



OPAL Community Environment Report

EXPLORING NATURE TOGETHER





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Published in 2013 by Open Air Laboratories (OPAL)

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All data are correct as of August 2012

Design by dsquared 01780 480690 dsq.co.uk
Printed on 100% recycled paper using vegetable inks and Cellogreen biodegradable laminate.

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Foreword

“ OPAL is a really remarkable programme that has given over a million people an experience of science that has been interesting and engaging. It has produced an overview of the environment that professional scientists alone could not have provided. It has shown the educational value of encouraging children to go out into their local environment and study topics important to all our lives. The high quality materials produced by OPAL to be used to study biodiversity, climate, water, air and soils have shown people from many different communities that science is not a mystery but something to which they can contribute.

Attending OPAL conferences was one of the most interesting aspects of my work as Chair of the Living with Environmental Change Partners' Board. It is a testament to the quality work that OPAL inspired that one team of girls won the opportunity to exhibit at the Royal Society Summer Science Exhibition.

OPAL deserves to have a substantial legacy, and it will. There are new practical online resources and activities: these include *iSpot* and biodiversity recording software, *Indicia*, which are freely available to groups interested in natural history. Many adults and early career scientists have a new focus and direction to their lives. The biggest legacy will be a new generation of young people, who have been inspired to think of science differently and consider careers linked to it. OPAL's approach to public engagement is one that I hope many organisations, including government, will examine closely and consider adopting.”

The Earl of Selborne



Welcome

OPAL's outdoor programme has involved more than half a million people, many from disadvantaged backgrounds. Communities examined street trees and hedges, allotments and woodlands, parks, gardens, playing fields and playgrounds, and recorded their findings. They discovered havens of wildlife, particularly in towns and cities, many of which they had not noticed before. Information from over 25,000 of the places explored has been submitted to the OPAL database. Collectively, such information plays a powerful role in understanding and monitoring environmental change; something we must do if we are to protect the natural world on which we all depend.

OPAL is providing people with the knowledge, skills and confidence they need to study nature where they live. We have worked in areas of deprivation, where parks and greenspaces were often not accessible or inviting. Experts went to the heart of these areas and worked with many communities that had not previously come into close contact with scientists. OPAL teams were welcomed and, together with local people, have gathered new data about wildlife and habitats, some from places previously unexplored.

The activities encourage participants to also think about the conditions that animals, plants and fungi need for survival: which aquatic invertebrates can tolerate polluted waters? Which lichens can grow next to a busy road?

Many people, young and old, have been inspired to continue their new interests through the OPAL programme and to work with the natural history societies, voluntary organisations and statutory bodies who have helped make OPAL such a great success.

OPAL shows that a more informed and active society can make a real contribution towards addressing some of the major environmental challenges facing us today. It also shows that exploring nature can be fun and exciting for everyone and can have a positive impact on people's lives.

It has been an amazing journey so far. Here we present the early findings of the OPAL programme as told by the scientists and the people they met along the way.

Linda Davies
OPAL Director



Summary



OPAL has initiated an England-wide study of local places by local residents. OPAL's research and education programme has directly involved over half a million people, 100,000 considered hard to reach, and engaged many more through our websites and media coverage.

The purpose of the study is to motivate local people to discover more about the outdoor environment where they live and work, to equip them with the knowledge, skills and support to explore and record information about local places and wildlife and to share their findings. Collectively such local knowledge can play a powerful role in understanding and responding to environmental change.

This report seeks to evaluate the impact of the OPAL programme against the objectives and targets agreed with the funder, Big Lottery Fund, at the outset of the project in December 2007.

OPAL key objectives

- A change of lifestyle – a purpose to spend time outdoors, observing and recording the world around us
- An exciting and innovative educational programme that can be accessed and enjoyed by all ages and abilities
- Inspire a new generation of environmentalists
- A much greater understanding of the state of the natural environment
- Stronger partnerships between the community, voluntary and statutory sectors





OPAL's impact

Changing lifestyles: spending more time outdoors exploring nature

- Over half a million people have actively participated in the OPAL programme, including 100,000 people in hard to reach communities^(a)
- More than 25,000 sites across England have been studied by local people and the information submitted to the OPAL database for analysis
- Nearly 2,000 schools have registered for OPAL resources and many more have submitted information about their school's grounds^(a)

Changing people's behaviour towards the environment

- 50% of participants said that this was the first time they had carried out a survey^(b1)
- Only 8% of survey participants said they would not carry out another survey^(b2)
- Almost half (43%) of people questioned about OPAL said taking part had changed the way they thought about the environment and more than a third (37%) said they will change their behaviour towards it^(c)
- Contributing to a national research programme was a key motivating factor for many participants

Learning about nature using OPAL's outdoor learning programme

- OPAL is broadening people's natural history knowledge and skills. 90% of survey participants questioned said they had learnt something new^(b3)
- 83% of participants said they had developed new skills^(b4)
- OPAL's high quality science programme gives confidence to both teachers and students to carry out more fieldwork. 230,000 field packs have been distributed. Over 2,000 people have taken part in OPAL training sessions^(a)

Working together for the benefit of people and their environment

- OPAL has worked with more than 1,000 organisations from the voluntary sector (53%), the community sector (38%) and the statutory sector (9%), designing and delivering activities together^(a)
- By involving people in their research, scientists have made their work more relevant to everyday life
- OPAL has developed new ways of bringing natural history societies and communities together to raise awareness of their work. 46% of OPAL grant-funded societies have increased their membership by more than 10%^(a)

Scientists now know more about the state of England's environment and so do the people who took part in OPAL's activities

- By working together scientists and the public have gathered a wealth of new data about wildlife, its distribution across England and the condition of their habitats
- Some of these data are from sites that have previously been difficult for scientists to access such as gardens and inner city areas, allotments and playing fields
- A wide range of information from measurements of tree girth to soil types and wildlife sightings has been submitted

Data sources

(a) Statistics collected by OPAL staff on a monthly basis

(b) Online questions following the data entry for the national surveys. Not all survey participants completed the full questionnaire. The number of responses is given below:

b1 8,450 out of 16,766 people who answered this question

b2 695 out of 9,261 people who answered this question

b3 13,142 out of 14,621 people who answered this question

b4 12,277 out of 14,765 people who answered this question

(c) Online questionnaires (593) and findings from interviews by social scientists



Some early results are presented here but data, particularly from the most recent surveys on biodiversity and climate, are still being analysed and will be reported through the OPAL website, scientific publications and a supplementary report

- Domestic gardens were found to be hotspots for earthworms. They had higher numbers of earthworms and a higher average number of different species compared with other habitats investigated, such as woodlands. The number of earthworm species and their population densities were found to be influenced more by soil properties than the low levels of chemical pollution which are found in many soils in England. Members of the public have contributed important information on soil properties and earthworms in areas that are rarely sampled. OPAL's research on soil is providing information that will facilitate improvements in how the vitally important soil ecosystem is protected.

- Lichens are very sensitive to air pollution. The OPAL survey found that pollution-tolerant lichens such as species of *Xanthoria* and *Physcia* were more abundant on oak trees growing close to roads or to intensive agriculture. These lichens are tolerant of nitrogen in the form of nitrogen oxides produced from vehicle exhausts and of nitrogen in the form of ammonia produced by intensive agriculture. The OPAL survey also showed that pollution-sensitive lichens such as species of *Usnea* and *Hypogymnia* were disappearing from our countryside. The survey showed that the OPAL lichen air quality index reflected modelled air quality data.
- A number of urban ponds with very good water quality were recorded but on average pond health scores, determined by the invertebrates present, were lower in urban areas than in rural areas. Algal blooms were less frequent in urban ponds than those in rural areas but rubbish was found more frequently in urban ponds. Pond sediment samples provided by the public allowed us to assess the concentrations of trace metals such as lead, mercury, copper, nickel and zinc. Our results show that there are elevated concentrations of one or more trace metals that could have a detrimental effect on organisms living in the water in each region.



- There are distinct differences in the plants that make up urban and rural hedges with urban hedges containing more Beech, Privet, Laurel and Yew, while rural hedges had more Hawthorn, Bramble, Blackthorn and Dog Rose. The four most common kinds of invertebrates recorded in hedges were spiders, ants, snails, and woodlice. Urban hedges contained 50% more ants than rural hedges. Hedges with better structure provided the most animal food and sheltered a greater animal diversity in both urban and rural areas, confirming that hedges are essential habitats for wildlife.
- We know that obstacles such as buildings and trees have an influence on wind speed and public data provided additional evidence of the range of wind speeds in different habitats. Lowest average speeds were found in the dense urban environment and woodlands, and higher wind speeds recorded in the open field sites. Findings on personal thermal comfort, that is how hot or cold we feel, also differ with 50% of participants in dense urban environments reporting feeling warm, compared with only 33% in open field sites at the same temperatures. These data contribute to a body of research that will help to inform strategies for managing the impact of climate change.
- Over 1 million invertebrates were counted, showing just how numerous invertebrates are, even in heavily built-up areas. Overall, more were found on soft ground surfaces than on plants or human-made hard surfaces, showing the huge diversity of life supported by common garden features such as bare soil, fallen leaves and lawns. Records of Species Quest invertebrates varied in number between urban and rural areas – for some e.g. Tree Bumblebee there was an equal split, but others e.g. Small Tortoiseshell Butterfly were recorded far more frequently in rural areas. These records are enhancing our understanding of invertebrates in urban environments.

OPAL has created a range of new resources

- An outdoor learning programme, which includes an extensive range of field-based resources for all ages and abilities.
- New online resources:
 - Educational Pathway and OPAL e-learning programme www.opalexplornature.org
 - *iSpot* – the wildlife identification website www.ispot.org.uk
 - *Indicia* – new biological recording software, free to download from www.nbn.org.uk
 - Nature Groups Near You – a directory of natural history societies



- A series of guides that draw upon lessons learned and best practice from OPAL.
- New public exhibitions, including:
 - An exhibition on the biodiversity of The Royal Parks
 - A permanent exhibition about public participation in biological recording at the Natural History Museum
- A range of regional resources
- A new environmental network that brings the community, statutory and voluntary sectors closer together to create a more sustainable way of life.

The future

OPAL has enabled communities to become more informed, active and skilled and has empowered them to make a real contribution to their local environment whilst enjoying spending more time outdoors.

The challenge now is to sustain this growing interest and continue to engage and reconnect more people with nature whilst promoting the benefits that the natural world provides and its importance to our well-being.



1. Introduction



OPAL has initiated a study of the natural environment by communities around England. OPAL's research and education programme, designed and delivered by a partnership of 15 organisations, has directly involved over 650,000 people, including 100,000 from hard to reach communities, and engaged many more through our websites and media coverage.

The purpose of the study is to motivate everyone to discover more about the outdoor spaces where they live and work. OPAL resources equip people with the knowledge and skills to explore with confidence, and record information about local places and wildlife and to share their findings. Collectively such knowledge can play a powerful role in understanding and responding to environmental change.

It has long been acknowledged that governments alone cannot resolve the big environmental challenges facing society today¹. Everyone has a role to play. OPAL provides a mechanism for more people to engage actively with nature and make their contribution to environmental protection.

This report evaluates the progress made against key objectives set when the OPAL programme was launched in December 2007. It draws on evidence from a range of sources including semi-structured interviews, online questionnaires and testimonials from OPAL participants (evidence sources are provided in the Appendix).



1.1

What is OPAL?

The Open Air Laboratories network, or OPAL, as it quickly became known, was launched in 2007 following an award of £12 million from the Big Lottery Fund's £200 million *Changing Spaces Programme*. Conceived and directed by Imperial College London, OPAL consists of 32 projects delivered by 15 partner organisations from across England, each bringing their own area of expertise (see box).

OPAL has two associate partners, the Environment Agency (EA) and the Department for Environment, Food and Rural Affairs (Defra). OPAL is affiliated to Research Councils UK (RCUK) through the Living With Environmental Change (LWEC) programme.



OPAL key objectives

1 A change of lifestyle - a purpose to spend time outdoors, observing and recording the world around us

OPAL aims to make at least one million people more aware of the open spaces and conservation sites around them and more knowledgeable about the contribution that individuals can make to protect them.

2 An exciting and innovative educational programme that can be accessed and enjoyed by all ages and abilities

Through new approaches to learning, people will gain the opportunity to become active participants with the knowledge and confidence to debate environmental issues.

3 Inspire a new generation of environmentalists

OPAL aims to inspire young people through its outdoor learning programme. OPAL aims to increase active membership of amateur natural history societies.

4 A much greater understanding of the state of the natural environment

OPAL wants to ensure that everybody can participate in projects to monitor the state of the natural environment and its biodiversity. It aims to help some of the most disadvantaged communities to identify, quantify and highlight environmentally deprived spaces.

5 Stronger partnerships between the community, voluntary and statutory sectors

Scientists at nine regional universities, with the help of specialist national centres, build connections with those who aspire to, or need to, improve their local environments. The portfolio aims to engage with over 500,000 people to encourage a greater sense of ownership of their local environment.

OPAL partners

- Imperial College London: Dr Linda Davies (OPAL Director), Dr Sally Power, Prof Ralf Toumi, Dr Nick Voulvoulis
- University of Birmingham: Dr Jon Sadler
- University of Central Lancashire: Dr Mark Toogood
- Field Studies Council: Dr Steve Tilling
- University of Hertfordshire: Dr Agneta Burton
- The Met Office: Dr Mark McCarthy
- National Biodiversity Network: Dr Jim Munford
- Natural History Museum: Dr John Tweddle
- Newcastle University: Dr Anne Borland
- University of Nottingham: Dr Peter Crittenden
- The Open University: Prof Jonathan Silvertown
- Plymouth University: Dr Maria Donkin
- The Royal Parks: Dr Nigel Reeve
- University College London: Prof Neil Rose
- University of York: Prof Mike Ashmore

OPAL set out to provide an opportunity for all sectors of society to get to know nature and to contribute to its protection. The programme uses a range of different approaches from new technologies to more traditional methods of direct community engagement. Two widely recognised factors required for community action² resonate strongly with the OPAL approach:

- **Inspiration** – people must feel inspired to be part of a sustainable future. This has to be done through sparking awareness and interest.
- **Relevance** – community groups have to see the relevance of their own activities and interests to the bigger picture.

Connecting with the natural world is known to be beneficial, not only to individuals but to the wider society: people's health, their education, the relations within and between communities, and actions towards safeguarding and improving the environment³. OPAL addresses each of these areas and has integrated them into one cohesive programme for the public.

There is a special emphasis on inclusion and accessibility for all and we actively seek and target time and funding towards deprived, disadvantaged and minority groups.

There are four core elements to the programme:

- Our regional networks connecting directly with local communities, developed and led by an academic institution in each region of England and centrally coordinated to ensure that the programme reaches all parts of the country (Figure 1)
- Six national centres set up to provide expert advice on the topics of biodiversity, climate change and pollution of soil, air and water
- Central support services including the website team who also design and manage the OPAL database, media communications, biological recording software, schools and parks services
- Research and education programmes including our series of national surveys

“ These kids have never done anything like this before. Getting them outside to start looking closely, and recording what they have done - it's a huge step. ”



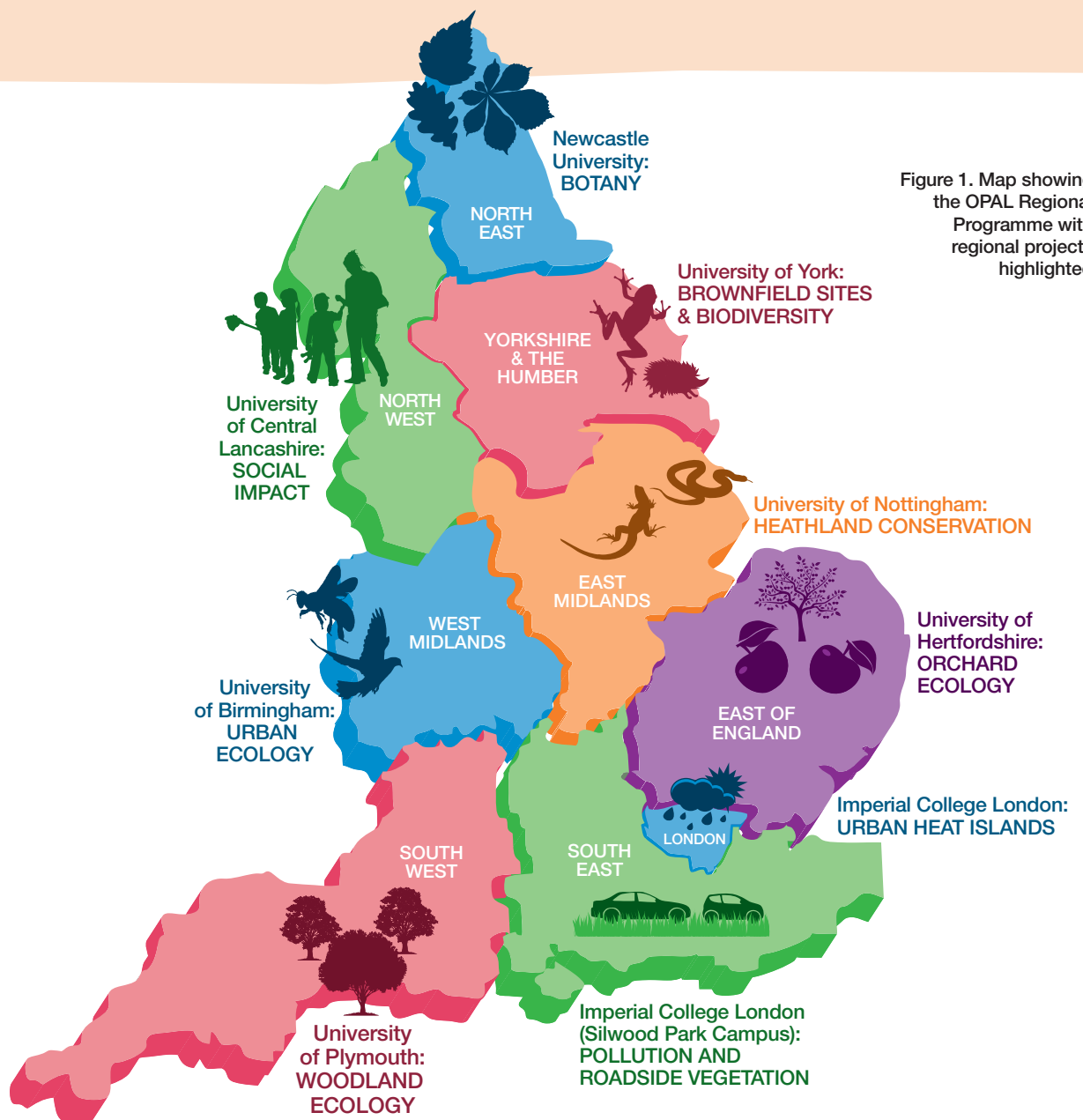


Figure 1. Map showing the OPAL Regional Programme with regional projects highlighted

1.2 Regional network

Although not often recognised, universities have close ties with their local communities. Many have outreach departments that support student volunteering in the community or develop projects in response to local needs. The OPAL regional network of universities extends this work and provides the national infrastructure for direct community engagement. There are two main strands to the regional network. One is to deliver OPAL national surveys and the other is to investigate a particular environmental research theme, specific to that region (Figure 1) or an educational issue of local interest. Each regional university employs an OPAL *Community Scientist* who works directly with local people.

