildlife, many commented how much they had learnt about spiders and their important role in the natural world.



Case Study 2

Disability forum take on challenges of outdoor work

Members of the Flintshire Disability Forum communicated to an OPAL Community Scientist at North Wales Wildlife Trust that they had assumed that they could not take part in environmental surveying because of their disabilities. Together with OPAL the group identified how some of these difficulties could be overcome. Putting these ideas into action the group visited Wepre Country Park to conduct the OPAL Water Survey where a pond was chosen that had good access via a concrete path and small jetties so that those in wheelchairs could safely get to the water's edge. Many people in the group only have limited support for visits and these are primarily indoors; the OPAL Water Survey gave the group a purpose to spend time outside. After taking part, many reported a sense of achievement by accomplishing something they thought was beyond their capabilities.

OPAL-UK Outcome

Developing New Knowledge and Skills

Increased confidence, greater self-esteem, improved employment prospects, and a sense of achievement through the development of new environmental knowledge and skills.

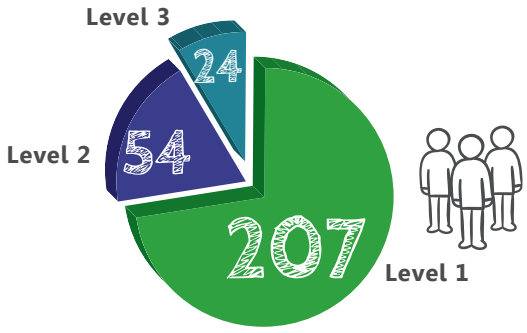
Training and accreditation by OPAL

3,900 people

Over 3,900 people at 219 organisations have been trained in using OPAL materials, including a diverse range of statutory, community and voluntary organisations.

285

285 participants received OPAL accreditation as assessed and certified by OPAL staff.



- **Level 1:** Gained skills through completing an OPAL survey
- **Level 2:** Demonstrated competence in leading groups to complete an OPAL survey
- **Level 3:** Completed the OPAL Open Learning Course administered by Queens University Belfast (participants are awarded 5 CAT points which are recognised across UK Higher Education institutions)

Training and accreditation by other organisations

2,800 people

John Muir Award 2015

2,800 people used at least one OPAL survey to achieve their John Muir Award during 2015.

24%

24% of people involved were from socially disadvantaged backgrounds.

"Did you learn something new today?"[6]

88%
answered "Yes".

"Did you learn something new about your local environment?"[7]

89%
answered "Yes".

Feedback from OPAL participants has suggested that getting involved in scientific investigation has equipped them to investigate what they see beyond their doorsteps. The case studies below provide a glimpse into this learning journey.

Case Study 1

OPAL training leads to specialised apprenticeship

In late 2015, Community Scientists in Wales led a series of OPAL survey training sessions where participants queried the lack of lichens at Porthkerry Country Park and questioned whether the local power station could have been having an impact on air quality. The interested participants were supported by OPAL over several weekends in spring 2016 to carry out OPAL Air Surveys across 15 sites in the Vale of Glamorgan. Not only did the group collect some interesting results but they also gained confidence in conducting fieldwork independently.

Following the survey two participants enquired about a Plantlife Cennad Lichen apprenticeship, with one being accepted. The apprenticeship is a two year commitment to study lichens growing on trees and collect more lichen records. This can help them gain employment in the environmental sector.

Case Study 2

Learning about nature enhances confidence and employability

A BSc Environmental Science undergraduate, volunteered with OPAL at the University of York.

"Volunteering with OPAL has enabled me to overcome difficulties I've had speaking in front of groups and individuals. I'd never been confident in my own abilities, especially my knowledge of nature and science. Working with the OPAL team and being placed in a variety of scenarios has helped me enormously. I feel more confident and passionate about community science. By working with OPAL I feel my employment prospects within the conservation field will be enhanced."

OPAL-UK Outcome

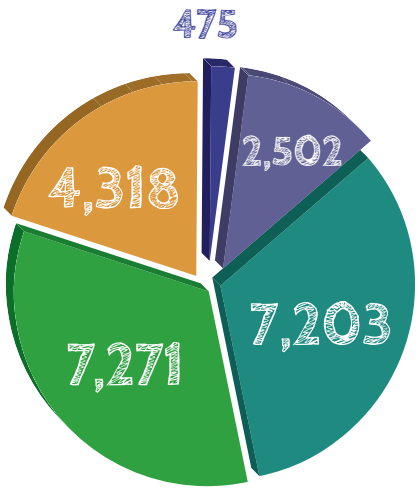
Supporting Schoolchildren

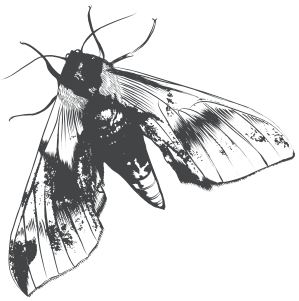
Schoolchildren, particularly from hard-to-reach backgrounds, will explore and understand their local environment and appreciate the relevance of the natural world to their lives.

21,700 schoolchildren

Over 21,700 schoolchildren from hard-to-reach communities have taken part in OPAL-UK.

- Marginalised rural community
- Inner city school
- 10% Most deprived
- 20% Most deprived
- Ex-mining/industrial community





3,770 teachers trained

Over 3,770 teachers trained to deliver outdoor learning to their students under OPAL-UK.

Equivalent to...

754%

of the overall OPAL-UK target!

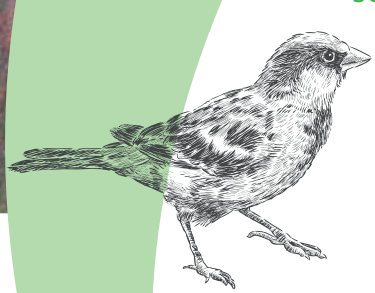
Particular attention has been paid to working with students and teachers. Stories about these experiences have been documented throughout the programme. An example of OPAL's impact is summarised here.

Case Study

OPAL surveys boost skills and stimulate environmental stewardship in schools

Community Scientists from the University of Newcastle have worked closely with Monkseaton Middle School to carry out the OPAL surveys, with the school embedding environmental education into the curriculum and its extracurricular activities. From the enthusiasm generated by the surveys, the children now survey their school premises on a weekly basis and have established an afterschool ecology club. Their increased awareness of the natural environment has also led to increased motivations to care for and improve their school environment. For example, after learning more about pollinators the pupils created a wildflower meadow with the aim of increasing the abundance and diversity of pollinators visiting their school grounds.

One of the teachers wrote "The group of children are developing interpersonal skills and a sense of community within the group, something they did not all possess because many are from vulnerable groups".



"The group of children are developing interpersonal skills and a sense of community within the group, something they did not all possess because many are from vulnerable groups".

Teacher, Monkseaton Middle School

OPAL-UK Outcome

Stronger Collaboration

Stronger collaboration between the statutory, voluntary and community sectors leading to improved social cohesion, resource efficiency and better environments.