The *Community Scientist's* role is unique in academic institutions, with public engagement being their primary purpose, motivating people to get involved in OPAL activities. Academics supervise the *Community Scientists* and, in most cases, OPAL-funded students. To ensure effective collaboration with all sectors of the community, regional meetings and workshops, open days, training sessions and community visits, are built into the programme. Groups included in this collaborative approach include local government, government agencies, schools, wildlife and naturalist groups, communities and voluntary sector organisations, all working directly with the academic team.

The regional programme introduces scientific study to the community. It demonstrates how and why research is carried out and how such information is used. Importantly, by involving people directly, it helps the community to learn about environmental problems and how they can help. It also benefits scientists who have been given access to new sites and to local knowledge.

OPAL's schools programme led by the Field Studies Council is an important part of the regional network.

“ Since I did the OPAL survey, I have been pond dipping 5 or 6 times. Before I did the survey, I hadn't been very interested in pond dipping, now I really like it! ”



1.3 National research centres and surveys

OPAL has five national centres whose work underpins many of OPAL's activities. The research centres provide a broad knowledge base that supports the regional programme as well as delivering a distinct research and education programme.

Each centre was also responsible for producing one survey in a series of national ecological surveys. The surveys, delivered across England through the regional networks, are the primary mechanism through which communities can explore and learn more about their local environment and, if they wish, to contribute to scientific research. Other opportunities arise through local community projects and events carried out by the centres. The OPAL surveys are designed to be self-explanatory and suitable for a wide age range. Each survey has a specific theme and includes a field guide (usually containing some identification guides for species under investigation), a workbook with clear instructions and for recording results, essential equipment for carrying out the survey, and some supplementary educational materials to support participants. Surveys take less than an hour each and involve a series of habitat observations, identification and recording of wildlife and site assessments. Background information is also provided on the OPAL website

where links to policy and other relevant publications and online resources can be found. After completing surveys, participants are invited to enter their findings into the online OPAL database or to return their results via a Freepost address. In total, 230,000 OPAL surveys have been produced and distributed free of charge: 50% directly to schools and 50% to the public. Over 100,000 survey resources have also been downloaded from the OPAL website. Data from over 25,000 surveys have been submitted to the OPAL database and we estimate that at least five times as many surveys have been completed.

OPAL Soil Centre

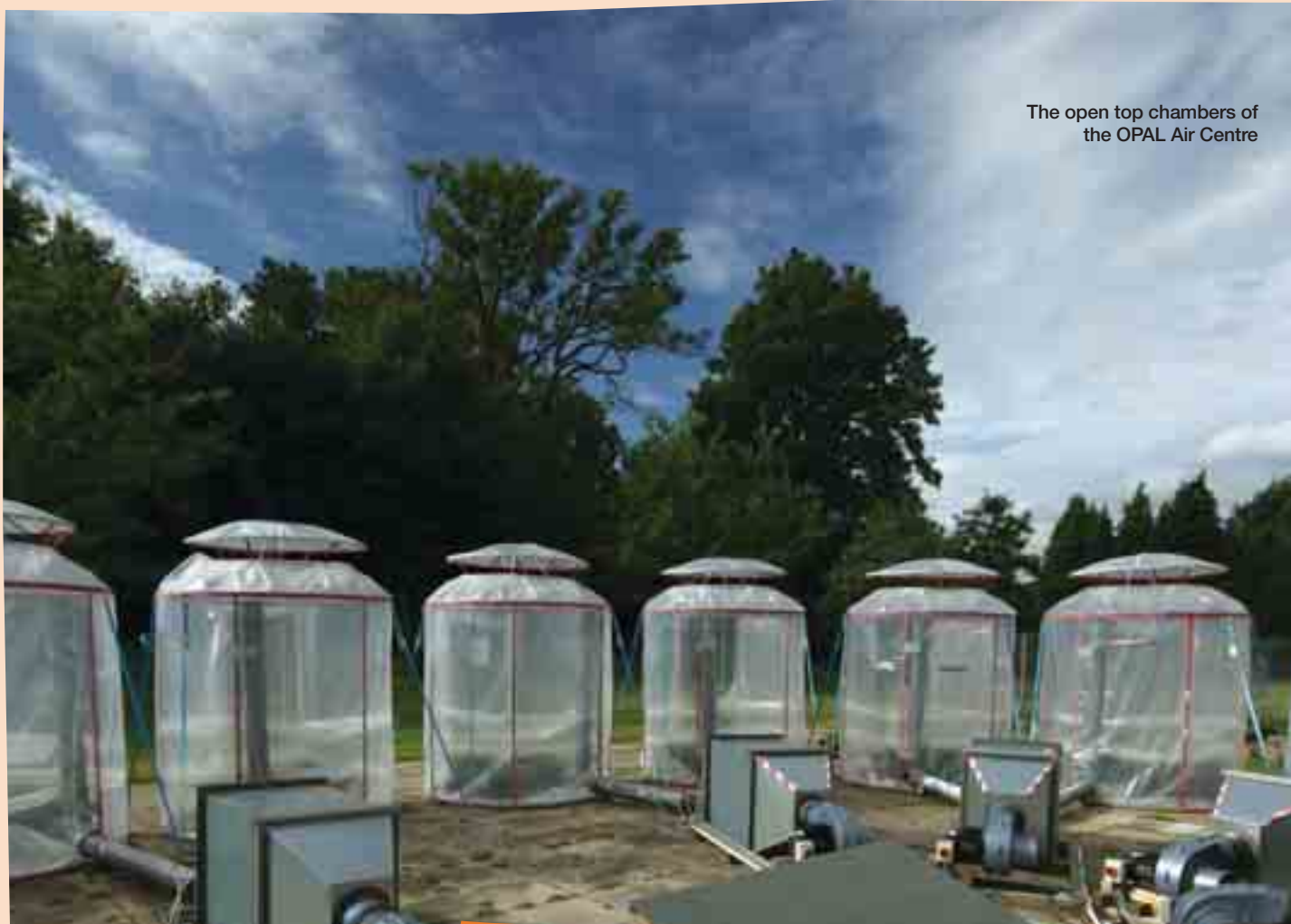
Soil is one of our most important natural resources, providing a range of essential benefits. As well as being a medium for growing crops and other plants, healthy soils provide

clean water and air, reduce flooding and regulate the climate. Soil is also home to an incredible diversity of life. The microbes and animals that live in the soil, especially earthworms, are vital in maintaining important functions such as decomposition (the decay and breakdown of organic matter) and nutrient recycling, to allow soils to stay fertile and to provide us with food. Soil, however, can be easily damaged by compaction, erosion and pollution, in turn reducing the ability of soils to provide all these benefits. To protect it, we need to understand a great deal more about soil and its biodiversity. The Soil Centre that OPAL established at Imperial College London has shared its expertise and knowledge with the regional OPAL *Community Scientists* and directly to communities across England. The centre led the design and development of OPAL's first national survey, the Soil and Earthworm Survey.

“ Thank you for a brilliant afternoon doing the worm survey. You made it amazingly exciting and fun. Everyone who came seemed to have a great time, and the children were enthralled. ”



The open top chambers of the OPAL Air Centre



OPAL Air Centre

The air we breathe is fundamental to life yet, over centuries of industrialisation, millions of tonnes of polluting chemicals have been emitted into it. As we came to understand the impacts of pollution on human health, measures were introduced to improve our air quality, such as switching our cars to unleaded petrol. New laws have been introduced as our understanding of air quality increases, not only to protect human health but also to protect the natural environment. The key topic for the OPAL Air Centre that we established at Imperial College London's Silwood Park Campus, was the effects of pollutants on vegetation. The Air Centre carried out a series of experiments using open top chambers, which they used to assess the impact of ozone, an important and damaging air pollutant, on a range of plants and plant communities. By varying the level of rainfall received by plants within

Using biomonitors to investigate the environment

Biological monitoring is the use of living things, such as plants and fungi, to monitor environmental change. These living things are known as biomonitors. Historically, change could only be assessed in this way. Local people were often the first to note the impact of a source of pollution, or a change in soil conditions, through its consequences, such as damage to crop yields or loss of aquatic species. In recent years, we have come to rely more on hi-tech equipment and computer modelling, used by a small number of experts, to monitor the world for us and tell us what is happening. However, biomonitors remain essential natural tools for understanding the environment and are available to everyone.

Biological monitoring is used in the OPAL programme to provide visible evidence of environmental change. For example, in the OPAL Air Survey we are using lichens as biomonitors to track changes in air pollution.

chambers, the importance of interactions between ozone and climate were also investigated. As well as providing air pollution expertise, the team led on our OPAL Air Survey in partnership with the

British Lichen Society. The survey uses the presence of lichens, which are sensitive to air pollutants, to indicate patterns in air quality.



OPAL Water Centre

Freshwater is essential for human health and ponds and lakes are an important habitat for many plants and animals. However, freshwater bodies are very susceptible to being polluted, whether through inadvertent run-off of fertilisers from soil or more deliberate dumping of human rubbish and waste. The OPAL Water Centre, that we established at University College London, carried out an extensive programme of research investigating the condition of lakes in each region of England, seeking to understand how pollutant levels have built up over time and their effects on aquatic biodiversity. The Water Centre also led on our OPAL Water Survey, which included the additional OPAL Metals Survey.

OPAL Biodiversity Centres

Putting names to species is fundamental to conservation, education and science, and to our understanding of the connections between the natural world and human well-being.

Using their expertise in biodiversity and web design, The Open University produced the interactive web-based resource, *iSpot*, one

element of OPAL's innovative educational programme to support taxonomy in England. *iSpot* was designed to help anyone, from complete beginners to those more experienced in biological monitoring, to identify plants and other wildlife. The Open University also led on OPAL's first Biodiversity Survey which focused on hedges as habitats for wildlife.

Taking care of over 70 million specimens and home to a dedicated Centre for UK Biodiversity, the Natural History Museum (NHM) provides a second arm to the OPAL Biodiversity Centre and an overarching support role to the wider OPAL portfolio. The NHM provides naming and identification assistance, giving OPAL staff access to the NHM library and specimen archives and producing new resources to help explain the classification of wildlife. They run a targeted programme of support for natural history groups on OPAL's behalf and an exciting and varied programme of large scale events to raise OPAL's public profile.

The NHM also led on OPAL's second biodiversity survey, Bugs Count, which focuses on invertebrates around people's homes, schools and workplaces.

Osmia rufa

Photograph: Jeremy Early



OPAL Climate Centre

Climate change is one of the most talked about topics today but there remain many misunderstandings and misconceptions around this complex area. The OPAL Climate Centre, that we established at the Met Office, led on OPAL's educational and research work on the topic of climate, developing an online suite of informative and educational activities, and introducing new weather stations to help monitor and explain the urban heat island (UHI) effect: the increased temperatures experienced in large cities. The Met Office led on the OPAL Climate Survey, which sought to investigate how people are affected by weather and climate and to demonstrate how human activities, such as building dense urban areas, can have an effect on the climate.





1.4 Supporting partners and associates

Our support services provide both external and internal support and are essential to the success of the programme.

The public website and database at the Natural History Museum

The OPAL website, led, managed and hosted by the NHM, is an essential way of sharing information about OPAL. The website is the place where individuals, schools and communities learn more about the environment and can enter and view survey results. It is also the place where teaching materials and other resources can be downloaded. Technical support from the web team enabled the development of innovative online recording and data storage facilities, tailor-made to each survey. Results can be instantly visualised on the

website, helping to make them more meaningful and allowing participants to investigate their own research questions: How does the number of dragonfly larvae I've discovered in my pond compare to the rest of the country? Are there more nitrogen-loving lichens recorded from London than Newcastle? The website also provides a means for sharing news of upcoming OPAL events and relaying community achievements.

The Communications Office at the Natural History Museum

The OPAL Communications Officer, based at the NHM, publicises OPAL both nationally and regionally. Media relations and external communication help to showcase OPAL's work and are essential to generate public interest. Over the past five years, OPAL has successfully achieved extensive media coverage. Highlights of our broadcast coverage include features promoting OPAL surveys on BBC television programmes, such as *The One Show*, *Springwatch*, *Autumnwatch*, *Bang goes the Theory* and *BBC Breakfast*.

Articles in national and local newspapers helped to attract participants and numerous radio interviews were held to launch the surveys.

Biological recording software at the National Biodiversity Network

Whilst improving people's abilities to identify wildlife is vital, it is equally important to record these findings somewhere and to share them more widely. Together we can gain a greater understanding of species presence, their distribution across the country, and how this may change over time, including from the effects of climate change. The National Biodiversity Network (NBN) manages the national database for biodiversity records across the UK, where records collected over decades can be viewed and downloaded by anyone.





As part of the OPAL partnership, the NBN developed new software that facilitates improved wildlife data capture and management, which is suitable for both newcomers and experts. Known as *Indicia*, it has benefited a large number of organisations, such as biological recording groups and wildlife groups, alongside individuals, from experienced natural historians to complete beginners.

Reaching out to schools

The Field Studies Council (FSC) has two core roles within OPAL. The first is to use their long-standing expertise in the production of identification keys and field guides and to lead on the design, printing and distribution of the OPAL national surveys. The second is to run a central schools outreach and training programme to enable schools across England to participate in all OPAL surveys and to encourage more outdoor education.

Reaching out through public parks

The Royal Parks provide testing sites for OPAL Surveys as well as locations for events and for new weather stations. The Royal Parks staff received training to enable them to carry out each of the national surveys with local volunteers, community groups and schools.

All OPAL activities have been developed with support from Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency, ensuring that they are compatible with environmental policy. OPAL is also affiliated to the Living With Environmental Change programme. This partnership of organisations actively involved in protecting the environment, aims to anticipate changes in the environment and in society, to prepare people to meet the challenges ahead and to take advantage of the opportunities they bring.



2. Changing lifestyles: spending time outdoors



In recent years, there has been substantial research to suggest that being active outdoors is beneficial, particularly to young people⁴. The benefits are not just related to the increase in physical activity associated with being outdoors. Experiencing the natural world contributes to a child's personal development and encourages a sense of freedom, which contributes to their well-being. Studies also show that spending time in green spaces can decrease the risk of mental health issues and reduce aggression, which in turn can help to reduce crime⁵.

Unfortunately, alongside research that endorses the benefits of being outdoors and experiencing nature, there are numerous studies documenting the decline in time spent outdoors. Reports suggest that fewer than 10% of UK children play in natural places such as woodlands, heathlands and the countryside, with the majority of children citing 'indoors' as their favourite place to play⁶. Adults too say they are often 'too busy' to visit natural places⁷.

OPAL was designed to encourage people to spend time outdoors by offering a programme that fits easily into their lives. The bite-sized activities, designed by scientists, take no longer than an hour to complete and have a clear set of instructions from start to finish, meaning that they are not too

daunting for the newcomer. Furthermore, because OPAL surveys are divided into short activities, people can choose to complete just the parts that interest them. This flexible approach appeals to communities, and means that OPAL works well for busy families and schools.

OPAL key objective

A change of lifestyle - a purpose to spend time outdoors, observing and recording the world around us

OPAL has directly engaged over 650,000 people through outdoor activities. There have been over a million visits to our websites, where people can learn more about local nature.



2.1 Inspiring people about nature

OPAL has motivated people to go outdoors and discover what is in their garden, in their local park, on the trees in their street, or even further afield; spaces that they may have been aware of but previously never had a reason to explore. Getting outdoors is the first step, but having a purpose to do something once there provides inspiration for many. Recording information about their environment either for themselves or to share with others through the database has proved to be an important aspect of the OPAL programme. This sense of purpose has been reported by many participants. From over 4,500 statements received via the OPAL website it is evident that people have discovered new interests and will take part in outdoor activities again. 8,265 survey participants told us that this was their first time taking part in an environmental survey. Many others reported that they simply had a great time taking part in OPAL.

The length and quality of the engagement covers a broad spectrum from a discussion with a scientist or demonstration at an OPAL event, through to participation in an OPAL survey, joining an OPAL training course or carrying out a research project with an OPAL *Community Scientist*.

The chance to take part in real scientific experiments and contribute to scientific research appears to be a strong motivating factor for some people. A manager of a park in Staffordshire, said:

"I've been using a whole range of the OPAL material and resources for quite a while now with a wide range of different groups. [...] These packs have proved excellent, very easy to use and a great



way of recording results so that the young people feel like they are doing a proper scientific experiment that is useful, which of course they are; it just happens to be great fun as well."

Being able to contribute to research is inspiring; it gives people a sense of purpose to venture outdoors and explore the world around them, knowing that they are playing a part and that what they find matters. Young people get great satisfaction from being involved in something of national importance; it inspires them to take their interest further. People like to know that their contribution is valued so being able to see the survey results displayed instantly online and to receive a regular newsletter are important features of the OPAL programme.

Through OPAL, we have found that people are really keen to learn more about the environment. This is demonstrated by the volume of interest when each survey is launched or simply that thousands of sites have been surveyed. The OPAL surveys have shown people where to begin with wildlife recording. The value of this is summed up by Mark, from a Community Garden in Newcastle:

"It was nice to find [out] from some of the surveys about the quality of the habitat we have here and in such an urban environment it's really good to have such a great oasis in a city and it's nice to have that clarified by scientific statistics [on] how good the habitat is."



"...the Hedgerow Biodiversity survey went well, with many of the lads confidently identifying the hedgerow species using the wonderful hedgerow field guide. ... [they] were chuffed to think that they were contributing to a national database!"

Teacher from a college in North Shropshire

"The survey awakened me to the incredible diversity of plants and wildlife in our hedges."

"This was an amazing experience, it was really fun and we all enjoyed doing this project. We found out lots of new things which were very interesting."

"I really enjoyed investigating our garden and uncovering the hidden treasure of insects and wildlife hidden in the hedgerow... fascinating discovery for all the family!"

"I and my partner enjoyed this interesting and fascinating trip because we got a chance to learn about creatures living in the ponds, pH testing and safety when near a pond. Thank you for this opportunity."

"I've never been excited to see a slug before, now I know how useful and beautiful the Leopard slug is!"

"I really liked doing this survey and have learned lots of new and interesting things. I hope to do another survey like this again. Thank You"

OPAL staff have helped communities discover places on their doorsteps they had not noticed before; in some cases, they have even helped them to make their own spaces for nature. In the North East, the OPAL team rejuvenated Moorbank Botanical Gardens and reopened the space to the public, providing an oasis of nature in the heart of the city. Four schools that worked with OPAL East Midlands created their own wildlife spaces after taking part in OPAL activities. Students from Haddon Park School created a heathland, pupils from Berry Hill Primary School created a wildflower bed, planted trees and created some minibeast habitats and pupils from Wynndale Primary and Oak Tree Primary created bug hotels on the school grounds.

Research carried out by OPAL's social science team at University of Central Lancashire demonstrates that people's behaviour is changing as a result of being inspired by OPAL activities. Using results gathered from an online survey of 593 OPAL participants, almost 75% of respondents said that they will try to do more surveys like OPAL's in the future. 43% of respondents said that the OPAL activity had changed their thinking about the environment and 37% said that the activity will change their behaviour towards the environment. Of participants who indicated that they were not a member of an environmental organisation, 36% said they were more likely to join one after participating in an OPAL activity.



Case study

Karen, Plymouth City Council Neighbourhood Manager for North Prospect, tells us about her experience of the OPAL surveys.

North Prospect is the third most deprived neighbourhood in Plymouth. Residents have low literacy and numeracy levels, poor health, high unemployment and benefit dependency. There is a much higher proportion of children living in North Prospect compared to the city and national average and an identified lack of open space. Titchy Park however has had a significant amount of investment over the last few years and it is important for us to promote Titchy Park as a safe, attractive and interesting play space for residents of all ages. In June 2011, the Neighbourhood Regeneration Team organised a Bugs Count Survey with OPAL in Titchy Park, as part of Love Parks Week.

The bug hunt was a resounding success. We had not organised a wildlife type event before and were unsure whether families would be interested. Fun Days in the Park have previously centred on bouncy castles and sports activities. Approximately 30 adults and over 60 children attended, more than we had catered for! The reason why I particularly liked this event was that it was such a family orientated activity which involved parents and children working together. As we frequently come across parenting issues and conflict within families, we found this to be a fun and positive experience for the whole family. Both children and parents were engaged and enthused by the nature surveys and they talked about going home and bug hunting in their garden. It provided us with an ideal opportunity to talk to them about other community issues and ask their views on parks and open space in North Prospect.



Impact through outdoor activities

OPAL regional *Community Scientists* have organised or taken part in an estimated 1,500 events and activities in communities and schools. This face-to-face contact is an important part of what OPAL does. Meeting a member of OPAL staff often inspires people to get more involved and learn about nature. *Community Scientists* have developed a range of techniques to help to engage people of all ages. They have also helped to dispel the myth that all scientists wear white coats, work in laboratories and are not very easy to talk to. OPAL staff also ran events at a number of large scale science shows such as the BBC's *Bang Goes the Theory Roadshow*, the *British Science Festival* and the *Cheltenham Science Festival*.

OPAL has given people the opportunity to experience the natural world through hands-on activities. The OPAL *Weather Roadshow* has visited a wide range of sites, local events and festivals, and has travelled across the country from Plymouth to Newcastle. The Roadshow has a number of activities, which demonstrate how weather is measured and forecast and how real life weather phenomena occur. The cloud in a bottle experiment, for example, helps people understand how clouds form. Other activities include demonstrations of air pressure, seeing and touching mini tornadoes, simulating lightning and a chance to see how a real weather station works. Participants have the opportunity to use equipment, such as hand-held anemometers, which allow people to measure and learn about wind, and, most popular of all, participants get to experience what it is like to be a television weather presenter in the weather studio.

An estimated 4,500 people have taken part in the Roadshow, including school groups who typically participated in a 45-minute activity session for some in-depth learning. At more public-facing events, people are free to enjoy the activities and talk to Roadshow staff

Recording wildlife against the clock – *BioBlitzes*

Some of the largest events run by OPAL staff are *BioBlitzes*. A *BioBlitz* is a 24-hour race against the clock to find and record as many living things as possible within a defined area. Scientists, amateur naturalists and the public work closely together at these exciting events, providing the opportunity for members of the public to conduct scientific surveys alongside experts in an informal setting. In line with the OPAL ethos of building stronger partnerships between the community, voluntary and statutory sectors, *BioBlitz* events excel as partnership initiatives.

The *BioBlitz* concept is relatively new to the UK, and OPAL championed this approach to public engagement and biological recording. Using OPAL's expertise in scientific research, public engagement and biological recording at *BioBlitz* events, the Natural History Museum and Marine Biological Association wrote *Running a BioBlitz: Hints and tips for planning and hosting a BioBlitz in the UK*, sharing OPAL's experiences and advice with others planning similar events. The guide is downloadable from the OPAL portal along with advice on press and media issues for *BioBlitzes*, plus data-sharing guidelines from the National Biodiversity Network. These 'how to' guides help other organisers to run successful *BioBlitzes* across the UK and internationally.

Alexandra Palace Park BioBlitz, Haringey

Alexandra Palace Park is a large park in the London Borough of Haringey. In June 2010, OPAL teamed up with the BBC, Haringey Council and the Alexandra Park Charitable Trust to *BioBlitz* the site. Over the course of 24 hours, 8,000 members of the public explored the park through the *Bug Hunters*, *Woodland Explorers* and *Grassland Detectives BioBlitz Discovery Zones*. 666 species were recorded, including a beetle which was last recorded in the UK in 1969, plus a breeding population of Stag Beetles, a protected species in the UK.

The response from participants was great.

“ My children were in their element, and there was something for everyone. Hope it becomes a regular event. ”

“ From now on we'll look at the park in a different way. ”



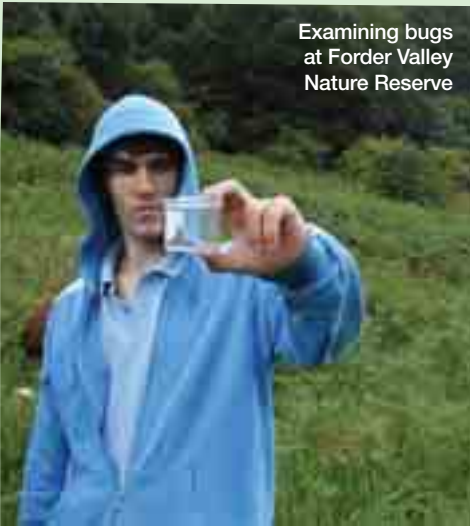
about the weather and climate. One teacher who visited with her class said: "The feedback from the children and staff was fantastic. They were truly inspired! Brilliant!"

The OPAL East Midlands team organised a number of community trips to green spaces and reported that people often

ask them about public transport to sites so they can visit again on their own. Some group leaders that worked with, or were trained by the team were so inspired by the benefits of the activities that they went on to run similar trips on their own or with partner organisations. In the South West, the *OPAL Community Scientist* organised two children's



Examining bugs
at Forder Valley
Nature Reserve



The team from OPAL North East worked with Year 5 pupils of Westgate Hill Primary School, who visited Moorbank Botanic Garden to carry out the biodiversity survey. The school has only a concrete playground so visiting green space and learning about nature is valuable to them. The children explored the garden and had a talk from a local beekeeper. They brought with them the bee hotels that they had made at school, placed them in the garden and made hexagonal artwork inspired by their day. The children's artwork was taken back to the school and arranged by the *community scientists* to look like a giant honeycomb!



university lectures at Forder Valley Local Nature Reserve in partnership with Plymouth City Council. A member of staff from the Council wrote to OPAL after the event, explaining how the activity had opened up new places for families: "Particularly interesting were comments from parents who said that they had not known about the nature reserves in Plymouth, and asked what was available there for families and young people who visited them. This included some families who live very close to [the] Reserve, who said they would be taking their children there again."

Questionnaires were given out at some OPAL outdoor events to help evaluate people's experience of the activities. When children were asked to select words that described how they felt about what they had done with OPAL, 95% indicated that they had found the activity inspiring, fun, exciting, interesting or educational. When asked: what did you enjoy the most?, their responses fell into two broad groups: those who enjoyed actively doing something such as worm hunting or pond dipping, and those who enjoyed discovering something such as finding a snail or catching creatures. Other children indicated that they had simply enjoyed being outdoors and others said they had enjoyed everything.

“ I do think that a survey like this made the activity more science based and allowed us to reach a more realistic conclusion. Going out with books and spotter sheets is all very well but relies on general observation and ability to correctly pin down the item found. The surveys got us to look at the whole area first, then narrow down to a specific item in that area and helped us to identify specific things. It was well put together.” ”

“Another plus [of taking part in the OPAL Air Survey] were the number of pupae, insects and spiders seen; we would not have spotted these at all if we hadn't been involved in the lichen survey. Our observation skills will have increased manifold after this survey.”

“ Realising that there is all that 'real ecology' to be done in the city, [I am] starting to really look at trees and realise there is such a variety and so many have a complete community living on them! ”

“I am now fascinated [by lichens] and look closely at any I see.”

“ I attended a community event and met one of the staff of the OPAL team – they showed us how we could do the surveys at home - my son was enthusiastic to try the earthworm digging, as well as making a bird feeder to take home! We try to think about wildlife much more now when we are gardening and what we can do to encourage it into our garden – a pond may be next on our list of things to do! ”



Adults too gain new experiences from working with OPAL. They were asked some specific questions at outdoor events about the activity in which they had participated. 89% of adults felt that they had learnt something new about their local environment and 80% said that they had developed new skills. These questionnaires indicate that most participants had a positive experience at an OPAL event or activity.

2.2 Being inclusive

OPAL activities were designed to be carried out by people from all walks of life, of different ages, backgrounds and abilities. Seeking to introduce new audiences to nature, OPAL has actively engaged with over 100,000 people who are classified as hard to reach (meaning that they are disadvantaged in some way). This represents only 20% of all people that OPAL has involved; however, proportionately, OPAL staff spend much more time with them, working closely in small groups, to build a strong understanding and trust.

The Index of Multiple Deprivation (IMD)⁸ was used to identify groups from deprived areas. Over 10% of the organisations and schools that OPAL

Case study

The friends group of a park in London took part in the OPAL Air Survey, led by The Royal Parks, in February 2010. The participants had some knowledge of lichens but it was very limited. After spending two hours in the park looking at the lichens with an expert, they were astounded at their own learning and committed to encourage others to get involved. The group wrote an article on their experience in the members' newsletter and soon discovered many others who were interested in lichens. Together they collected lichen samples and put together a learning package for studying at their wildlife centre. They then advertised this in their next newsletter, which has encouraged more members to meet up and explore lichens together.

works with, and 6% of submitted OPAL surveys, are located in the 10% most deprived areas in England (Figure 2).

People who may have shown no interest in the environment in the past are discovering how inspiring the natural world can be. In the South West region, Plymouth University worked with Foundation Learning, a youth group for 16-18 year olds not in employment, education or training. Commenting on the young people's participation in the OPAL Water Survey, the group's coordinator said: "...[they] responded brilliantly to this work and got really involved in the surveying, catching the pond creatures and learning about them... The young people asked lots of questions and expressed a genuine interest ...when you take into account that some of them have major behavioural problems and can be very disruptive, to see this energy put into something positive was fantastic..."

The experiences of the participants demonstrate how OPAL has helped them to raise aspirations. One unemployed young person who came said: "OPAL has provided an opportunity to learn more about the world...I feel I can learn new things without being picked on... I want to do more so I can go on to get a qualification."

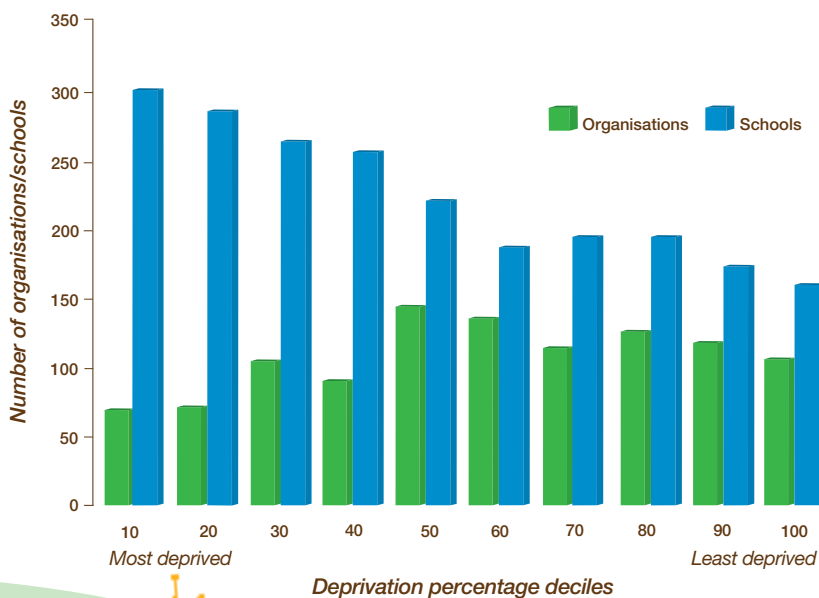


Figure 2. Organisations and schools that OPAL has worked with across the range deprivation deciles

In Sheffield, OPAL has worked closely with Sheffield Black and Ethnic Minority Environment Network (SHEBEEN). Here, a volunteer from SHEBEEN describes how young people's eyes were opened to the natural world: "In March 2011, I took a group of young people to Burngreave Road in Sheffield to carry out the OPAL Air Survey. They were amazed to find out that lichens and black spots on leaves had anything to do with air pollution".

After taking part in an OPAL Survey in Sheffield, Haleema, age 7, who thought that there was no aquatic life in her local pond said: "Through OPAL I have learnt about the different creatures that live in the pond and that we should not throw garbage into the pond because the creatures won't survive and I don't want them getting stuck in the rubbish. I care about these little creatures because they are part of nature and there is a need to protect them."

The older generation also benefits from OPAL activities. The OPAL East of England team and the University of the Third Age (U3A), whose members are 60 plus, have worked together carrying out research on orchards, particularly orchard-dwelling mosses (bryophytes).

One member of U3A Dacorum, Hertfordshire said: "Since becoming involved with OPAL, the entire group has an added interest and awareness of mosses. We now look more closely at all the varieties we spot on our walks and with the OPAL East of England team's help and expertise, we hope to identify them". As one member said: "When I take the grandchildren out for a walk I would like to be able to identify what we are looking at and OPAL helps do that by providing opportunities for many people to actually notice what they are seeing and to increase their awareness of their natural environment".

Case study

In Preston, the access team at Myerscough College has used OPAL surveys as a basis for activities with a number of young adult learners with special educational needs. The Air Survey has worked particularly well with this group, with the students compiling a display of their experiences and providing feedback at an OPAL committee meeting. Staff members at the College have told us that being involved in a national project, that has a wider purpose, had made them keen to do more OPAL surveys. One teacher at Myerscough College, Preston said:

"There are 3 in the group with a very high level of care need. None can read. One can recognise numbers. Therefore I adapted the lesson towards finding trees with hand shaped leaves, and to filling buckets with the correct leaves. Back in our room, we laid out the leaves and took lots of photographs...I've never tried anything like this with the students before, but I was really impressed. They are now all talking (or signing) about lichens, something totally new to them all. This morning, D... kept stopping and pointing at sycamore trees. He had remembered from last week. This is a major development for him. He has his [OPAL] chart pinned up in his room."





2.3 Health and well-being

There is evidence that the more deprived an area, the more likely it is to experience the worst environmental conditions, such as highest levels of air pollution⁹. People living in deprived areas have the least access to greenspaces¹⁰ and also poorer health. For example, there is a clear relationship between childhood obesity and deprivation; the prevalence of childhood obesity in the most deprived areas is almost double that in the least deprived areas¹¹. By dedicating one-to-one time with these communities and carrying out regular visits, OPAL enabled people to take steps to explore their local area and in turn, improve the health of the community. Many case studies and testimonials have been collected that illustrate these groups' positive experiences from their interaction with OPAL.