Growth of the OPAL network during OPAL-UK

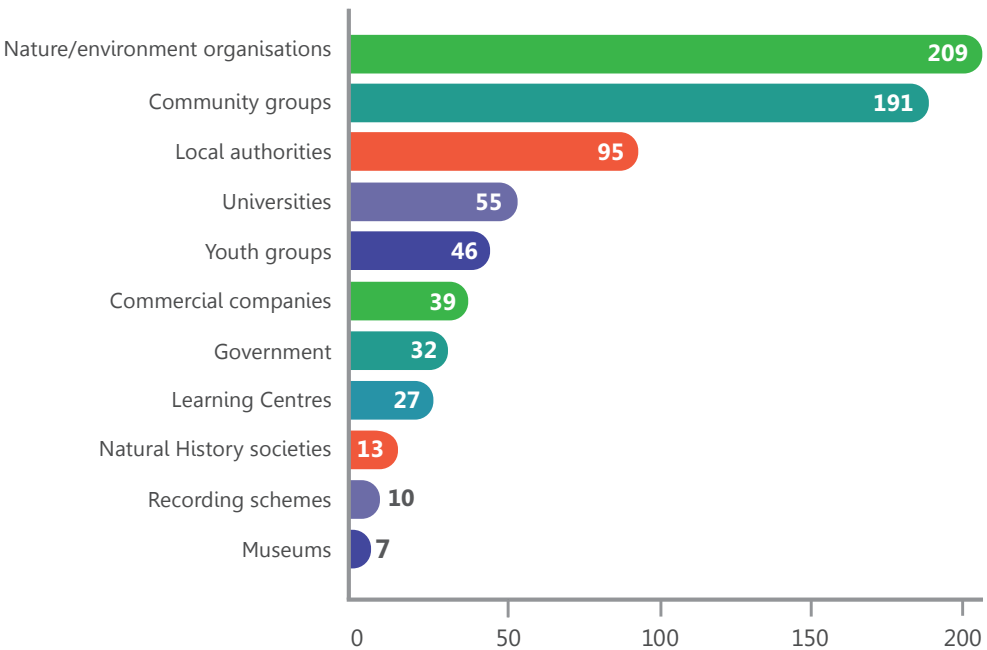


Figure 2: *Organisations working with OPAL under OPAL-UK by organisation type 170 organisations fit into more than one category and have not been included above*

894

OPAL has worked with 894 organisations under OPAL-UK.

Online digital community

12,000

Almost 12,000 registered users on website.

6,500

Over 6,500 newsletter subscribers.

4,000

Around 4,000 Twitter followers.

From national down to local scales OPAL partners have worked together with groups and organisations to support people to explore nature as shown in the two examples below.

Case Study 1

Youth groups and OPAL join forces for science festival

Leaders from the Scouts, Guides, Boys Brigade and Girls Brigade collaborated with an OPAL Community Scientist to bring a mini science festival to the Glasgow region. As a spin-off from the successful joint event, Glasgow Science Centre is now working with groups to enable OPAL surveys to be incorporated into badge schemes. Many of the groups were from inner city areas where they have less access to good quality green space but through the event the children were able to experience hands-on exploration of the natural world and meet with scientists who they would not normally encounter in their day-to-day lives.

Case Study 2

Making connections in Northern Ireland

In late 2014 and early 2015, OPAL Community Scientists in Belfast contacted local area partnerships, which bring communities together for development of their local areas. The Community Scientists delivered training to three partnership organisations: the Belfast Hills Partnership, the Slieve Gullion Landscape Partnership and the Faughan Partnership, along with teachers from schools who work with the partnerships. Participants were trained to deliver the surveys and through doing so learnt more about the environment in their local area. Teachers also found out about the support local community partnerships can offer them, such as funding for equipment. Teachers were so enthused with OPAL that many asked the Community Scientist to visit their schools to work with their pupils. Working with the local partnerships proved a great way for OPAL to build relations in marginal rural communities and inner-city areas.

Working with the local partnerships proved a great way for OPAL to build relations in marginal rural communities and inner-city areas.

The OPAL Surveys

Introduction to the OPAL surveys

Over the life of the OPAL programme there have been eight major national surveys, and numerous smaller or regional surveys. The surveys explore the health of our soils and trees, the quality of our air and water, how humans impact the climate, the distribution of invertebrates, and the importance of hedges and pollinators.

The surveys use simple methodologies, readily accessible equipment (either provided by OPAL or common around the home), and avoid scientific jargon, guiding participants through all the steps necessary to complete their investigation. The surveys were designed to be suitable for ages 13 upwards. Younger or less-able participants can take part with appropriate support or with suitably adapted materials.

Since 2007 participants in the OPAL surveys have been submitting their data either by freepost or online.

To date OPAL has received over 62,000 survey returns. This information has helped OPAL scientists build up a picture of the UK's natural environment and has resulted in numerous academic publications and reports.

Along with OPAL's national surveys, a range of local environmental monitoring surveys have been developed by OPAL's Community Scientists, ranging from invasive crayfish monitoring to hedgehog surveys. These projects have often arisen from local communities identifying topics of environmental concern and then working with OPAL Community Scientists to develop methodologies, carry out activities and analyses, and take action on findings.

The following pages feature some of the results from six national surveys that have been active throughout the OPAL-UK programme (2014-2016).

OPAL's Scientific Questions

The OPAL surveys help people contribute to investigations into some of the major environmental challenges facing society, including climate change, quality of air, soil and water, biodiversity and invasive species. The OPAL surveys also capture important information on people's motivations and learning experiences.

Invasive Species

An invasive non-native species is an organism that lives outside its original geographic range and which can cause damage if it spreads into new areas or environments.

OPAL survey data returns

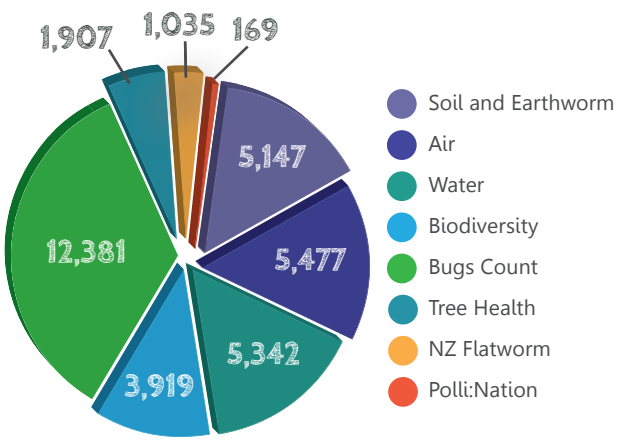


Figure 3: *The pie chart provides a breakdown of responses for all OPAL surveys, excluding the OPAL Climate Survey which is no longer active*

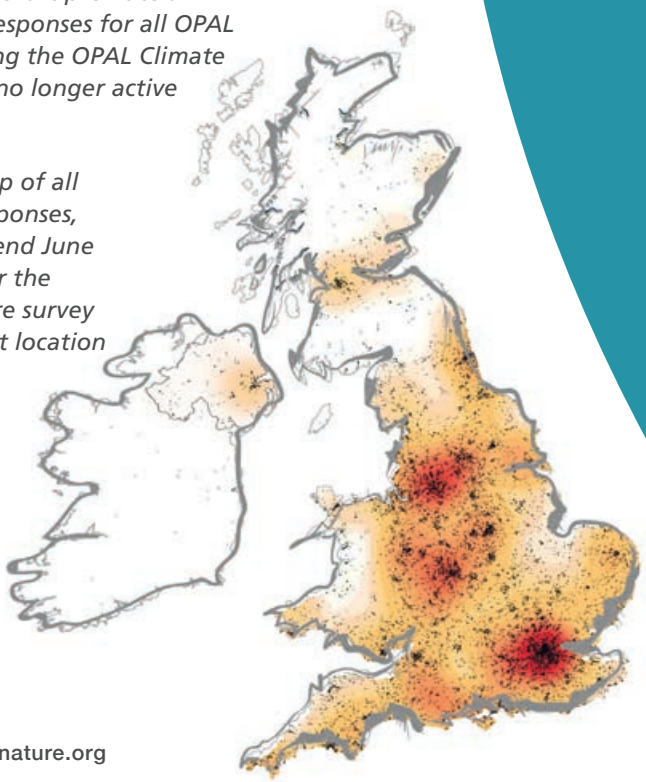


Figure 4: *Heatmap of all OPAL survey responses, over 62,000, to end June 2016. The darker the shading the more survey responses in that location*

In Focus **Tracking Invasives**

The New Zealand Flatworm causes harm by eating earthworms. Since its arrival in the UK in the 1960s, it has spread to gardens and agricultural land.