In 2008, The New Economics Foundation (NEF) published recommendations for improving personal well-being. Four of these are particularly relevant to OPAL activities¹²:

- Connect with the people around you
- Be active and step outside
- Take notice of the world around you
- Keep learning

These four objectives for improved well-being are integral to OPAL and are a welcome but unexpected outcome from the programme. Testimonials and statements from OPAL participants support this. John, from the West Midlands, carried out the OPAL Water Survey with a charity that supports women who have suffered domestic abuse. John wrote to us after the survey:

"...last Monday I did the pond dipping survey with some ladies [...]. They have had problems with violent partners in the past, but were looking for something they could do with their kids next year during the summer holidays. The survey went brilliantly...from getting the ladies to build their pond nets and clarity meters, to the pond dipping itself. They really had a good time and thoroughly enjoyed the day [...]. Next Monday, we are going to look at biodiversity. I am dealing with people with mental health issues, such as depression, and spending a few hours out in the open air, doing things they did as kids, has really boosted their confidence. Thank you for letting me use the OPAL Surveys as a base...it is proving well worthwhile."



A few months later, John wrote to us again. This time he had been using OPAL surveys with a group of young homeless adults. John told us: "One of the groups I took on the course was renowned for being trouble-makers. Not only did I not have any problems with this group, it has been the first time for many years that I can say my heart has been uplifted...they really enjoyed the days out...and that's thanks to you and all at OPAL. Being outside does work."

Talking about his experience of using the surveys in general with groups, John went on to say: "I have never seen people get so much pleasure from doing something so simple...and then listening to the thanks because they now have something they want to pass on to other people, be it friends, children or grandchildren."

The OPAL East Midlands team has worked with refugees, asylum seekers and new arrivals groups. Participants in OPAL events have commented that they have made new friends and improved their well-being: "It's useful for us to be able to socialise and cement friendships."

“ It's really fantastic to come to the very core of nature. Long walks by the river, valley, sheep, meadows all are quite amazing to watch. They gave a lot to our mental health. [I am] hungry for the next tour. ”

OPAL East Midlands also works with groups that support people with mental health issues and learning difficulties such as Inspire, Headway and Young Diverse Minds (YDM). YDM are a support group for people aged 16-30 from ethnic minority backgrounds who have mental health needs. After a day's work with the *community scientists* on the local heathland, learning about its degradation, Daniel from YDM wrote and performed a rap song based on his experience. His lyrics demonstrate what Daniel had found out and how he felt about it.

OPAL East Midlands has continued to work with YDM for over two years and together they have produced a video to accompany the rap song, available to watch on OPAL's YouTube channel
<http://www.youtube.com/OPALexplorenature>

**“ Minibus, minibus, minibus,
Went on a trip with all of us
YDM OPAL we adjust,
Wildlife protection we a must
Stand with trees not tower blocks,
Beautiful pond for a camera shot
Through the surface you will find,
Newts and insects many a kind**

**Minibus, minibus, minibus,
Went on a trip with all of us
Adders and nightjars do the task,
They could go quick, they could go fast
Better land management we should ask,
In a brand new style, in a brand new class
Creating the heathlands stay focused,
Letting them wither is outrageous ”**

A song, written by Daniel from Young Diverse Minds (YDM)

Daniel from YDM performing the rap he wrote about his experience working with OPAL East Midlands.





OPAL activities have been well-received by those who have disabilities, particularly those with autistic spectrum disorders (ASD). The National Autistic Society (NAS) carries out OPAL activities with both adult and youth groups. As a charity with a limited budget for funding educational activities and visits, OPAL enables them to achieve objectives of delivering education in a fun and hands-on way.

In Newcastle, a group of young people working with NAS visited the OPAL North East team at Moorbank Botanical Garden to take part in the OPAL Water Survey, the Biodiversity Survey and the Climate Survey. It was the first time that the group had visited a botanical garden or been involved in any environmental work.

One staff member from NAS said: "... These activities were educational and allowed both staff and group members to get involved, have lots of fun, learn about their environment, and unwittingly work on their communication and social skills, two aspects individuals with an autistic spectrum disorder struggle with."

Another said: "...a lot of the guys we work with on the autistic spectrum are very sensory so the activities that we've done with smell, with touch, with taste, have been really cool."



Staff from NAS also explained that OPAL can help the young people's social abilities: "[Doing OPAL activities] helps them form sort of social bonds, which has been great and when the phase with the youth groups came last year, the group had only just started so it was a good way of meeting people and working together as a team."

Being part of something outside of their own school has helped motivate some people with an ASD. When children with an ASD in Newcastle were asked how it felt to be a scientist for the day, one boy replied: "It felt like that I was smart, that I was an adult."

OPAL has worked with a number of homeless charities. For example, the OPAL Water team and the NHM OPAL team, in partnership with London Wildlife Trust's *Budding Together* project, spent time with homeless adults from St Mungo's in London. OPAL's involvement was found to help to rehabilitate and build participants' confidence through hands-on conservation-based activities. Some participants had very low self-esteem and lacked confidence; they said it was the first time that they had been asked for an opinion on anything or to contribute their expertise for quite some time. This showed in the growing trust and enthusiasm that they exhibited throughout the day, along with their obvious enjoyment. Towards the end of the day, many of the group openly discussed their current difficulties and plans to change their futures. Neil Rose, the scientist leading the OPAL Water Centre, also noticed that people seem to open up more when engaged with an activity. Referring to his experience of running many events with community

groups, Neil said: "At many events, while talking to people over a tray of invertebrates, we have found that they like to talk about many personal issues. These have included mental and physical health issues, employment and education experiences and prospects, and family and home life. Being willing to listen has therefore proved to be an important part of OPAL."

Over 4,000 comments from the public have been received via the OPAL website. Over 1,500 of these used the word 'fun' to describe an OPAL activity, many people say what a great time they have had, how inspired they have felt and explained more about what they had learnt or found particularly interesting, all of which resonate with New Economic Foundation's recommendations for improving personal well-being. A further 2,700 comments provide additional information to the actual survey, indicating that participants are keen to contribute even beyond the requirements of the survey.

Our evaluation of OPAL shows how more people are making a personal connection to nature, how they are taking their interests further and in some cases, changing their behaviour.



3. Learning



Learning about nature is at the heart of the OPAL programme.

Through education, people gain new skills and confidence that can be used for further informal and formal study and for future employment. There are no learning goals to OPAL activities, no ultimate 'by the end of this survey you will understand...' because we realise that people come to the surveys with different levels of experience and we acknowledge that people will take from the activities what they will.

Accurate identification of animals and plants is the cornerstone on which real involvement with nature and biodiversity is built. In addition, an understanding of the conditions of the habitat that species require and the local climate are important to gain a full appreciation of the natural world. To get more people involved in taxonomy (the naming and

OPAL key objectives

An exciting and innovative educational programme that can be accessed and enjoyed by all ages and abilities

OPAL has designed and delivered an outdoor education programme and new resources for people of all ages, abilities and backgrounds.

Inspire a new generation of environmentalists

OPAL aims to inspire young people through its outdoor learning programme. OPAL resources are widely used in formal and informal education programmes.

classification of organisms), barriers to accurate identification need to be lowered or removed altogether. To do this, taxonomic resources need to be accessible and engaging for every age group.

In 1992 at the Earth Summit in Rio de Janeiro, the UK Government signed the *Convention on Biological Diversity (CBD)* to promote the sustainable use and conservation of the wide variety of life on earth¹³. The commitment of signatory nations to survey and document the extent of biodiversity on their own territories put taxonomy on the policy map¹⁴. However, despite this commitment, the number of people who were able to identify organisms and therefore document their presence was in decline. The Royal Society described the taxonomic sciences as being in crisis, and noted that, without knowing what already exists and where it is, it is not possible to know if biodiversity is still declining or improving^{15,16}.

OPAL was in part stimulated by this crisis and seeks to help to address this issue by providing a way in for people new to nature recording and create the taxonomists of the future as well as to support those already actively involved as members of natural history societies.

Watching birds may be fun, but seeing a bird you can identify for the first time gives a thrill and a sense of achievement that motivates people to go further. If people are inspired by direct involvement with the natural world and wildlife identification, they may decide to further their interests by joining a natural history society or to pursue formal qualifications.

All participants of OPAL national surveys were asked questions about their experience. When asked whether participants had learnt something new, 90% of people indicated that they had (Figure 3). 83% said they had developed new skills (Figure 4).

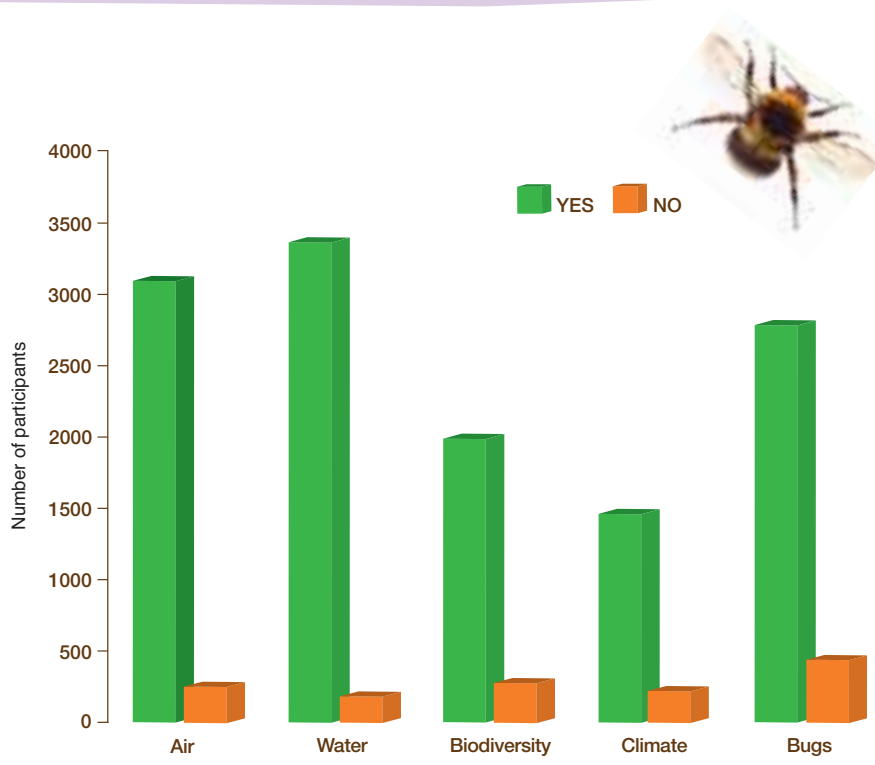


Figure 3. OPAL survey participants who reported that they had learnt something new. The question was introduced after the OPAL Soil Survey was launched, therefore the soil survey is not included here.

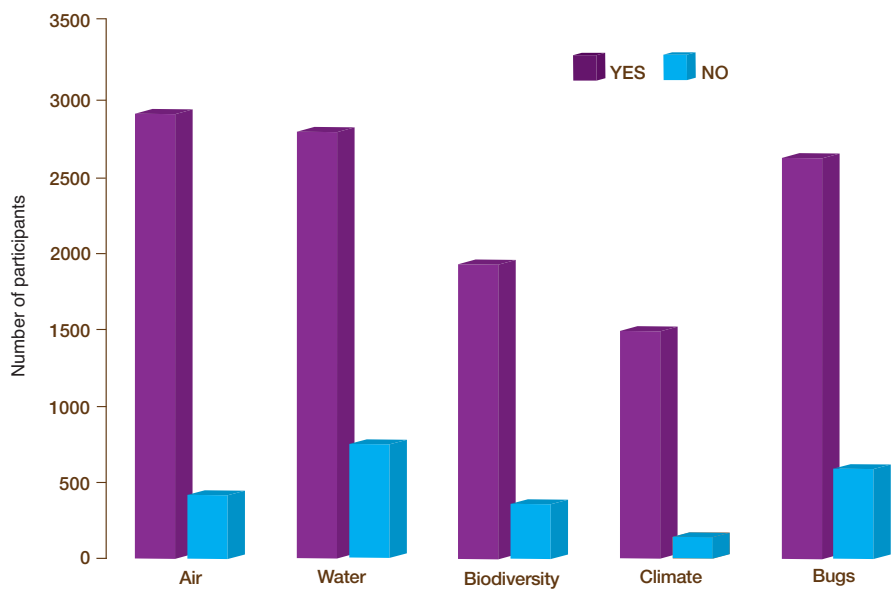


Figure 4. OPAL survey participants who reported that they had developed new skills. The question was introduced after the OPAL Soil Survey was launched, therefore the soil survey is not included here.

Outdoor learning offers a wide range of benefits for children. Topics become more interesting when they experience them first-hand, giving them an enriching educational experience. Children can become more creative, learn how to be independent, develop an understanding of risk, cope with behavioural issues and develop personal and social skills¹⁷. Over 2,000 schools have received OPAL's surveys enabling teachers to take classes outdoors and make the most of the school grounds and beyond. Other teaching resources, such as the *OPAL Discover classification toolkit*, include suggested lesson plans and PowerPoint presentations. The toolkit is one of many teaching resources that can be downloaded free of charge from the OPAL website.

Informal learning, particularly where experts and communities have an opportunity to work together, as with OPAL, can be a powerful means of gaining new skills, knowledge and confidence without the commitment of more formal learning institutions or the prejudices caused by previous bad experiences in formal education.

3.1 Online learning resources

The OPAL website is an essential part of the OPAL programme. Here, newcomers can learn about OPAL's resources, the environment and events in their region. It provides the database for collection of survey results and allows users to review data using interactive graphs and maps.



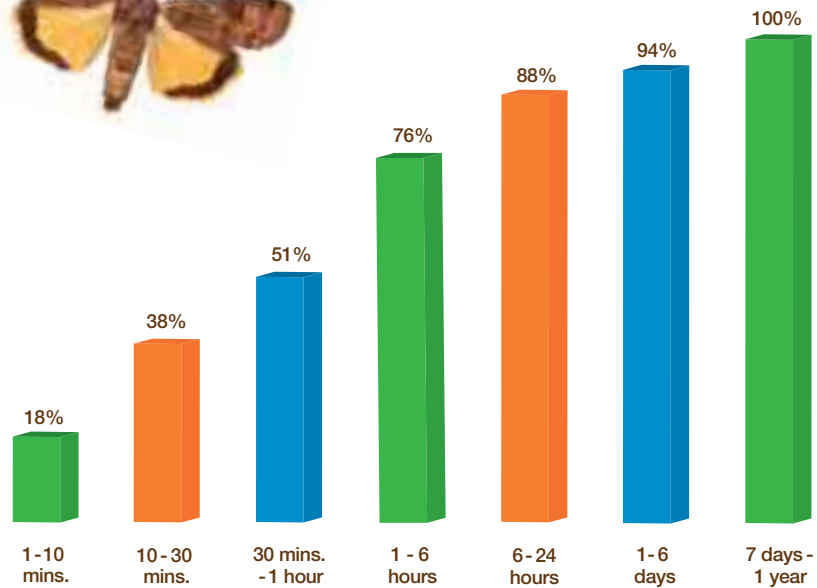
Visitors to the OPAL website in the first four years of the project exceeded 350,000. To date nearly 140,000 identification guides, survey packs and activity sheets have been downloaded. This is in addition to over 250,000 copies of printed materials for fieldwork.

A science teacher from a College in Plymouth commented on how the OPAL website supported her students' work on the OPAL Water Survey: "All my year 7s were raving about it today and can't wait to go pond dipping again (some have been doing it at home and looked at the OPAL website to help with identification)."

Each national survey is supported by online resources. Coinciding with the launch of the OPAL Climate Survey, web pages for the OPAL Climate Centre went live. As well as a climate knowledge quiz, the website team provided some innovative learning opportunities, including an 'Ask the expert' section, which received over 200 questions about climate change. The most frequently asked question was: why are we so worried about carbon dioxide when there are so many other contributory factors to climate change?

Encouraging people to develop their learning and take it in new directions is an important part of the OPAL programme. The OPAL education web pages guide participants on where they could go next with their learning journey.

More recently, a mobile phone app was developed to accompany OPAL's Bugs Count survey. This free app combines an invertebrate identification guide with the ability to take a photo of any bug of particular interest to the survey and submit it to the OPAL website in real time. It utilises the inbuilt camera and GPS capability of smartphones to create an instant and accurate biological record of what was found, where and when. The app has been downloaded over 5,000 times and almost 50% of the photos submitted to the database are via the app. It is



currently used as a model for mobile-based recording by several UK natural history societies. This type of mobile technology is likely to play a vital role in the future of wildlife recording and OPAL has been able to facilitate and freely share this technological development.

The *iSpot* website, www.ispot.org.uk, created and managed for OPAL by The Open University, has been a great success. It is based on the foundation that knowing the correct name of an organism is the key to learning about it. *iSpot* aims to help create a new generation of naturalists by combining the traditional skills of natural history with the benefits that new technology affords. To date more than 250,000 people have visited the website and 17,000 are registered users.

As a testament to the success of *iSpot*, the website won a prestigious *Wildscreen Panda Award* in 2010, in the new media category.

Figure 5. Graph showing the short length of time it takes *iSpot* users to name uploaded observations





Corizus hyoscyami,
a species of shieldbug
identified using *iSpot*

In October 2009, a six year old girl from Berkshire found an unusual moth on her windowsill. Intrigued, her father posted a photograph of the moth on *iSpot*. An insect specialist from The Open University identified the moth as the Euonymus Leaf-notcher, *Pryeria sinica*. This provided the first known record of the moth in Britain, as it is native to Asia, and the discovery created a significant amount of press interest.

Judges described *iSpot* as: “A virtual community of interest putting amateurs in contact with experts in an unintimidating environment.”

iSpot allows anyone, from complete beginners to experts, to upload a photograph of their observations of nature (usually, but not limited to, an animal, plant or fungus) to the website. Over 100,000 photographs have been sent to *iSpot*. Within hours, the online community of biodiversity experts will identify the organism, enabling users to improve their identification skills. In fact, within 24 hours, 88% of uploaded observations are named (Figure 5).

Although helping people to learn about wildlife identification via the sharing of observations is the main activity on *iSpot*, the software offers many other facilities, including online

discussion, various ways of searching for and displaying *iSpot* data, provision of identification keys and the extraction of biological data to pass to recording schemes.

iSpot observations, once verified as correct, are given to the relevant recording societies, such as The British Dragonfly Society, The Mammal Society and the Ladybird Recording Scheme. *iSpot* records are ultimately added to the *National Biodiversity Network (NBN) Gateway*. *iSpot* has received so many observations for some species that these data alone have become a valuable and unique scientific resource. For example, photographic observations of shieldbugs through *iSpot* reflect recent northward and inland spread of species, most probably due to climate change.

“ I just love *iSpot*. It has got me completely hooked and has truly transformed my life. My interest in wildlife began in the late 1970s and it remained a large part of my life until around four years ago when, due to a variety of circumstances I won't bore you with, I suddenly stopped. Now, thanks to *iSpot*, my interest has been revived to the extent that I have now bought myself a new camera and look forward to getting out and about again. ”

“[...] *iSpot* has improved my life greatly, I know that may sound a little over the top to some ... I heard of the site on Radio 4 and then my love for nature and life came back and I am also addicted to the site ...I think there are a lot of people out there who feel the same – it should be prescribed as a form of therapy. It also allows you to see things from all over the country that I myself would never visit and chat to like-minded people. I have also noticed how helpful everyone is and the odd laugh too.”

Bayesian Keys - enabling easier identification

Knowing where to begin when identifying an organism can be difficult for those new to the topic. Often the keys provided in books and guides can be cumbersome. *iSpot* offers novel identification keys that simplify the identification of groups of animals and plants with computer-aided methods. The keys are based on Bayesian probability. This means that the software can determine the probability of a species occurrence, based on the characteristics that the users select (for instance, the number of legs, or the organism's size). Users can select characteristics in any order making them 'multi-access'; unlike dichotomous keys which can only be used in a specific order (imagine a flow diagram, where you have to follow an

established path of characteristics in order). The *iSpot Bayesian Keys* can also take into account the commonness or rarity of species found at the user's location, using live data, where available, from the National Biodiversity Network (NBN).

Comments from users of the keys have demonstrated that they work:

“ The Bayesian [*iSpot*] Key did better than my [traditional] key ... I like the idea of Bayesian Keys which provide another tool for identification. ”

representatives are badged on *iSpot*. A team of *iSpot Biodiversity Mentors* work face-to-face with people all over England, enabling *iSpot* to reach new audiences. The primary role of the *iSpot Biodiversity Mentors* has been to help people on the *iSpot* website make identifications from their photographs; however, some have also spent time within the community, engaging the public in activities such as nature walks, rockpooling, bug hunts, exhibitions, events, training days, surveys and *BioBlitzes*.

The North East regional mentor worked with an organisation called JET (Jobs, Education and Training), leading activities in Newcastle that successfully linked ICT training and public engagement with nature. The participants enjoyed the sessions and following this, three of them started voluntary work with the National Trust, two signed up to work with Groundwork Newcastle and one participant signed up to volunteer with the Northumberland Wildlife Trust. Speaking about the *iSpot* training, one participant commented: "I haven't seen many of the plants before so it was a new experience for me. I enjoyed getting to know the names of all the wildlife. I was very interested in this and want to learn more..."

3.2 Training

Training is an important element of the OPAL programme. It enables people to learn about nature for themselves but importantly, it also allows them to train others in either formal or informal settings. We know that the OPAL regional teams alone have trained over 1,000 people; however, we also know that those people in turn have rolled out training within their communities and with the groups that they work with directly although we cannot quantify the extent of this snowballing effect.

In the Yorkshire and the Humber region, the OPAL regional team has partnered with the Yorkshire



Thanks to the site's ease of use, *iSpot* is used successfully by many people in many contexts, including outreach projects that target people with little or no prior experience of interactive websites, or of wildlife identification. It has also rekindled the enthusiasm of those who, through various circumstances, no longer pursued an active interest in nature. *iSpot* owes its success to the highly interactive and friendly online community that was created during the project. This includes not only the many thousands of registered users, but also the large number of natural history schemes and societies whose





Naturalists' Union (YNU), to increase the capacity of community groups and individuals to carry out the OPAL surveys and to learn to identify wildlife more broadly. The team has trained over 500 people, 36% of whom are classed as hard to reach. Many of the trained group leaders use their skills to train others. Feedback from participants has been excellent. As well as improving people's nature skills informally, the courses have benefited the YNU by increasing their membership by more than 10%.

In the South West, regional researchers investigated methods for teaching and learning about plant identification. In particular, OPAL researchers investigated whether plant identification could be taught in a way that would engage a wide range of people and inspire the next generation's interest in botany.

A variety of groups took part in these plant identification workshops, including adults on unemployment/back-to-work schemes. Participants tried different learning methods with different sets of plants and were asked to recall and write down the names of the plants after each period of learning. Informal teaching methods were used such as word associations and pictorial card games. A more traditional dichotomous key (an identification tool that allows choices to be made using two or more alternative paths) was also tested. The results demonstrated that adults with no prior motivation or interest in plants were capable of learning plant identification from fairly short workshops. The groups really enjoyed the sessions, particularly the less traditional methods. This was true of adults with few or no formal

qualifications and suggests that, if taught in a relaxed way, plant identification can be engaging for all.

In Birmingham, the OPAL West Midlands team ran a highly successful bird ringing programme. Ten of the volunteers gained licences and three of these are now full 'C' licence holders, meaning that they can work independently of their trainer and are able to help to engage other volunteers in this important area of science. Two other participants from the West Midlands advanced their environmental education via Masters programmes. They reported that it was the skills base with which OPAL had equipped them that was a key factor in helping them gain access to financial support for these courses. One of these volunteers is now undertaking a PhD at Oxford University.

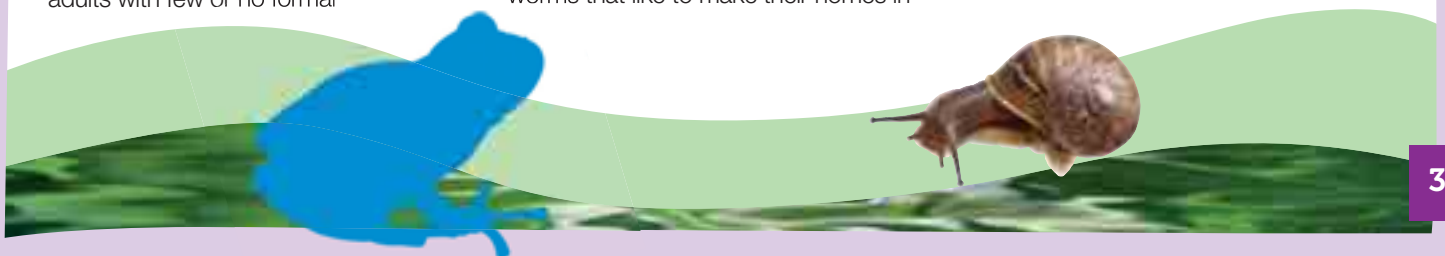
In the East of England, members of community groups were trained to identify and record seven species of moss plus the nine lichens in the OPAL Air Survey to assist with orchard monitoring research. Training in the use of microscopes and keys to identify and recognise mosses and lichens was held in local village and church halls before going outdoors to look in the orchards. OPAL keys to mosses and lichens were developed, with help from members of specialist societies, to be a legacy for use by community groups to monitor their local orchards, especially the new community orchards that are gradually becoming important habitats for biodiversity.

As well as the training delivered by OPAL's regional teams, OPAL survey teams also rolled out survey-specific and more specialist training across England to enable people to learn more about the OPAL survey topics. For example, the OPAL Soil Centre led a number of earthworm identification courses to help people learn how to identify worms. The courses were hosted by the *Master Composters*, people who encourage others in their local community to start composting in their gardens and allotments. The training helped people to identify the worms that like to make their homes in



compost. The coordinator for *Master Composters* wrote to OPAL to express her thanks: "The *Master Composters* who attended the Earthworm Survey sessions all thought it was extremely informative. Many of them will now use their new found knowledge to engage pupils at schools and the general public at roadshows to talk more about the importance of soil health and worms."

The Royal Parks worked in partnership with the Met Office to provide training for volunteers in the use of the newly installed, OPAL-funded weather stations. There are four of these, based in four of The Royal Parks across London. The volunteers learn about the purpose of weather stations, how to use them, how to understand the information they collect and how that information contributes to environmental management. They now collect data regularly for use by ecologists and other scientists to help to understand the relationship between weather and wildlife in urban areas.



3.3

Schools and further education

OPAL has involved every sector of the traditional learning pathway, from nursery and infant schools to primary, secondary, special schools, home learners, sixth form colleges and universities, though it was not designed to meet the requirements of the national curriculum. At every stage, the emphasis is on encouraging people to go outdoors to explore the world around them, providing them with an opportunity to learn in an exciting and hands-on way.

OPAL has worked regularly with nearly 2,000 schools (1,033 secondary, 830 primary) as well as a number of Pupil Referral Units (PRUs) and schools for children with special educational needs (SEN). Of these schools, 13%, including 23% of the primary schools, are in the top 10% most deprived areas in England¹⁸. Over 65% of the national survey data submitted to the OPAL website is from school children.

Whilst the OPAL *Community Scientists* from all regions have worked closely with schools and established good relationships with them, the Field Studies Council (FSC) is the primary deliverer of the OPAL schools programme. The FSC sent survey packs to over 1,800 schools. 768 schools requested and received more than one type of OPAL survey and, of these, over 20% have taken part in all six surveys. To ensure that children with fewest opportunities could explore outdoors, the FSC targeted schools in areas of deprivation. This resulted in 15% of schools with whom they worked, or delivered surveys to, being in the top 10% most deprived areas of England.

The FSC's OPAL Education Officer has delivered nearly 400 outreach sessions directly to schools and other learning groups, from nursery age through to post-16. In OPAL's fourth year of operation alone, it is estimated that these visits reached almost 7,000 students. Such was the success of these visits that the OPAL Education Officer was often invited back to schools at the launch of each new OPAL survey, helping to establish relationships with teachers and pupils and to put together effective lesson plans for the future.



Case study

The OPAL South West team began working with Leigham Primary School in February 2011. Leigham Primary is in a deprived area of Plymouth yet is very close to Forder Valley Local Nature Reserve.

As part of the *Stepping Stones to Nature* project the South West team worked with the entire Year 2, 3 and 4 classes at the school and engaged over 170 children. They carried out the OPAL Water Survey, Soil Survey and Bugs Count as well as doing woodland nature trails at the reserve, which helped them with school topics on 'plants and animals in the environment', 'rocks and soils' and 'water quality'.

Pond dipping was a big favourite amongst the children, with groups consistently finding tadpoles, dragonfly nymphs, cased caddisflies and newts, with help from the OPAL Water Centre team who came to work with Year 3. Children learned how to assess the water quality by looking for signs of pollution, testing the clarity of the water and examining what lives in the pond. Bug hunts were also a big success, with children eager to start exploring their gardens and school playing field for bugs and excited to tell their friends about the new creatures they had just discovered.





Feedback from students after receiving an education visit from the Field Studies Council:

“I didn’t realise there were so many ladybirds – I only thought there were two or three.”

Student from John Masefield High School, Herefordshire

“I liked going down to the pond because I learnt something new.”

Student from St Gabriel’s RC High, Bury, Manchester

“I enjoyed it because it was so much fun but you still learn things you never knew before.”

Student, Market Drayton Junior School, Shropshire

Excellent feedback on these sessions was received from both teachers and students.

Uptake of science subjects

Through the FSC’s schools outreach programme and the work of the regional *Community Scientists*, OPAL has helped to increase uptake of science subjects in schools.

Blessed Edward Oldcorne RC Comprehensive School in Worcester has found OPAL to be immensely beneficial to them. One teacher explained these benefits in a filmed interview: “I was awarded ‘Most dedicated teacher’ [nationwide] for STEM (Science Technology, Engineering, Mathematics) last year and part of the reason for that is that I’ve brought OPAL in and we’ve used OPAL in many different activities ... we [also] have a really high take-up of AS-Level Biology and Chemistry.....well above the national average.”

The school also reported that when asked by National Strategies, part of

the Department for Education, how they achieved such a high uptake in biology, they said: “...we show them [children] real biology outside, it’s not textbook, it’s not PowerPoint, it’s the real world.”

The OPAL North East team enabled over 150 pupils from across Newcastle City to participate in *Plant Masterclasses* at Moorbank Botanic Garden. The OPAL North East team designed classes in collaboration with local teachers, providing a range of hands-on science-based activities to learn how plants can adapt to different environments. One popular activity included a Forensic Botany workshop whereby children and adults learned how plants could be used to solve a murder using taxonomic approaches. Through these enrichment activities, OPAL North East has significantly enhanced the school curriculum. St Cuthbert’s Catholic High School in Newcastle reported that all 43 students that took part in *Plant Masterclasses* with the OPAL team are now to take biology as a discrete GCSE. A teacher at St. Cuthbert’s commented: “students particularly enjoyed the freedom they had to explore their own

research ideas and the access that they had to experts.”

OPAL played an important role in helping the region achieve 15% extra take-up in triple Science GCSEs from 2009-2011 and in contributing to improved results at Key Stage 4, with 26.5% more students achieving two A*-C passes.

The OPAL East Midlands team at the University of Nottingham also found that OPAL changes young people’s perspective on studying science subjects. One A-level student wrote to the East Midlands team to say: “I wasn’t sure about what subject to take at University but now I really want to do Environmental Science.”



Fresh approaches to teaching

Engaging with OPAL has had a significant lasting impact for many schools, with some embedding outdoor work into their lessons. In a filmed interview, a teacher from a school in Rusholme, Manchester commented: "We've rewritten all our schemes of work so that units in Year 7 and Year 8 are now going to be based almost exclusively outside for the environmental work that we're going to do."

Another teacher from the same school said: "You've left so many resources in our school, like magnifying glasses, all the surveys and fantastic posters, things that we would not normally have access to."

A teacher from Feversham College in Bradford told the FSC in an interview that since participating in OPAL, they will run more outdoor activities for students, particularly in years 8 and 9. The teacher noted that it was not just the science education that has improved since OPAL: "...[Students have] learnt a lot about each other and how to work within groups as the surveys provide them a different way of interacting with each other, which they wouldn't normally get."



"Taking students out on field trips is one of the most important parts of studying science and opportunities to do this are becoming rarer. Studying a different habitat somewhere other than the classroom has opened the students' eyes to where science can take them. The [OPAL] project at Sherwood Pines has helped the students to understand project work in science, environmental work, adaptation and habitats, as well as being able to use new technology and equipment, which schools just don't have the money for. The students even had an exam question about quadrats in their GCSE exam at the end of year 11 and all of them came out of the exam saying that they could answer the question because of using quadrats [with OPAL staff] at Sherwood Pines!"

Science Teacher at Hadden Park School, commenting on the outreach provided by the OPAL East Midlands team.



In the West Midlands, the OPAL regional team held classes based around the topic of bees. At William Shrewsbury Primary school in Burton-on-Trent, children learned about the life-cycles of bees and their importance for pollination, as well as having the opportunity to make 'bee hotels' to put up in the school grounds.

The pupils also made their own wildlife documentaries following talks from OPAL staff about 'our world in motion' showing how everything changes over time. One teacher at the school said: "OPAL has brought a dynamic and interactive way of thinking to our school science. It has made the science more hands on for the children and they have, as a consequence of this, been far more enthusiastic in their science lessons. The fresh ideas and methods of delivery have brought different areas of the subject alive. For example, the children now fully understand, and can see, food chains/webs as a direct result of intervention and support by OPAL. Many thanks."

Evaluating environmental education in Yorkshire and the Humber

One OPAL research project looks at evaluation within environmental education. Many practitioners of environmental education believe that it improves attitudes and behaviour towards the environment and millions of pounds are spent on funding environmental education projects; however, evaluation of the success of these projects is often not thoroughly carried out. The research has used an 'action research' approach, where the researcher and environmental education practitioners are seen as equal partners, working together to compile existing tools and to develop new ones for evaluating environmental education projects.

The research found that environmental educators believe that their work can achieve a wide range of outcomes, from improved personal health and well-being to community cohesion. It also found that evaluation of projects occurs much more frequently than reported in the literature but that regular evaluation tends to be fairly simplistic and focuses mainly on whether people enjoyed themselves or not. Changes in attitude and behaviour towards the environment are hard to evaluate and, as such, these more detailed evaluations rarely take place.





“Having done the survey myself I feel more able to advise the students and help them identify different plants etc.”

“The session was perfect. I feel more confident that I can identify organisms with the use of the charts.”

“Everything worked well; it was really good fun too. I am happy to have a go now.”

Comments from teachers attending OPAL twilight training sessions.

Facilitating experts to work with students has been shown to be a very effective method of getting them excited about nature. However, it is not possible to work directly with every pupil. The FSC developed an effective method of delivering training to teachers instead. These ‘teacher twilight’ sessions, so-called as most were held after the school day had finished, meant that teachers were equipped with the knowledge and skills to be able to carry out the OPAL surveys on their own with their students. Five hundred teachers and outdoor educators were trained in this way, and twilight sessions in particular received some very positive feedback. Giving teachers confidence in biodiversity identification enabled OPAL surveys to reach more students than the OPAL team could through direct contact.

In interviews with primary school teachers about the OPAL Surveys, they noted the usefulness of having a survey pack with all the necessary information contained within it. “They were brilliant” said one teacher. Two others mentioned that it was great to have something they could “pick up and run

with” on the day, with little preparation. A science-trained teacher said she felt it would be good for non-science staff to use an OPAL survey and another teacher said that having a prepared and tested outdoor science activity “takes the fear factor out” of leading it. Several teachers expressed the view that it was a good activity with which to introduce a new topic.

In Norfolk, a teacher at Brisley CE VA Primary School told the *East of England Community Scientist*: “We have used two of the OPAL kits in our school as part of our woodland activities and doubt that we would have undertaken such research without this support. The children of all ages have been absolutely fascinated and thoroughly enjoyed researching our various hedges and bugs. [...] As I am not an expert in these areas myself, having access to such user-friendly material makes it possible for both staff and children to work together to make the most of our marvellous outdoor facilities both at school and from home. This means that children also get their families involved at home, which we feel is also key to encouraging our pupils’ thirst for learning beyond the classroom.”