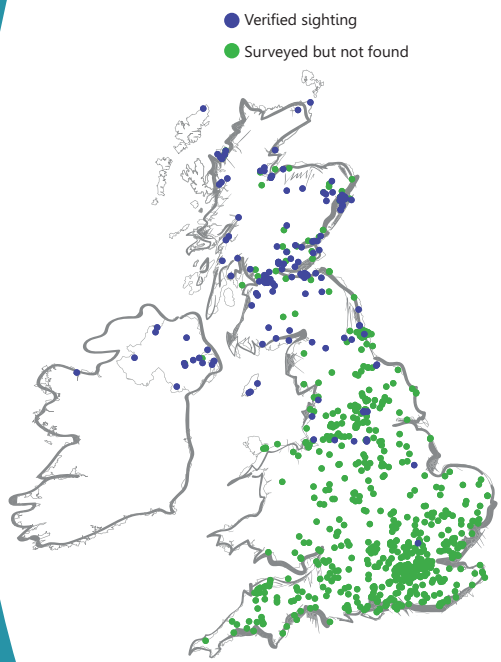


Figure 5: *The OPAL New Zealand Flatworm Survey seeks to track the spread of this species. Initial data from the survey appears to indicate that this worm is more common in Scotland and Northern Ireland than in England*

The OPAL Water Survey

How healthy is your lake or pond?

Indicator species

A species whose presence, absence or relative well-being in an environment is a sign of the ecosystem's overall health. Indicator species have been used to assess water quality for over 100 years. They are easy to sample and identify at a broad classification level, making them well suited to public studies, especially with children.

Surprisingly little is known about the quality of the UK's fresh water bodies. Ponds, rivers and lakes support a huge variety of plants and animals, and us too. Good water quality is essential for a functioning, healthy ecosystem. However, water is easily affected by pollutants from the air and on land. The aim of the OPAL Water Survey was to provide a national 'snap-shot' assessment of water quality for as many lakes and ponds across the UK as possible, and, in doing so, to improve education and awareness of aquatic environments.

The survey includes four activities to help participants build a picture of water quality in their local environment:

1. Measuring water clarity – using the OPALometer
2. Measuring water pH using a dip-strip
3. Recording the presence or absence of aquatic invertebrate 'indicator species'
4. Recording the presence or absence of amphibians, dragonflies, damselflies and duckweed

Water Health	Indicator species:	Pond Quality Score:
💧💧💧	Caddisflies, dragonflies, damselflies, alderflies	10
💧💧	Mayflies and stoneflies, water beetles, water bugs, freshwater shrimp, pond skaters	5
💧	Water slater, water snails, worm-like animals	1

Survey results

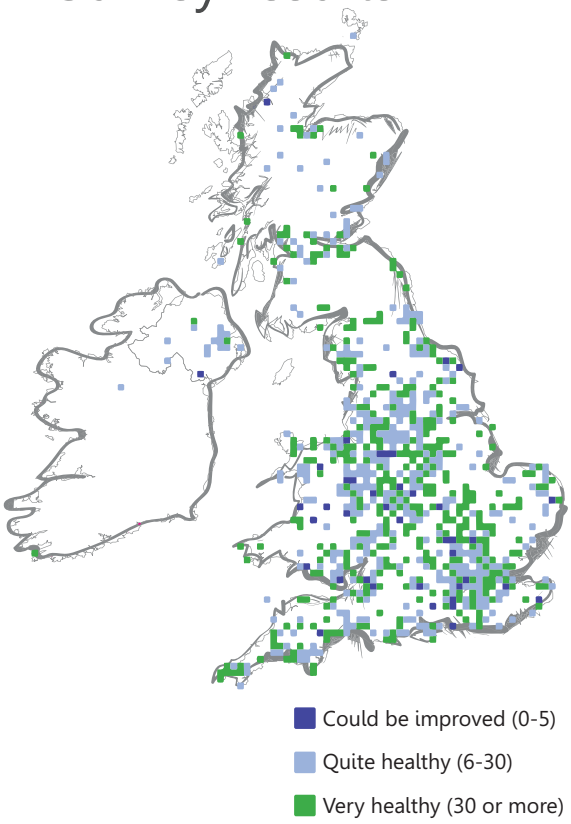
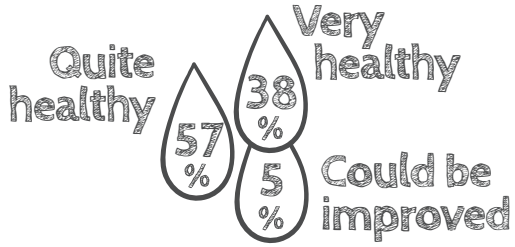


Figure 6: *The average (mode) OPAL Pond Health Score for each 10km grid square across the UK and Ireland*

Water Survey Facts:



5,200

Over 5,200 OPAL Water Surveys have been completed since its launch in March 2010.

The data shows that 38% are 'very healthy', 57% of water bodies are 'quite healthy' and 5% 'could be improved'.

3,000

During 2010, 3,000 people took part in the survey making it the largest lakes and ponds survey undertaken via public participation in the UK to date.[8]

In Focus
Data Quality and Control

When data are collected by non-experts there is a concern that this might not be of high enough quality to be useful for research purposes, especially when volunteers are mostly untrained and can submit data anonymously - as is the case with OPAL. To better understand the data from the OPAL Water Survey, the Water Survey team carried out a series of activities investigating the data and its reliability, whereby they:

- Examined the effect of surveying effort and duration by comparing different sampling methods at 10 lakes (870 surveys performed)
- Compared the accuracy of species identification between untrained volunteers and experienced scientists
- Created a self-assessment identification quiz to assess the level of expertise of individuals submitting data
- Compared the data collected using simplified OPAL methods with data collected using other more rigorously scientific technical approaches.

These investigations demonstrated that simple sampling and identification methods, as used in the OPAL Water Survey, can allow the collection of repeatable results, particularly where multiple habitats are sampled and summarised in a single pond health score.

Although there will always be inherent uncertainty in data collected by untrained volunteers, the application of quality control at all survey stages (design, identification tests, data submission and interpretation) can help increase confidence in the quality of generated data.[9]

The OPAL Soil and Earthworm Survey

Uncover the world of soil and earthworms and contribute to valuable research

Soil is one of the world's most precious natural resources. It is vital for plant growth, providing food and materials for humans and animals; it regulates water by filtering out pollutants and can reduce flood risks; and it is home to a vast array of animals. Despite all these vital functions, much less is known about soil than air or water. Soil is made up of water, air, minerals and organic matter. Soil properties are influenced by the bedrock beneath it, the local environment, the plants that grow on it, and the animals that move through it. Of these animals, earthworms are one of the most important to soil structure and fertility. The OPAL Soil and Earthworm Survey aims to find out more about soil and earthworms and investigate the relationships between earthworm species and habitats and soil types.