Creating a legacy for environmental education in the East Midlands

Creating a legacy for schools and other educators to continue environmental learning programmes is important. The OPAL East Midlands team created a new environmental educators' network for the region, allowing people working in environmental education to come together for seminars and conferences, thus facilitating networking and training. At a conference held in early 2012, which over 100 people attended, over 90% of people indicated that they had learnt something new that they could use in their future work and 89% agreed that they had made some useful new contacts. Feedback from the day includes:

“...inspirational. One of the best events I have attended.”

“I've gained a better understanding of a wider range of environmental education.”

The East Midlands team put together a number of school resource packs that focus on heathlands, a topic that is under-resourced in schools and the main topic of the OPAL East Midlands regional research programme. They created resources for both GCSE and A level students that can be downloaded free of charge from the OPAL website.



Pupil Referral Units and Special Educational Needs

As well as mainstream schools, OPAL has worked with other non-mainstream but structured educational facilities, most notably Pupil Referral Units (PRUs) and schools for children and young adults with special education needs (SEN). On many occasions, staff praised the OPAL surveys for being easy to use with their groups. For some groups, particularly those who are severely physically or mentally disadvantaged, OPAL activities have been adapted by OPAL staff and carers to suit the group.

A tutor for PRU students who has worked closely with the FSC, said: “Our task is to support the most challenged and challenging of young people and often the most disadvantaged and marginalised. The OPAL packs are so helpful for providing stand alone, engaging, real science opportunities which interest, challenge and motivate pupils who have disrupting patterns of behaviour.”

When discussing the OPAL Surveys, one teacher from a school of very mixed cultural backgrounds and abilities stated: “...they are not likely to work it out on their own – they need something visual.... Some children [with special educational needs] and very quiet children, those with difficulty writing – this is good because no writing is required. For those with English as an additional language, they can still get involved through collecting, identifying - [they can] have an input.”

Case study

OPAL staff have worked with a specialist education centre based near Shrewsbury, catering for pupils aged 12-16 years old. Pupils who attend this centre have a range of social, behavioural and learning disabilities including autism, ADHD and phobias.

Taking part in various OPAL surveys inspired the staff to include more opportunities for outdoor learning and develop a wildlife garden at the centre. The garden includes log piles, a small pond and a variety of plants to attract wildlife.

“I enjoy working outside – it's better than being stuck in the classroom.”

“Students have started to create a garden and wildlife area in the school grounds and I feel this is a direct result of participation with OPAL.”

The OPAL Yorkshire and Humber team carried out a seven week course with teenagers who had been permanently excluded from mainstream education. This was challenging at first but over the course the team developed activities to suit the individuals, such as nature walks, magnifying minibeasts, pond dipping, and small mammal trapping. The York team found that the young people were reluctant to talk about their experiences but were willing to communicate their thoughts and feelings through other means and so they were encouraged to take photographs and build a scrapbook.



“ The lads were really interested in finding the bugs. Some of the group have a natural enthusiasm for peering under logs and looking under stones! They are such practical lads, difficult to manage at school and quite seriously disaffected in many ways. To stimulate them at all takes a lot of effort, so I was impressed at how well some of them responded to your OPAL Project resources and how they took part in the survey work. ”

Teacher, Pupil Referral Unit, Shropshire

In London, OPAL partnered with the National Children's Bureau (NCB) to raise interest in the environment in pupils in PRUs in the London Borough of Waltham Forest. One of the PRUs had a visit from the OPAL *Weather Roadshow* where some pupils demonstrated real enthusiasm for the topics discussed and asked the *Community Scientist* how he had become a scientist and what subjects they needed to take to become one. Such was their enthusiasm that three pupils stayed behind after school hours to show local councillors from the Borough around the Roadshow, demonstrating how much they had learnt.

The Royal Parks team has worked in partnership with the Holly Lodge Centre to engage young SEN pupils, some of whom are severely impaired, in each of the six OPAL surveys. The team used the basis of the OPAL surveys to encourage interest in the environment and involvement with the activities. The sessions proved enormously beneficial to the young people participating.



Further and higher education

OPAL funded 10 post-graduate PhD students. These students were important to the programme in providing the academic staff with research support but also exposed them to the role of public engagement in their studies. Many have made a significant contribution to their team not just through their research but from their work in the community and their willingness to share their career development with others through blogs, attending events, making videos and generally offering extensive support to the *Community Scientists* in their work with local people. Many have developed strong relationships with local communities and others have completed their PhD and taken jobs that involve working with the public.



OPAL's universities

10 of the 15 organisations within the OPAL partnership are universities. OPAL's educational programme has been integrated into a number of courses.

- OPAL resources have been used for the Urban Ecology undergraduate courses at the University of Birmingham;
- The OPAL Soil Centre, based at Imperial College London, introduces students on the MSc Environmental Technology course to the OPAL Soil and Earthworm survey as part of their research. The course syllabus also includes lectures on citizen science and environmental data, taking inspiration and examples from OPAL;
- OPAL Air Surveys are used in MSc projects at Imperial College London's Silwood Park campus;
- The University of Hertfordshire uses OPAL surveys as part of a number of modules in the Geography and Environmental Management degrees, as well as incorporating surveys in research projects;
- At University College London (UCL), the OPAL Water Survey is used as part of first year undergraduate fieldwork as a measure of water quality assessment and as part of a post-graduate aquatic science course;
- MSc students based at the University of York use OPAL surveys for their projects and also as part of undergraduate teaching.



3.4 Other educational approaches

OPAL worked with a number of external partners to develop and promote OPAL educational materials.

British Science Association – CREST Programme

In Autumn 2010, through collaboration with OPAL, a new set of activities was sent to 785 schools and clubs that are part of the CREST Star Investigators scheme, run by the British Science Association. The scheme is for primary children aged 7 to 11. The activities are nature-based and encourage young people to think about their environment. The British Science Association welcomed working with OPAL scientists as previously CREST Star did not have any environmental activities in their programme.

As well as the CREST Star scheme, OPAL surveys were used as part of studies for bronze and silver CREST awards for secondary age children. Gaining a CREST award is seen as a real achievement. To gain their award,

Year 10/11 students from Nottingham High School for Girls designed independent projects to explore the effect of air pollution on lichens. Using the OPAL Air Survey field guide, they recorded the distribution and abundance of key lichens on Oak, Ash and Sycamore trees, and compared the results across different sites. Amongst other things, they discovered a gradual change of lichen distribution from Nottingham city centre into rural areas.

A school in North London used the OPAL Air Survey towards their CREST award. They applied to OPAL for an air and lichen expert to work with them through The Royal Society school grants scheme. The Natural History Museum and British Lichen Society were able to help and the school was invited to exhibit their work at the prestigious *Royal Society Summer Science Exhibition* in 2012, a tremendous success.

Working with youth organisations

Over 40 cubs, scouts, guides and brownie troops have used OPAL Surveys and contributed data. Such was the interest in climate and weather that OPAL sponsored the relaunch of the Scout Association's Weather badge. Through a visit by the *Weather Roadshow* to a Cub Scout camp, OPAL helped over 150 young people successfully complete their Weather badge.

Students from Nottingham High School for Girls carrying out the OPAL Air Survey to gain their silver Crest Award



The Natural History Museum worked in partnership with The Wildlife Trusts and the National Trust to create a new resource pack to support the Cub Scouts' Naturalist badge. The badge can be achieved by completing selected OPAL Surveys.

In 2011, Catch 22, a support organisation for young people, invited OPAL to be part of the government initiative pilot scheme, *National Citizen Service*. This enabled OPAL to involve post-GCSE age children with nature, a typically difficult age group to engage. OPAL staff visited six separate youth groups to carry out various OPAL surveys such as the Climate Survey and the Water Survey.

National Geographic Kids magazine

National Geographic (NG) Kids, a nature and wildlife magazine for children, has promoted every one of the OPAL surveys by including a feature in their magazine plus downloadable activity sheets. Alongside the promotion, *NG Kids* ran a competition for young people. The prizes provided by OPAL included £1,000 to improve the winners' school grounds or local green space plus a class trip to the Natural History Museum. Prize winners were:



The winning class from Woodhall Primary School receive their cheque at the Natural History Museum

- St Osmund's Primary School, Salisbury
- Osbaston Primary School, Monmouth
- Little Ridge Community Primary School, East Sussex
- Woodhall Community Primary School, Suffolk
- Baldwin's Gate Church of England Primary School, Newcastle
- Westley Middle School, Suffolk

Here a teacher from Woodhall Community Primary School tells us how his school has used the prize money: "The money was spent in various ways: bird feeders and binoculars, two benches for our pond area, four large microscopes and a set of 16 mini microscopes, a book of wildlife poems, a strimmer for the pond area, and an ant farm. We wanted the children to be able to enjoy our grounds so the benches have allowed us to sit and work in the pond area. The microscopes have been a fantastic resource when pond dipping and looking at plants and insects. The feeders, binoculars and poetry book allow us to think about the outside while being stuck in the classroom over the winter. The ant farm has allowed the children to think about how animals live their lives."

OPAL's informal accessible outdoor learning programme has introduced many new audiences to nature.



4. Research

OPAL key objective

A much greater understanding of the state of the natural environment.

Through the OPAL programme we have gathered a wealth of valuable data from all parts of the UK and from all sectors of society. Collectively this information is important to our understanding and management of the natural environment. *Community Scientists* carried out their work in some of the most deprived parts of England.



Grey Worm (*Aporrectodea caliginosa*)
Photograph: Natural History Museum

Over the past 50 years humans have changed natural habitats and the wildlife they support more rapidly and extensively than in any period in human history¹⁹. The result has been a substantial and largely irreversible loss in the diversity of life on Earth and general degradation of the quality of soil, air and water.

Scientists leading the OPAL programme continue with their research interests, environmental challenges, but whilst also providing an opportunity for the public to participate in and learn about research and its value to society. OPAL scientists through community engagement have had the opportunity to learn more about local places, gain new insights into local issues by tapping into local knowledge and expertise and to discuss their work with people of all ages, abilities and backgrounds. The experience has proved to be a very positive one for many of the scientists and communities involved.



Photograph: Natural History Museum 2011

There are three broad levels of community participation in OPAL's research programme:

- **National surveys** provide opportunities for the public to carry out their own investigation of their local environment and, if they so wish, share their results with the broader community by submitting data to the OPAL national database. Field guides, workbooks, materials, training and other support are freely available to everyone, either from OPAL *Community Scientists* or from the website.
- **National research centres** carry out research into air and water quality and soil condition, in which there are varying levels of public participation.
- **Regional research programmes** offer local people opportunities to participate and/or learn about research carried out in their locality and of importance to the region.

“ Just thought I'd let you know that the Friends of Sandall Park did a water survey, courtesy of OPAL, last week and came up with tremendous results. We have a very healthy bog pond and garden with masses of different bugs and water life. We reached a high score in the 'healthy pond' category. All the participants and bystanders found it very interesting and educational and it was well worth the effort. We will be doing the survey again in our larger lake sometime in the near future. ”

The research topics for the national ecological surveys were agreed at the start of the programme. The survey topics are soil, air, water, biodiversity (two surveys) and climate. A survey was produced and launched every six months, starting in the spring of 2009. Each survey takes about 30-60 minutes to complete and follows a similar format but uses a different methodology. To date, over 230,000 OPAL survey packs have been distributed and used by schools and community groups, with many more downloaded from the OPAL website. The surveys alone have contributed scientific data on almost 25,000 sites across England.



4.1 Soil

The OPAL Soil and Earthworm Survey

The OPAL Soil and Earthworm Survey, led by Imperial College London, is the largest public participation survey of soils and earthworms ever undertaken in England. Since the launch of the Soil and Earthworm Survey in March 2009, results from over 4,200 surveys have been received. Of these, 63% of surveys were returned by school groups. The most surveyed habitat type was domestic gardens, which represent one quarter of surveys, followed by playing fields at 22% (reflecting the high level of input from schools).

The Soil and Earthworm Survey involved:

- digging a soil pit (20 cm x 20 cm x 10 cm depth);
- recording soil characteristics: amount of roots and objects in the soil, soil hardness, soil moisture, soil pH, soil texture, soil smell, soil colour and soil fizz (to indicate presence of carbonates, which can affect soil productivity by influencing soil pH and water flow);
- counting all earthworms in the pit and identifying the adult earthworms using OPAL's *Key to Common British Earthworms*.



Earthworms were found in 76% of surveys, with more than 17,000 earthworms reported in total so far. Over one third of these were adult earthworms, and participants identified them to species level. The rest were juvenile earthworms, which were not identifiable because they have not yet developed the anatomical features that distinguish one species from another. The highest number of earthworms (adults plus juveniles) recorded in a single survey was 88 individuals, the highest number of identified earthworms was 24, and the highest number of different species recorded in one survey was 10. This is very high compared to other studies of British soils, and the result suggests there are some habitats with a much higher number and species richness of earthworms than we would normally expect. The most commonly reported earthworm was the Redhead Worm (*Lumbricus rubellus*) (Figure 6).

The survey results reveal that domestic gardens are hotspots for earthworms, with higher numbers (average of 7.3 earthworms per survey) compared with other habitat types. Gardens also had the highest average number of species. The average numbers of both earthworms and species in rural gardens were higher than in urban gardens. However, urban gardens have the highest abundance and highest number of different species compared with other urban habitats. A garden, due to numerous factors such as its environment, history, the activities of gardeners and plant production, often has a wide variety of microhabitats in which many different species of earthworms can co-exist. Earthworm species have different habitat preferences and will be attracted to different microhabitats therefore grass lawns, flower beds, compost heaps, and rockeries may each attract different species. Earthworms are an important part of the garden ecosystem, with benefits including improvement of soil structure (aeration and drainage) and fertility. A large number of earthworms is one sign of healthy soil. This suggests

that gardeners do a good job of maintaining or improving the soil they are looking after, attracting greater numbers of earthworms, which in turn help to improve the soil even further: a great partnership between gardeners and earthworms.

On average, surveys in urban woodlands showed higher numbers of earthworms and greater diversity of species compared with rural woodlands. This may be because urban woodlands have higher soil pH compared with rural woodlands.

The OPAL results show that the three most common species likely to be found in grasslands are the Green Worm (*Alolobophora chlorotica*), the Grey Worm (*Aporrectodea caliginosa*), and the Rosy-tipped Worm (*Aporrectodea rosea*). By contrast, the Octagonal-tailed Worm (*Dendrobaena octaedra*) is found in woodlands but is rare in grasslands. The Redhead Worm (*Lumbricus rubellus*) is probably the most widely distributed earthworm, found in most habitats.

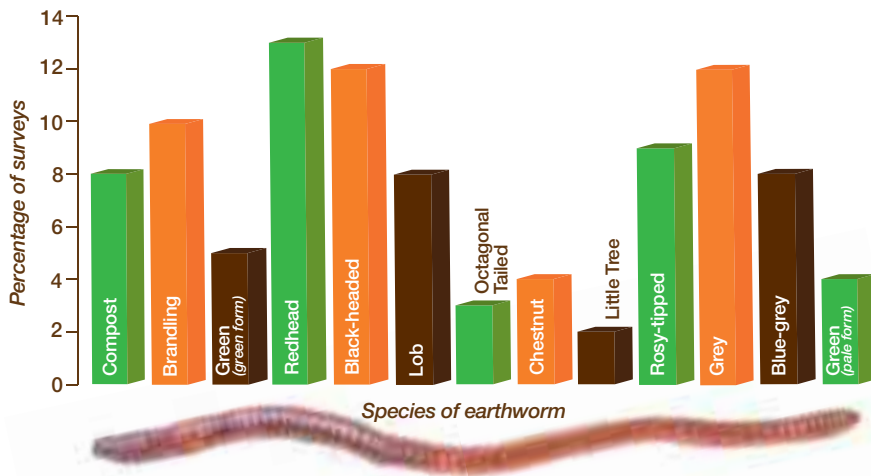


Figure 6. Graph showing the earthworm species found in OPAL Soil and Earthworm Surveys. The Redhead worm was most commonly found, closely followed by the Black-headed Worm and the Grey Worm.



The topsoil pH reported by OPAL participants identified the same broad-scale patterns as found by scientists in earlier surveys. The pH of the soil i.e. how acid (0-6 pH) or alkaline (8-14 pH) is one of its most important properties. It influences plant growth and affects what happens to different types of pollutants when they enter the soil. Soil acidity has important impacts on soil biodiversity, including the earthworms and microbes that live in the soil. The pH of the topsoil reported by survey participants indicated that soils in England can be mainly classified as moderately or slightly acid (pH 4.6 – 6.5) (Figure 7).

Soil pH is determined partly by accumulated decaying vegetation, partly from broken up fragments of the underlying rocks, and also by the water that fills the spaces between soil particles. The differences in soil pH

identified from the survey reflect the differences in underlying rock types and vegetation across the country; for example, soils derived from limestone may have very high (alkaline) pH values. Furthermore, soils in upland areas tend to be more acid than soils in low-lying areas.

Survey returns showed that the most common soil textures reported were silty loam and silty clay loam. Similarly in gardens, the most common soil texture was silty clay loam. Soils of these types contain a broad range of particle sizes with a mixture of clay, silt and sand, which feels quite smooth or floury when rubbed between the thumb and fingers. Gardeners and farmers like these types of soil because they are good for growing seeds and plants. These soils are easier to dig and plough and do not have the extreme characteristics and

behaviour of pure clay (solid and mouldable) or sandy soil (crumbly).

The OPAL Soil and Earthworm Survey and further research by the Soil Centre have provided a unique look at the soils and earthworms of England²⁰. They have encouraged thousands of people to go out into their local environment and learn about soils and the earthworms living in them. The data submitted by members of the public have identified large areas of England as being of interest for more detailed investigation, and have allowed scientists to study the interaction between earthworms, soil properties and pollution. The good news is that because of the varied soils and microhabitats that they contain, gardens have been discovered to be great homes for earthworms.