The survey contains five activities:

1 Digging a soil pit to take a soil sample

2 Investigating the properties of the soil sample (e.g. hardness, moistness, pH, texture)

3 Recording the different species of earthworm

4 Searching for earthworms in other habitats

5 Recording other organisms found in the soil sample

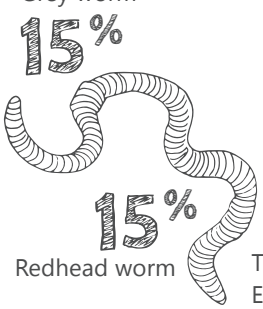
Survey results

Soil and Earthworm Survey Facts:

5,100

Over 5,100 survey responses were submitted, and collected from:

- **44% suburban areas**
- **38% countryside**
- **18% in urban areas**



The most commonly found Earthworm species were:

- **15% Grey worm**
- **15% Redhead worm**
- **11% Lob worm**

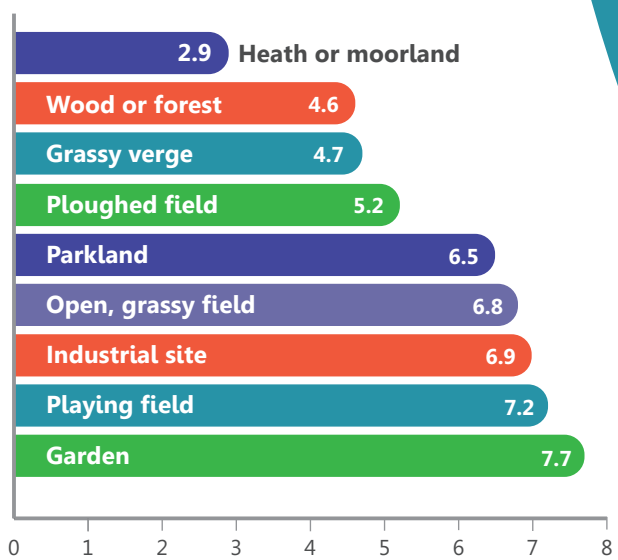
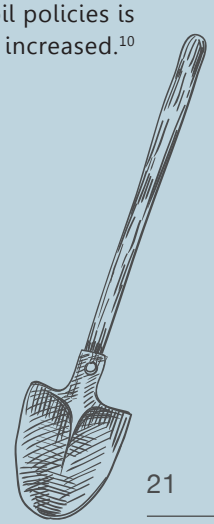


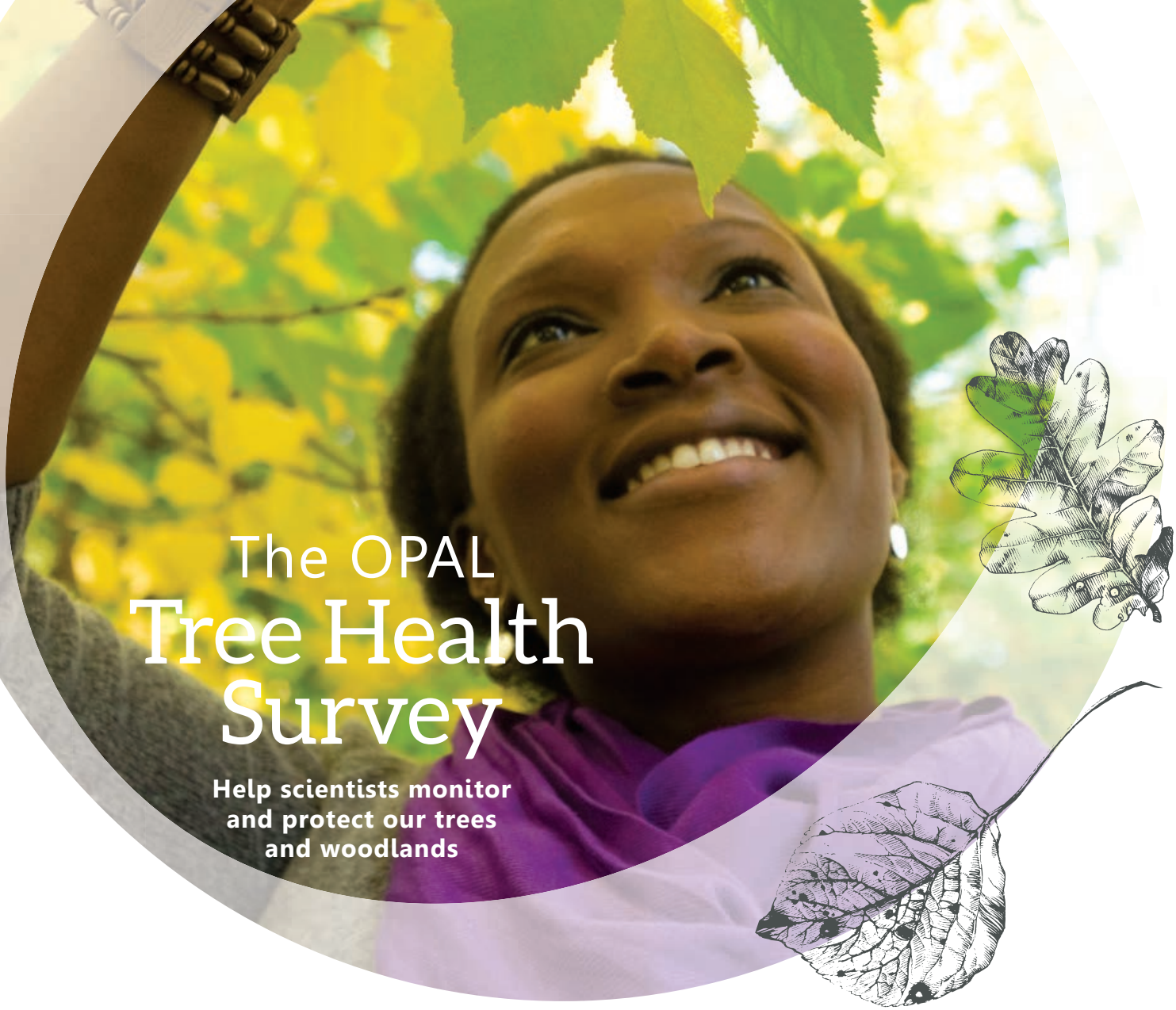
Figure 7: *Average number of earthworms found across different site types*

In Focus
Policy Drivers

In addition to answering scientific questions, OPAL surveys have also been developed to meet environmental policy priorities. At the time of the OPAL Soil and Earthworm Survey's development a proposed European Union soil protection policy, which sought to identify areas requiring protection from soil degradation, was being met with opposition on the grounds of excessive cost and resource demands. The OPAL Soil and Earthworm Survey was developed as a way to increase the public's understanding of soil but also to investigate whether citizen-collected data could support meeting soil policy evidence requirements.

Thousands of people across the UK participated in the survey and collected useful data on soil properties and earthworms. On top of the direct educational benefits, the OPAL Soil and Earthworm Survey demonstrated that citizens could support the identification of those areas that could potentially be at greater risk of degradation and which should be prioritised for further, more detailed assessment. This approach would likely provide more cost-effective screening of sites than that that could be provided through official government screening; furthermore, through participation in the survey public perception of ownership and acceptability of soil policies is likely to be increased.[10]





The OPAL Tree Health Survey

Help scientists monitor and protect our trees and woodlands

The OPAL Tree Health Survey was developed in direct response to the UK Government's growing concerns about the pests and diseases threatening the country's trees and woodlands, and addressed the Government's objectives to raise public awareness of tree health and empower people to work with officials to monitor trees. The survey was designed by people from a wide consortium of government, conservation and academic organisations. Its launch in May 2013 was timed perfectly to harness public interest following the first finding of Chalara ash dieback in the UK the previous autumn.

The survey consists of three activities:

1 Identifying and assessing general tree characteristics

2 Recording the presence of pests and diseases on Oak, Ash and Horse Chestnut trees

3 Recording the presence of six of the most serious pest and disease threats, "The Most Unwanted", and reporting them to officials

Nearly 2,000 surveys (of 3,000 trees) have been submitted via the OPAL website. The incidence and distribution data needs further analysis but initial results show that Horse Chestnut was the least healthy tree with the following incidences of pests and diseases recorded:

- Leaf blotch 39% • Bleeding canker 29% • Scale 7%
- Leaf miner 47% (including four suspect sightings as far north as the Central belt of Scotland - it has been spreading north at around 40-60 km a year since it was first found in the London area in 2002)

Survey results

Tree Health Survey Facts:

77%

OPAL provided 77% participants with their first experience of working with trees.

93% 87%

93% of participants learnt something new and 87% developed new skills.

64%

Taking part in the survey helped 64% of participants to change the way they think about the environment.

60%

60% said their behaviour towards the environment would change.

In Focus **Government Monitoring**

The OPAL Tree Health Survey has made great progress in meeting the Government's objectives to raise public awareness:

- Over 1,500 people including over 700 school teachers have been trained in the survey
- Over 4,000 people have conducted a survey, often in groups and with family and friends.

Over 25,000 tree identification guides have been downloaded from the OPAL website – making it OPAL's most downloaded resource.

People have supported official surveillance by reporting suspect sightings of 'The Most Unwanted' to the Forestry Commission's official recording site 'Tree Alert'. There has been one false alarm of emerald ash borer (which turned out to be a green dock beetle) and two of the first findings of Chalara ash dieback in the official government distribution map were made initially by people doing the OPAL survey.

The OPAL Tree Health Survey won the DEFRA Civil Service Reform award for 2013/14. Sir Bob Kerslake, the then Head of the Civil Service, commented upon presenting the award that the OPAL Tree Health Survey helped individuals to 'actively engage in support of wider government policy, in this case, safeguarding plant health'.

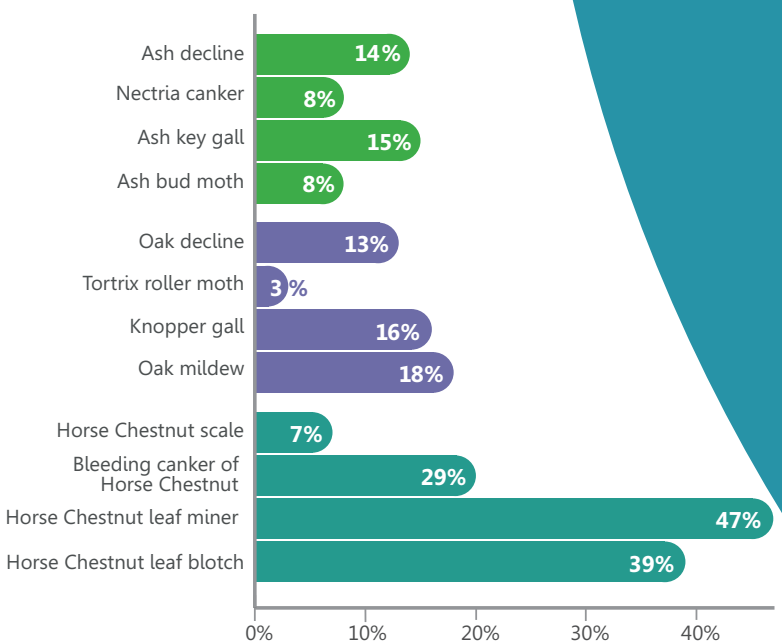


Figure 8: *The percentage of trees surveyed in Activity 1 on which the Oak, Ash and Horse Chestnut pests and diseases were spotted*

The OPAL Biodiversity Survey

What's living in your hedge?

Hedges are a familiar feature in both urban and rural environments across the UK but they are often under-appreciated in terms of the benefits they provide. They are an important habitat for wildlife and can act as corridors through the wider landscape, they help to prevent soil erosion, and they regulate water supply and provide protection from flooding. Despite their high ecological value the overall abundance of hedges across the UK has decreased over the last 70 years. Most research focuses on rural hedges, with comparatively little known about hedges in urban areas, or how hedges from these two environments compare. In 2010, OPAL launched the Biodiversity Survey to help address this knowledge gap and to educate the public on the importance of hedge habitat for wildlife.

The survey was undertaken through four activities:

1 Describing the hedge's features and components (e.g. location, hedge structure, shape, length, etc.)

2 Estimating the abundance of food sources present in the hedge (i.e. the types of trees and the berries, nuts and flowers they produce)

3 Noting any evidence of animals living in the hedge

4 Recording the invertebrates found in the hedge

Survey results

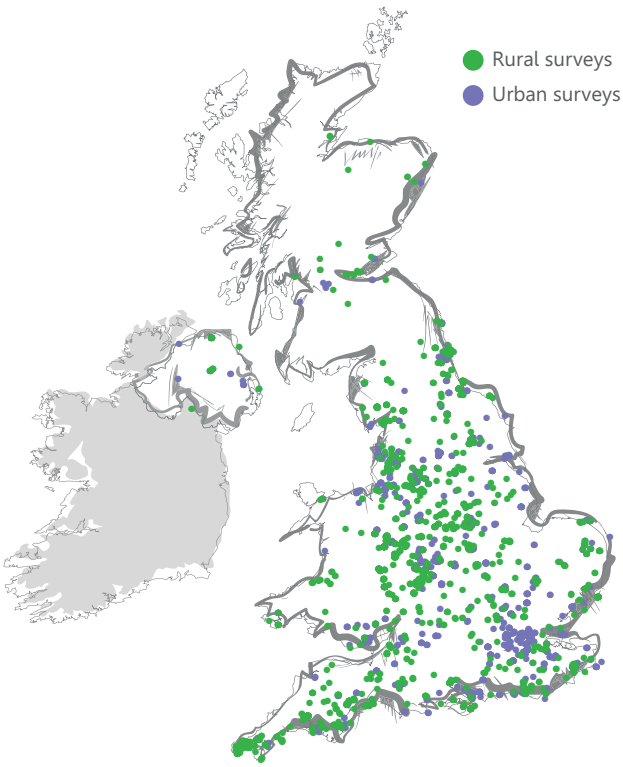


Figure 9: *OPAL Biodiversity Survey responses collected till the end of July 2016*