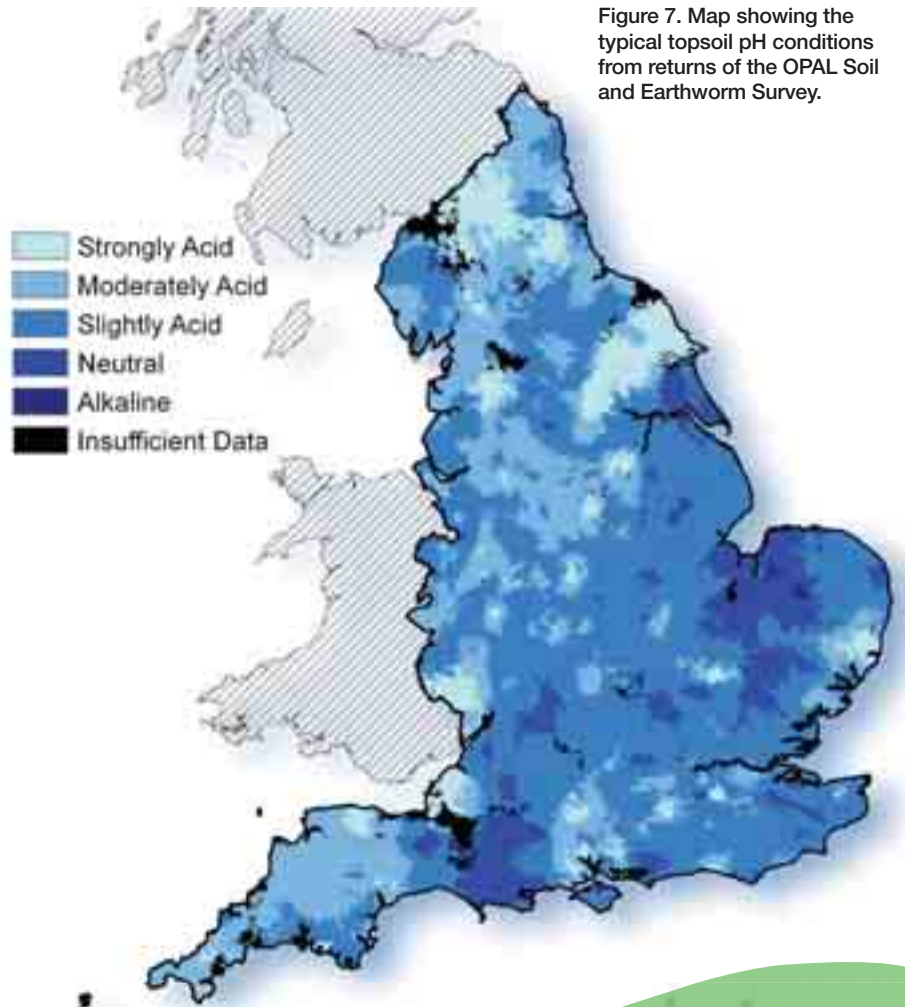


Figure 7. Map showing the typical topsoil pH conditions from returns of the OPAL Soil and Earthworm Survey.

Citizen science in soil protection policy

The OPAL Soil Centre PhD researcher undertook an investigation into the role of citizen science in soil protection. The research examined the requirements for management of soil quality set by the UK and European Union, investigating problems of degradation and the methodology for soil quality assessment. OPAL Soil and Earthworm Survey data collected by the public showed that some areas of England have different numbers of earthworms than others. This finding directed fieldwork to compare different areas of the country that appear to have higher or lower populations of earthworms in order to understand what might be causing these patterns.

This study involved working with farmers, land owners and managers to collect more detailed information on earthworm species, soil properties and pollutants on their land. The research, funded by the Engineering and Physical Sciences Research Council, involved collecting earthworms, recording soil properties and taking soil samples from these areas, which were subsequently analysed for a number of types of pollutants: metals, polyaromatic hydrocarbons (formed during the burning of fuel and other organic substances) and pesticides.

The results from this work provided an insight into the factors influencing earthworm populations and how pollutants move through the environment. Overall, the levels of pollution detected in soil samples were low. Analysis showed that soil pH has a stronger influence on earthworm numbers than any single pollutant that was measured. It also found that woodland soils appear to trap a number of pollutants from aerial sources and may be important in reducing human exposure to these harmful chemicals. This work has generated a large amount of new information about soil properties and earthworm populations in the areas studied. The research illustrates the complexity of soil ecosystems and the importance of continued research into soil biodiversity. It emphasises that public participation in soil protection should be included in future policies for environmental protection.



OPAL Soil Centre research programme

The research undertaken by the OPAL Soil Centre involved two PhD students and 16 MSc projects, on topics ranging from soil pollution and earthworm ecology to public understanding of environmental issues. The Centre carried out research into pollutants, their pathways (how they get into and move through the soil), and the way that they affect soil and ecosystems. All of the topics covered in the research had close links with soil policy in the UK and negotiations on soil protection policy in the European Union in order to understand how best to protect and improve this important part of the environment.

The Soil Centre is also investigating the environmental impact of spreading waste material, such as municipal compost and by-products from paper recycling onto agricultural land. Whilst finding potential uses for waste and by-products has significant environmental benefits, some concerns have been expressed in the past over this practice potentially releasing pollutants. A further detailed investigation is currently under way into the influence of different types of waste on soil properties, pollutants and earthworms. This research will improve our knowledge of soil and waste management practices, and help to guide policies controlling them.

4.2 Air

The OPAL Air Survey

The OPAL Air Survey, led by Imperial College London in association with the British Lichen Society, provided people with an opportunity to investigate the impact of air pollution on lichens in their local area.

Poor air quality can have a negative effect both on our health and on the condition of the natural environment. Human activities have increased the amount of pollutants in the atmosphere and in recent decades certain pollutants containing nitrogen have increased, mainly as a result of agricultural activities, such as the manufacture and use of nitrogen-rich fertilisers, and as a consequence of burning fossil fuels for vehicles and heating. Whilst nitrogen is essential for plant growth, large amounts of some forms can be harmful.

Directly monitoring air pollution is expensive and requires specialist knowledge and often costly equipment. The OPAL Air Survey therefore focused on organisms such as lichens that respond to local air pollution and can provide us with some indication of changing atmospheric conditions. Using lichens to alert us to important changes in our local environment is known as biomonitoring.

The OPAL Air Survey had two activities to enable people to learn more about local air pollution and its impact on fungi. The first activity asked people to look for lichens on trees.



Participants collected information about:

- the species of tree and the girth of the trunk at a height of 1 metre above ground;
- the presence and abundance of nine indicator lichens on tree trunks (three nitrogen-tolerant lichens, three nitrogen-sensitive lichens and three intermediate or neutral lichens);
- the presence of green and orange coloured algae;
- the presence of the nine indicator lichens on tree twigs;
- the insects present on the tree trunk.

Lichens as biomonitors

Lichens are found everywhere, from the steppes of Siberia to the Namibian desert, but very often we do not even notice them. They grow on trees, rocks and buildings, and even some in places where other organisms cannot survive. Structurally, they are in fact two organisms: a partnership between a fungus, which gives the lichen its shape, and one or more algae, which produce food and energy by the process of photosynthesis (the same process by which plants gain energy from sunlight). Lichens are classified as fungi. They are fascinating and unique organisms and they are also extremely useful to humans, helping us to understand air pollution. Some lichens are incredibly sensitive to pollutants of one kind or another, and some are very tolerant of those pollutants; this means that depending on which lichen you identify it can tell you about the likely pollutants in the atmosphere around you. The effects of air pollution on lichens have been recognised since the 1800s and lichens have been used extensively as biomonitors of pollution since that time. Though the nature of air pollution has changed over time, lichens are still one of the most widely used biomonitoring systems today. The OPAL Air Survey focused on lichens that grow on trees.



The second activity asked participants to look for and record the presence of tar spots on Sycamore trees (*Acer pseudoplatanus*). Tar spots are caused by a fungus called *Rhytisma acerinum*, which is widely distributed across England. Fungal spores (reproductive cells) spend the winter in leaf litter and infect the trees' new leaves in the spring. After infection, the disease causes large black spots to appear on the leaves in July and August. Previous studies have shown that *Rhytisma* infection may be suppressed by some air pollutants and, therefore, could be a useful biomonitor.

Participants collected information about:

- the girth of the tree trunk at a height of 1 metre above ground;
- the quantity of fallen leaves under the tree;
- the number of tar spots on 10 randomly chosen leaves;
- the width of each leaf.

By summer 2012, over 3,700 lichen surveys had been submitted to the OPAL website, with data from over 14,000 trees. Analysis of data on Oak trees showed that as nitrogen pollution in the atmosphere increases, the number of different types of lichens decreases but the abundance of the OPAL-selected nitrogen-tolerant lichens increases. This supports findings from several academic papers and suggests that lichen diversity is at risk from the high levels of nitrogen pollution currently present in the air, affecting sensitive lichens.

The OPAL Air Survey confirmed that the diversity and abundance of the nitrogen-sensitive lichens are lowest where concentrations of ammonia are predicted to be at their highest. Levels of ammonia have greatly increased due to modern farming techniques over the last century so this and results from other research carried out by the scientific community add more weight to the evidence that increasing levels of this pollutant can cause changes in our environment.

Historically, acidic pollution was a major problem for our health. In areas where such pollution reached high concentrations, very few lichens were able to colonise and survive, leading to 'urban deserts' where just a handful of lichen species could grow on trees. Over recent decades this acidic pollution has been reduced and air quality has changed. We expected lichens to return to our cities and the OPAL Air Survey has confirmed this to be the case, with nitrophytes (nitrogen-tolerant species) most frequent and abundant. Interestingly, nitrophytes were also recorded just as frequently in rural areas, suggesting that different forms of nitrogen pollution are affecting their distribution.

Results from the OPAL Air Survey also show that lichens are sensitive to climate. The distribution of British lichen diversity in the OPAL survey results reflects the different temperature and rainfall requirements of the species surveyed. These findings support published data, indicating that if climate change predictions of increasing temperatures and changing patterns of rainfall occur, lichen communities could be more at risk in the future.

The number of invertebrates on surveyed trees was mainly affected by



Sycamore leaf displaying the characteristic black spots of *Rhytisma acerinum*

rainfall and land use. The variety of invertebrates recorded during the study was lower in areas where nitrogen deposition was high, suggesting that air pollution concentrations could have indirect effects on invertebrate as well as lichen communities.

When examining the effect of nitrogen pollution on the fungus *Rhytisma acerinum*, the main factors associated with its distribution were the amount of nitrogen deposited in rainwater (as opposed to levels in the air) and the presence of leaf litter surrounding the trees. The latter is to be expected as leaf litter harbours the fungus over winter and, therefore, contributes a source of fungus to infect new leaves in the following year. This finding provides wide-scale support for previously published data.



The OPAL Air Centre research programme

The research team at the OPAL Air Centre at Imperial College's Silwood Park Campus in Berkshire investigated the effects of the air pollutant ozone on vegetation, using semi-open top fumigation chambers. These allowed measured levels of ozone to be applied to plants in a controlled manner. Investigations were carried out on a variety of typical acid grassland plant species, including clover, plantain and several grasses. Results show that ozone has a highly significant effect on the performance of most of the plant species involved, but that grasses were generally less sensitive to ozone than herbs (including legumes, a family of important nitrogen-fixing plants that contains peas, beans, soy and lentils). This means that the nature of the plant community changes dramatically under moderate ozone exposures, becoming more grass-dominated and less diverse.

Drought reduced the growth of all species but also caused plants to close their stomata (tiny pores through which carbon dioxide and ozone gain entry to the leaf), reducing the amount of damaging ozone that enters their leaves. Drought and ozone in combination resulted in greatly reduced plant growth; the magnitude of growth reductions varied between species, resulting in large changes to the plant community. Research carried out at the OPAL Air Centre has provided important new insights into the likely impact of ozone on the diversity, performance and composition of grassland ecosystems under changing climatic conditions.

Other studies carried out at the OPAL Air Centre include one investigating effects of ozone on three different lichens (*Flavoparmelia caperata*, *Parmotrema perlatum* and *Xanthoria parietina*). The results show that all three lichens tolerate ozone well but to differing degrees, and this tolerance is attributed to a pool of compounds (chemicals) necessary for the frequent dehydration-rehydration cycles (wetting and drying under different weather conditions) to which they are naturally subjected.

Another research project on spinach and onions shows how vegetation can be affected by ozone, with both showing visible damage on their leaves and reduced plant performance, even over relatively short exposure periods. Visitors to the centre learnt about research techniques and met OPAL scientists.



Plant subjected to various atmospheric conditions as part of research by the OPAL Air Centre



OPAL South East regional project: Roadside air pollution

The South East region has the highest rate of vehicle flow in the UK with an average of 5,000 vehicles per day, compared with the national average of 3,500 per day²¹. These vehicles emit pollutants, including nitrogen dioxide (NO₂). The potential for impacts of air quality on suburban greenspaces and their associated plants, insects, mammals and birds is an issue of widespread concern, and the subject of the OPAL South East project.

Local communities, concerned about the potential effects of pollution on the local environment, were involved in taking measurements of NO₂ concentrations at sites that included parks, recreation grounds, nature reserves, Sites of Special Scientific Interest (SSSI), school fields, allotments and gardens.

Their data demonstrated that pollutants within 100m of roads were frequently at

(or close to) levels that might be expected to have detrimental effects on nearby plants and ecosystems. Sites further away from roads generally had lower concentrations. In more densely populated urban environments (e.g. London), the highest levels of NO₂ were recorded alongside major roads, although even quiet residential roads had levels which are comparable to busy roads in less built-up locations.

In collaboration with the Brighton and Hove *Walk to School* group and physicists from Imperial College London, the South East regional team also helped two schools in Brighton to monitor local levels of air pollution and to explore the link between pollution and environmental health. Children measured the levels of airborne pollutants at different times of the day at various locations around the school, including the playground. Results were displayed on plasma screens inside the schools, helping pupils to learn about how pollution levels fluctuate throughout the day and how they might be affected by factors such as weather and the number of passing cars.



An air pollution monitoring kit used for research carried out by OPAL South East



The effect of air pollution and climate change on grassland ecosystems

The OPAL South East PhD research student took a closer look at the effects of traffic-derived air pollution on grassland ecosystems as their PhD topic. This involved detailed studies of air pollutant concentrations at three calcareous (chalk) grassland sites of high nature conservation importance, located alongside roads. Environmental conditions (including for example soil pH, nutrient availability and heavy metal concentrations) were measured at varying distances from the roadside and found to be related to patterns in plant community composition. There was evidence of increased soil moisture, pH and heavy metal concentrations in roadside soils. Increases in the abundance of pollution-tolerant plant species (mostly grasses) at roadsides were associated with vehicle exhaust emissions.

Using these results, a broader study of the effects of roads on plant composition at eight sites containing chalk grassland habitat was then carried out, demonstrating consistent evidence of detrimental effects of roads on adjacent habitats. This research highlighted the potential role of management techniques (e.g. physical barriers/buffer zones) to reduce the effects of roads on nearby chalk grassland ecosystems.



4.3 Water

The OPAL Water Survey

The OPAL Water Survey, led by University College London, was launched in May 2010 and provided people with an opportunity to monitor water quality in their local environment. Water is easily affected by pollution from agriculture and industry, waste we throw away, and air pollution. However, good water quality is essential for the many animals and plants that live in and around our lakes, ponds and rivers.

The survey included four activities:

- a measurement of water clarity using the *OPALometer*, a device created especially for the survey and related to the level of suspended material (e.g. algae) that can make the water look murky;
- a measurement of the pH of the water using a dip-strip;
- an assessment of the water quality based on the presence or absence of aquatic invertebrate groups using a scoring system²²;
- The presence of species of amphibians, dragonflies and damselflies and duckweeds using identification guides produced by Amphibian and Reptile Conservation, the British Dragonfly Society and the Botanical Society of the British Isles respectively, in collaboration with OPAL partners at the Natural History Museum.



Photograph: Natural History Museum 2011

At the time of publishing, over 4,300 responses had been received. These surveys were well distributed across England. Survey responses were also received from other areas of the UK and internationally from Greenland to Greece and from northern Finland to Spain.

Using the national results received in 2010 (Figure 8), 6.7% of surveys reported poor water quality, while 62% were intermediate. Pond health scores were generally lower in urban ponds than in rural areas and rubbish was found more frequently in urban ponds. However, algal blooms (an accumulation of algae in an aquatic system) were more frequently recorded in rural ponds. In order to identify ponds of exceptional diversity, an additional 'excellent' water quality category, where pond scores reached 52 or more, was added. Using

this, 26.2% of surveys reported 'good' water quality and 5.5% reached the 'excellent' level. The East Midlands region returned the highest proportion of 'excellent' survey responses (16.9%) and the West Midlands the least (2.1%). Water clarity and pH results were equally well distributed. Distribution and frequency of the different invertebrate groups were also monitored. For example, alderfly larvae were reported in 13.6% of surveys while water snails were reported in 58.7%.

All data collected can be explored on the OPAL website; for example, you can compare the relationships between invertebrate species and site information, such as water pH.

Figure 8. Water quality results nationally and by region. The upper panel shows the scores for the whole country (left hand column) and then for the nine regions dividing them into good, medium and low quality using the Water Survey results. The lower panel shows the percentage of survey returns with scores 52 and over, considered 'excellent' water quality.