In Focus **Urbanisation**

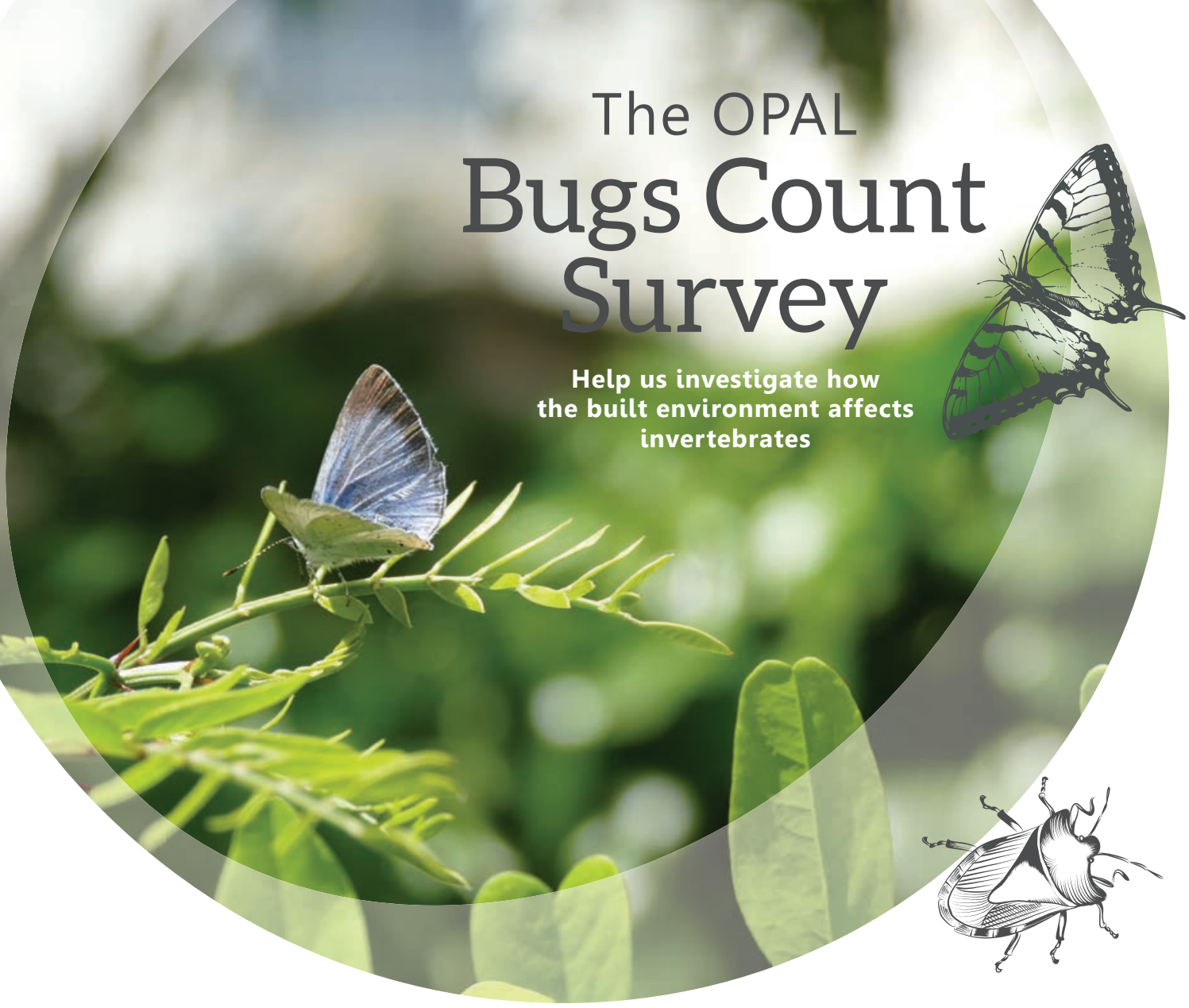
A growing number of people in the UK live in towns and cities. OPAL's network of Community Scientists work closely with communities in urban areas, often in areas of high deprivation, to provide people with the knowledge, skills and confidence they need to study nature where they live. Urban areas are typically under represented in terms of biological recording, but by working in urban areas OPAL can help to address significant research gaps, which will in turn help to inform scientist's understanding of how natural phenomena respond to rural and urban conditions.[11]

Most common plants and invertebrates in urban and rural hedges

An analysis of over 2,800 survey results collected in England between September 2010 and August 2012 show trees and shrubs differ significantly between urban and rural areas, and that certain groups of invertebrates are more common in either urban or rural environments. Furthermore, the presence of hard surfaces, such as roads, adjacent to hedges reduces the amount of food available for wildlife, and the diversity of invertebrate species found within them.[11]

The OPAL Bugs Count Survey

Help us investigate how the built environment affects invertebrates



Invertebrates have been termed 'the little things that run the world'. They are a vital part of all ecosystems, and perform a huge range of essential functions, such as pollination or breaking down organic matter.

An incredible 96% of all known animals are invertebrates. Without them the world would be a very different place. They really do count.

The objective of the OPAL Bugs Count Survey was to investigate the effect of urbanisation and habitat characteristics on the abundance of 16 broad invertebrate groupings, such as snails, earthworms, butterflies and moths, and centipedes. The survey also sought to investigate six particular invertebrates, each of which were selected in order to investigate a particular question (e.g. How far north and west has the Tree Bumblebee spread since arriving in the UK?) and because they are relatively easy to identify to species level.

The survey was divided into four activities:

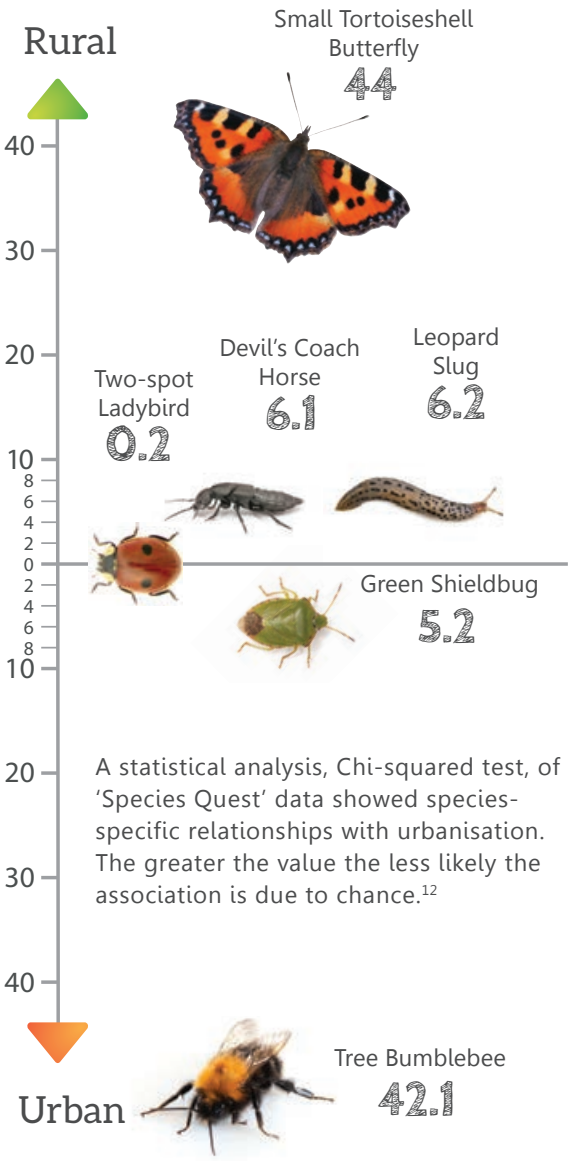
1 Hunting for ground-living invertebrates on soft ground surfaces like soil, short grass and among fallen leaves and twigs

2 Searching for invertebrates on human-made hard surfaces like paving, fences and the outside of buildings

3 Looking for invertebrates on plants, including long grass, flowers, shrubs and trees

4 Looking out for the six Species Quest bugs throughout the three activities listed above

Survey results



A statistical analysis, Chi-squared test, of 'Species Quest' data showed species-specific relationships with urbanisation. The greater the value the less likely the association is due to chance.[12]

In Focus
Low Barriers to Participation

The Bugs Count Survey has had thousands of participants, in part because of its low barriers to participation. It was designed to produce scientifically useful results and be easy to do, requiring no previous identification experience. Consequently, almost anyone of any age and experience can participate. This approach offers three important advantages over surveying by professionals. Firstly, data can be gathered over larger scales of space and time, including from areas otherwise difficult to study, such as private property. Secondly, members of the public can gain a better understanding of their local environment and their relationship to it. Thirdly participants will better understand how the process of scientific investigation is carried out, equipping participants with new skills and empowering them with a role within the scientific process.

Low barrier to entry citizen science surveys are perhaps best suited to scoping broad trends that can then be explored in more detail by professional scientists or non-professionals with more experience.[12]

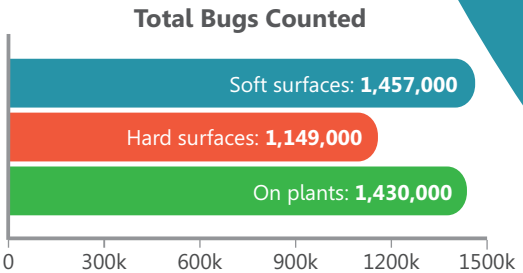
Bugs Count Survey Facts:

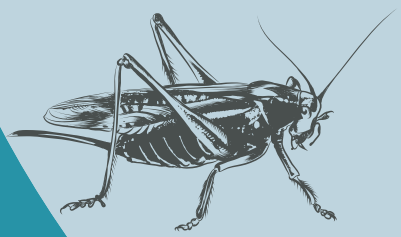
4 million

Over 4 million bugs have been counted.

12,000

Over 12,000 Bugs Count Surveys submitted.





The OPAL Air Survey

Discover the impacts of local air quality on our natural environment

Lichens are 'dual' organisms, made up of a fungus and either an algae or bacteria living together

The OPAL Air Survey allows participants to find out about the air quality in their local area and across the country, and discover how the natural environment is affected by air pollution. It uses 'bioindicators', species whose presence or performance is sensitive to changes in environmental conditions. The OPAL Air Survey contains two activities, using different bioindicators of air pollution.

Activity 1: Lichens on trees

The survey recorded the abundance of nine different types of lichen growing on trees. This provided a bioindicator system for nitrogenous air pollutants, by including lichens that are nitrogen-sensitive (declining where pollution is high), nitrogen-tolerant (increasing where pollution is high) or intermediate (no strong preference).

Activity 2: Tar spot fungus on Sycamore

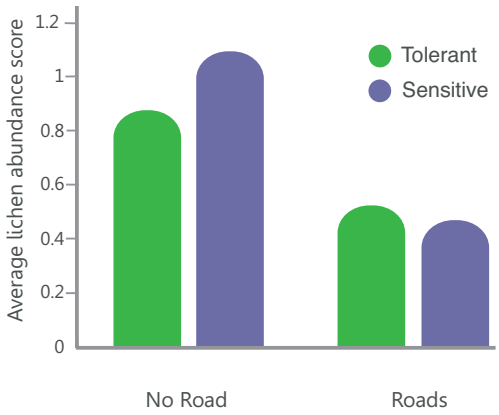
The tar spot fungus is sensitive to sulphur dioxide (SO_2) pollution, and is less common where levels are high. Even though SO_2 pollution has reduced over the past 50 years, recent observations suggest that tar spots are still less frequent closer to city centres. Activity 2 tested two hypotheses as to why this might be:

A Street cleaning in city centres removes fallen leaves, which are a source of the fungus that causes tar spot

B Other types of air pollution, particularly nitrogen dioxide (NO_2) from road traffic, reduce tar spot formation

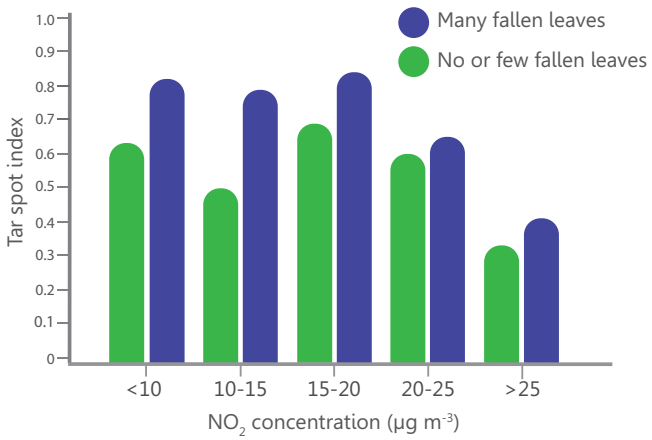
Survey results

Activity 1: Lichens on Trees
Analyses of lichens on over 12,000 trees has shown that nitrogen-sensitive lichens are less abundant on trees next to busy roads, whilst nitrogen-tolerant lichens are found in greater abundance on trees next to busy roads. This difference is most likely the result of higher levels of traffic pollution in road-side environments.[13]



Activity 2: Tar spot on Sycamore
A 'tar spot index' was calculated for each Sycamore tree by dividing the number of tar spots on a leaf by leaf length.

The analysis shows that the tar spot index value is lower at sites with no or few fallen leaves; and at an approximate threshold of nitrogen dioxide (NO_2) around 20 µg m^{-3} the tar spot index starts to fall. This suggests that hypotheses A and B are potentially correct.[14]



Hypothesis

Science seeks to better understand the physical world. A hypothesis is a proposed explanation for something observed, often made on the basis of limited evidence, that can be tested by scientific investigation.

In Focus
Hypothesis-led Citizen Science

The OPAL Air Survey aimed to develop new bioindicator methods that could be used to test the local effects of NO_2, which is now the major pollutant in cities. Data collected by participants supported the hypothesis that the abundance of nitrogen-sensitive lichens, and of tar spots, would decrease close to busy roads or at high concentrations of NO_2, while that of nitrogen-tolerant lichens would increase.

Conclusion: The simple OPAL methodology can detect the effects of high NO_2 concentration, such as nearby busy roads, although its sensitivity to more subtle changes in pollution exposure is uncertain. This supports a use for well-designed citizen science projects in environmental hypothesis testing.[13]

Lessons Learnt

Approaching the tenth year of OPAL a great range of lessons have been learnt. Partners from universities, museums and environmental organisations have taken a variety of approaches to support science in the community. These approaches have yielded a wealth of experience about what works well and what does not work so well.

As the field of citizen science develops, the importance of sharing these experiences is paramount. Findings from OPAL have been shared through conferences, reports and academic papers, and have highlighted the challenges associated with delivering both research and outreach, how to navigate challenges in delivery, and how to overcome barriers to participation.

Survey Design and Development

OPAL's approach has been to design surveys that capture people's interest and are written so that non-scientists can understand them.[15]

- Understand your survey objectives: is the emphasis on research to answer specific questions, surveillance to monitor for specific organisms, or public outreach to raise awareness and/or foster environmental stewardship?
- Only require people to do tasks that they have the ability to do. For example, identify organisms to group-level (e.g. butterflies or moths) rather than species-level, unless species are easy to identify (e.g. Small Tortoiseshell); if species-level identification is required and species are hard to identify then ask participants to provide a sample or a photograph of their observation.
- Build in data verification processes to ensure scientific outputs are fit for purpose (e.g. conduct checks on accuracy of identification to assure data quality).
- If you want to measure change or impact make sure to establish a baseline (i.e. before and after surveys).
- Remove ambiguity from the data entry process e.g. by specifying units of measurement (centimetres, litres etc).
- Ensure that the form in which survey data are collected is optimised for compatibility with other databases.

Understanding and Supporting Participants

OPAL's approach has been to prioritise supporting the 'citizen' in citizen science by seeking to understand, and appropriately tailor activities to, participants' interests and abilities.[15]

- Involve participants in all stages of the activity where appropriate.
- Explain the issue under investigation, why it is important, and why help from the public is needed to investigate it.
- Communicate the importance of entering survey results. All results, even negative ones (e.g. this organism was not found here), are useful.
- Recognise and reward participant input (e.g. provide feedback on what their results mean).
- Provide training to participants to support learning and development of skills.
- Ensure that surveys are engaging and clear. Use plain English and simple language, avoid scientific jargon, and provide easy-to-understand images, diagrams and guides.
- Ensure activities and surveys are inclusive and accessible to all participants, including hard-to-reach audiences. Provide materials in appropriate languages (OPAL's surveys are available in English and Welsh), include as much of the equipment necessary to carry out activities as possible, and offer alternative methods of data entry (OPAL has a freepost address for those who are not able to submit results online).

Case Study

A commitment to hard-to-reach and disadvantaged communities distinguishes OPAL from many of its peers and provides an important underlying social ethos for activities

The OPAL team at University of Nottingham worked with a mental health support and outreach service for the Black, Asian, minority ethnic community called STEPS. Over a series of visits, the needs and interests of the group were better understood. Resources and activities were tailored for two residential homes for those with long-term health needs. Using the tailored resources and working with translators OPAL delivered a session with Punjabi, Hindi and Urdu participants and carers, with an age range from 4 to 90 years old. The session led to "lots of smiles, laughter, chatting, and comments about the activities reminding them of their childhood". These groups had no prior experience of similar activities. OPAL Community Scientists are now monitoring the long term social impact for those participating in the sessions.

Support Motivate
Understand
Include Engage
Involve Communicate

Collaboration and Partnership Work

OPAL's approach has been to collaborate and work in partnership with others, playing to each other's strengths or sharing knowledge and skills for mutual benefit. You cannot do it alone.[15]

- Think carefully about which organisations may have an interest in the project and what skills and experience are required to deliver the outcomes sought. It is likely to involve organisations from across community, academic and statutory sectors.
- Establish project partnerships, with collaboration at many stages, including co-creation of activities and surveys where appropriate.
- Get full buy-in from partners, especially senior managers who ultimately are responsible for committing time and resources to the project.
- Ensure that those involved with the project have clearly defined roles, responsibilities and receive training where appropriate.
- Build team spirit through regular contact and communication.
- Ensure that the project management team have the requisite skills and expertise to ensure effective project management, co-ordination, and web and database support for project or wider network.
- Where possible, seek to support participants face-to-face, through local champions or working in partnership with local organisations.

Case Study

The OPAL Tree Health Survey was developed in direct response to the Government's need to make people more aware of trees and to help official surveillance by keeping an eye out for new pests and diseases

A broad consortium of people from around 18 organisations involved in trees and forestry from across the academic, statutory and community and voluntary sectors were brought together to design, develop and deliver the survey. OPAL's experience from previous surveys tempered the experts' initial inclination to simply ask people to do the same job as officials. A pioneering "buddy scheme" was used in which novice participants received assistance from people professionally engaged with trees.

What Next?

Regardless of the exact path that OPAL takes in the future, whether continuing as a funded network or through its legacy of newly empowered communities carrying out citizen science on the ground, both will be informed by, and build upon, the great achievements delivered by OPAL to date.

OPAL's vision for the future is one where:

- Every citizen has the opportunity, appropriate support, and encouragement to go outside to explore and better understand the natural world around them. This is especially important to those groups who traditionally have not had access to science or formal opportunities for further and higher education, or those groups who traditionally spend less time in nature, including those with less access to good quality natural spaces.
- Participants in citizen science and environmental monitoring are energised and excited to take their interest and skills further, they feel supported to take the next step in their learning and understanding of the natural world, and in doing so further blur the boundaries between citizen and scientist.
- Communities feel empowered and enabled to take more of a role in local decision making and are equipped with the skills necessary to design and implement their own projects, either independently or in collaboration with scientists and policymakers, to investigate issues of local environmental concern.
- A standing army of motivated and trained citizen scientists is ready to respond to the increasing environmental challenges the world faces, to become stewards of their environment so that nature is better conserved and precious resources are better managed.
- Voluntary, community, university, business and statutory sectors work together to advance sustainability and tackle the environmental challenges we face.

Appendix

References and evidence base:

1. Everett, G., Geoghegan, H. (2016) *Initiating and continuing participation in citizen science for natural history.* BMC Ecology, 16(1), 15-22.
2. 84% (of a total of 14,636 responses) answered *'Yes'* to the question *"Would you recommend OPAL to your family and friends?"* (responses collected to end June 2016).
3. 90% (of a total of 12,645 responses) answered *'Yes'* to the question *"Will you sign up for the next OPAL survey?"* (responses collected to end June 2016).
4. 76% of 580 post-activity questionnaire responses (between June 2015 and June 2016), answered *'Yes'* to the question *"Would you like to do an OPAL survey again?"*.
5. 51% of 25,849 responses to this evaluation question, collected up to end June 2016.
6. 88% of 580 post-activity questionnaire responses (between June 2015 and June 2016), answered *'Yes'* to the question *"Did you learn something new today?"*.
7. 89% (of a total of 21,951 responses) answered *'Yes'* to the question "Did you learn something new about your local environment?" (responses collected to end June 2016).
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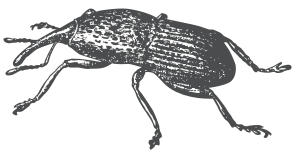
All data correct as of end June 2016



Acknowledgements

We would like to acknowledge the funding and support of the Big Lottery Fund. Without their awards through the *Changing Spaces* and *Supporting UK-wide Great Ideas* programmes, OPAL's work across the UK would not be possible.

We would like to thank all of the OPAL staff, students, volunteers and collaborators, past and present, for their dedication to the programme since its initiation.

OPAL's innovative approach to take scientists out of their laboratories and into the community was developed by Linda Davies, OPAL's founder and original director. Her passion, creativity and hard work paved the way for all OPAL's successes that have followed.

We express enormous gratitude to Jim Storey who as a member of the Project Board has been a valued advisor since the OPAL programme began.

We are very grateful for the guidance provided to us by members of the OPAL Advisory Board: Zen Makuch, Judy Ling Wong, Tom Flood, Shaun Russell, Mary Barkham, Craig McGuicken, Roddy Fairley and Andrea Sforzi. National Committees in Scotland, Wales, Northern Ireland and England have provided invaluable support throughout the OPAL-UK grant.

Finally, we would like to express our sincere gratitude to everyone who has taken part in OPAL surveys and activities. You, as citizen scientists, make OPAL what it is.