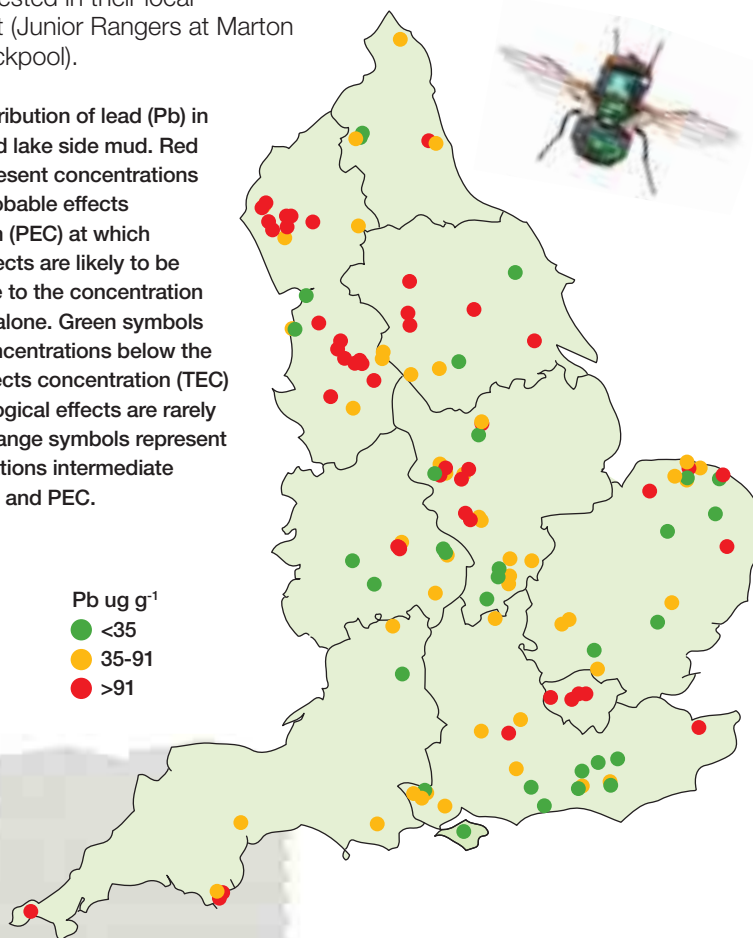
In addition, participants could request a special pack to participate in the Water Centre's additional survey, the OPAL Metals Survey. This survey ran from May 2010 to December 2011 and was the first of its kind in England. Participants were sent sample tubes and asked to send mud samples from the edges of lakes and ponds, which were then analysed for the trace metals lead, cadmium, copper, zinc, nickel and mercury. This survey was carried out in collaboration with the British Geological Survey (BGS) and their analytical protocols were used so that the OPAL data would be of sufficient quality to be included in the BGS's national G-BASE database²³, which holds extensive national records of soil and stream geochemistry. A series of calibration experiments was also undertaken to assess how these lake edge samples compare with samples from other areas of water bodies, including deeper lake sediments, catchment soils and inflowing streams.

The data for each metal were divided into three categories: low (below the threshold effects concentration (TEC) at which biological effects are rarely observed); high (concentrations that exceed the probable effects concentration (PEC) at which biological effects are likely to be observed); and medium (values between these TEC and PEC thresholds). Figure 9 shows the distribution of these categories across England for lead (Pb). As expected there are various 'hotspots' of elevated lead concentrations; these occur in each region. Although there is a wide range of lead concentrations within each region, the north-west region shows the highest mean value and south-east the lowest.

Monitoring of lakes in nine English regions

The OPAL Water Centre undertook detailed quarterly monitoring at a lake in each region of England over a four year period. This included physical measurements, such as water temperature, conductivity (the concentration of ions in the water), dissolved oxygen, pH, clarity, chemical parameters, such as nutrients, trace metals and persistent organic pollutants and biological monitoring of zooplankton, phytoplankton and diatoms. These data allow us to see how the lakes change over the seasons, variability between years and the extent of the impact of any local events or activities. Many of the lakes have local interest groups that use these data in management plans and as a basis for other studies (e.g. Fleet Pond Society in Hampshire; Friends of Chapman's Pond in York; field centres at Slapton Ley in Devon and Holt Hall in Norfolk) and as a way to get young people interested in their local environment (Junior Rangers at Marton Mere in Blackpool).

Figure 9. Distribution of lead (Pb) in lake and pond lake side mud. Red symbols represent concentrations above the probable effects concentration (PEC) at which biological effects are likely to be observed due to the concentration of this metal alone. Green symbols represent concentrations below the threshold effects concentration (TEC) at which biological effects are rarely observed. Orange symbols represent Pb concentrations intermediate between TEC and PEC.



Metals in London's lakes

The OPAL Water Centre's PhD research student studied trace metals in London lakes, particularly, the long-term changes at a number of lakes on Hampstead Heath, to see whether these reflect patterns on a broader geographical scale. Studying one lake, Vale of Health Pond, in great detail has enabled assessment on whether metal contamination in different ecological compartments (sediments, water, aquatic organisms) can be linked to changes in the lake sediment record. One striking result of the research is the scale of contamination in London lakes. Not only are the concentrations of metals much higher than those seen in many of the other OPAL monitoring lakes but the sediment record shows that although concentrations are declining (i.e. improving), they are still exceeding sediment quality guidelines.



Although monitoring can tell us a great deal about short-term changes, it takes a long time to see whether things are improving or getting worse. Extracting lake sediment cores allows us to put seasonal monitoring into an historical context so we can observe changes over decades and centuries. The team carried out sediment core analysis of chemical and biological parameters at each of the monitoring lakes to explore these long-term changes. Each core was dated using radio-isotopes (^{210}Pb ; ^{137}Cs) allowing us to see not only the direction of change (whether contamination or water quality is improving or deteriorating) but importantly the rate at which any change is occurring. As an example, Figure 10 shows the changes in lead (Pb) contamination over a 150 year period in Crag Lough (north-east region) and shows how, after many decades of contamination, the lake has started to improve in recent years. This is because

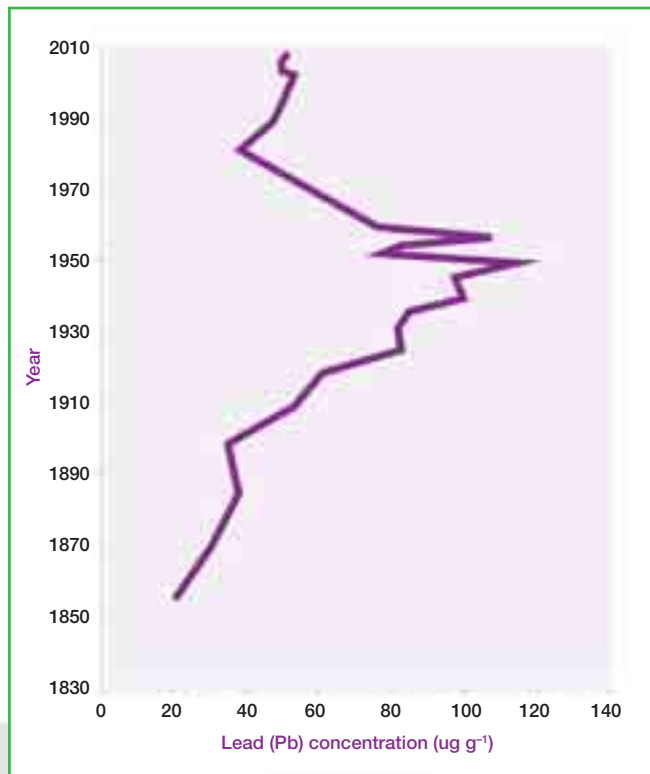
lead emissions have declined significantly since the 1970s, due to not only the removal of lead from vehicle fuel but also reductions in the use of coal and lowering of industrial emissions.

Despite their importance as toxic contaminants, there are very few data about two of the factors investigated: trace metals (especially mercury) and persistent organic pollutants in UK lakes. OPAL studies have therefore generated a lot of new information about the scale of contamination across the country. In addition to lake water and sediment studies, trace metals and persistent organic pollutants were analysed in fish taken from each lake. As fish are at, or near, the top of the aquatic food chain in UK lakes, they provide a good indicator of the overall impact from these pollutants. Highest concentrations of mercury were found in a pike (*Esox lucius*) from Marton Mere (north-west

region). Pike are piscivorous (fish-eating) and therefore tend to accumulate mercury to higher concentrations.

Work on brominated flame retardants (BFRs) has also produced a lot of new and interesting data. BFRs are chemicals used in furniture and other household goods to reduce the risk of fire. However, they are also toxic chemicals and can accumulate in aquatic organisms when released into the environment. Apart from producing the first seasonal trends for a range of BFRs in lake waters, work at the University of Birmingham as part of OPAL Water Centre research has shown that fish may be changing some of these chemicals into other forms inside their bodies in a process called bio-isomerisation²⁴. This finding has major implications for research into the way in which these chemicals are thought to transfer along aquatic foodchains.

Figure 10. Pb concentration for a sediment core from Crag Lough



4.4 Biodiversity

Two OPAL surveys concentrated on biodiversity. The first, led by The Open University, invited people to find a hedge and to record the variety of life that could be found within it. The second, known as the OPAL Bugs Count Survey, was led by the Natural History Museum (NHM) and asked participants to look for and record invertebrates around the places in which they lived, worked and went to school.

The OPAL Biodiversity Survey: Hedges

Hedges form a familiar part of both the English countryside and urban areas, where they surround gardens, schools and parks. In addition to being part of our cultural heritage and a record of historical land use, hedges are valuable refuges for wildlife, help to prevent soil loss, regulate water supply and assist in flood protection.

Despite their value, hedges have increasingly been removed to make room for agricultural and urban development, especially in the last 30 years. This has led to hedges being included as a priority habitat for conservation in the *UK Biodiversity Action Plan*. Thus the OPAL Biodiversity Survey was undertaken both as an education service to the general public and to help scientists and conservation managers to locate areas where hedges and their wildlife still thrive.

The biodiversity survey asked participants to carry out four activities:

- to describe the hedge's features and components (e.g. location, surroundings, whether it has been trimmed, whether there are gaps, etc.);
- to record the main hedge shrub species and its potential to provide food for wildlife (berries, nuts);
- to determine what invertebrates could be found in the hedge;
- to record evidence of animal nesting holes at the base of the hedge.

The data gathered were turned into hedge scores to provide a simple but robust indicator for survey participants of the quality of their hedge and its suitability for wildlife. Each hedge was rated as 'gold', 'silver' or 'bronze' according to its structure, the amount of food that it provided for wildlife and the animal diversity it contained. This method, as tested during development, highlighted the fact that different hedges provide different benefits for wildlife; hence a hedge scoring highly in one of these categories does not necessarily score highly in the others.

Participants in the OPAL Biodiversity Survey studied 2,700 hedges (as of November 2011), of which 57% were conducted in rural areas and 43% in urban ones. The majority (65%) were surveyed by school groups, while volunteer groups accounted for 20% and family/friends for 15%.



Photograph: Nigel Adams, Hedgelinek



The three most common hedge plants encountered were Bramble (found in 55% of hedges), Hawthorn (51%) and Ivy (37%) but there were differences between urban and rural hedges. Urban hedges had more Beech, Privet, Laurel and Yew while rural hedges had more Hawthorn, Bramble, Blackthorn and Dog Rose. Hedge composition was also influenced by region, with hedges within 50km of each other being more alike than those further apart. This may reflect the fact that hedges in any particular region often follow local traditions in planting and management, so that the hedges add to the distinctive character of many local landscapes.

The four most common kinds of invertebrates recorded in hedges were spiders, ants, snails, and woodlice. There was little difference between urban and rural areas, except that there were approximately twice as many froghoppers and blowflies in rural hedges than urban areas, while about 50% more ants were found in urban than rural areas. It is not yet clear why this difference arises and further analysis is under way.

Analysis of hedge condition scores showed that hedges with better structure also provided more animal food and sheltered a greater animal diversity in both urban and rural areas. On average, rural hedges scored slightly better than urban ones on all three measures, but the differences were slight, demonstrating the wildlife value of hedges, even in urban areas. In general, urban hedges tend to receive far less attention than rural ones for their wildlife importance, but the results of the OPAL Biodiversity Survey show that high-scoring hedges can be found in both urban and rural areas throughout England.

All participants who added their results to the OPAL website could explore the results further through interactive graphing, and were provided links to the extensive information and hedge management advice available through the OPAL and *Hedgelinek* websites.

The OPAL Bugs Count Survey

The OPAL Bugs Count Survey investigated how the built environment affects different groups of invertebrates. It also raised awareness of the wealth of nature that lives amongst us.

The survey involved:

- recording micro-habitat features (e.g. flowerbeds, hedges, decking, fences) to build a picture of the resources that are available to invertebrates within the survey area;
- three 15 minute activities or 'challenges', where participants were asked to find as many invertebrates as possible on human-made hard surfaces, soft ground surfaces and taller plants;
- the Species Quest activity, looking for six particular species of invertebrate (Leopard Slug, Tree Bumblebee, Green Shieldbug, Small Tortoiseshell Butterfly, Devil's Coach Horse and Two-Spot Ladybird) to help map their changing distributions, investigating the responses of these species to various issues including climate change, non-native species and urbanisation.



Looking at bugs on plants as part of the OPAL Bugs Count Survey



To date, more than 6,000 completed surveys have been submitted and over one million invertebrates have been counted. Bugs Count appealed to school groups, which was reflected in the high proportion of surveys returned by primary (30%) and secondary (34%) schools. 62% of survey sites were located in urban areas and 38% in rural locations.

Overall, more invertebrates were found on soft ground surfaces than on plants or human-made hard surfaces, showing the huge diversity of life supported by common garden features such as bare soil, fallen leaves and lawns. Despite seeming initially inhospitable to wildlife, human-made hard surfaces such as paving, fences and walls were heavily used by certain invertebrate groups such as ants, spiders and woodlice, showing that some species groups are able to take advantage of the resources such as structure, protection and warmth offered by the built environment.

Records of Species Quest invertebrates varied in number between urban and rural areas. Nearly four times more Small Tortoiseshell butterflies were recorded in rural villages and hamlets than in towns and cities. However others, such as the Tree Bumblebee, showed little preference, thriving in environments with a high proportion of human-made hard surfaces. The ability of this species to



A Green Shieldbug (*Palomena prasina*), one of the six species in the Species Quest

utilise resources in built-up areas such as bird boxes for nesting, may be a contributory factor to its rapid spread across the country following its arrival on the south coast in 2001.

Future data analysis will concentrate on better understanding how the different groups of invertebrates respond to varying levels of urbanisation.

Birds of Birmingham

Some of the most familiar and best loved urban animals are birds. The research carried out by the OPAL West Midlands PhD research student in Birmingham looked at birds in urban areas and asked some specific questions. How do birds manage to live in highly disturbed and fragmented urban landscapes? Do small islands or long corridors of green space allow them to more easily move through the urban landscape? What features of urban green spaces help to support these populations?



Seventy 500x500m squares of varying building density were surveyed for birds and habitat quality across Birmingham. A network of local, skilled volunteers allowed data on bird occurrence to be collected at a large number of sites. It was found that generalist species that are not usually choosy when it comes to habitat such as Blue Tit, Blackbird, and Robin can be very successful in cities and thrive in urban habitats. More specialist species such as Chiffchaff and Willow Warbler were much less abundant in urban areas but could still be found in fragments of more natural green spaces, when these were not too isolated from other green spaces.

Teams of trainee and trained bird ringing volunteers also examined bird movement and habitat use. The ringing data, coupled to the other bird survey data, showed that linked tree lines were very important in sustaining bird populations by providing foraging (via food provision e.g. insects, berries) and nesting habitat as well-connected space that enhanced bird movement.



OPAL West Midlands regional project: city ecology

The OPAL West Midlands team looked at wildlife in and around the city of Birmingham. In the UK, the majority of people live and work in built-up areas and so it is not in the countryside or in wildlife reserves that people most often encounter and enjoy green spaces and wildlife, but in our towns and cities. Built-up areas are, however, complex environments for wildlife to live in, comprising of habitats that range from small fragments of near natural green space; through parks, urban wastelands and gardens; to the solid pavements, roads, car parks and buildings that we first think of when we imagine a town.

Accommodating people and wildlife in cities is crucial because of the many services that green spaces provide for us, including helping to improve our emotional well-being²⁵. All research carried out by OPAL West Midlands has included some community involvement, whether intensive training in scientific survey methods of bats and birds or sharing findings of research on bees within the community, through providing talks, practical sessions, and advice on gardening for bees. The West Midlands team also worked in collaboration with the Garden Moth Scheme and community members to study the effectiveness of a variety of garden moth traps and the effect that garden character and landscape context have on the moths.



Trypoxylon clavicerum
Photograph: Jeremy Early

The effect of urbanisation on bees

Recent reported declines in the abundance and species diversity of bees has caused concern that we might be facing some kind of 'pollinator crisis', which might threaten natural ecosystems and reduce our capacity to produce food. One potential threat is urban sprawl and the loss of green space in existing towns and cities²⁶. OPAL West Midlands surveyed bees in urban, suburban and rural areas in and around Birmingham, and found that bees were less abundant and that there were fewer species in the city. Encouragingly though, there were still quite diverse bee populations in the city, especially where there were lots of flowers. OPAL West Midlands also placed bee hotels on allotments throughout the city to look at how effectively they can provide a nesting habitat for bees. Around 90% of hotels were used and the number of bee parasites (the natural enemy of bees) was quite low, suggesting that bee hotels might be a good way to boost the natural population of bees.

The effect of urbanisation on moths

The Garden Moth Scheme (GMS) is a national survey of the moths in participants gardens, surveyed using light traps. OPAL West Midlands has used the data collected by the GMS to explore which light traps catch the most moths and which garden and landscape features are associated with the highest number of moths and species of moths. Although many factors were analysed, urbanisation and the number of microhabitats in gardens showed the strongest effects. The abundance of moths, the number of species, and the number of rare species were all lower in towns and cities. However, the abundance and number of species of moth increased where gardens had lots of microhabitat features such as trees and hedgerows.



Lime Hawk Moth
Photograph: Dave Grundy



Ancistrocerus nigricornis
Photograph: Jeremy Early



A bee hotel in Birmingham



Peach Blossom Moth
Photograph: Dave Grundy

OPAL Yorkshire and the Humber regional project: brownfield sites

The industrial history of the Yorkshire and the Humber region has created a long-term legacy that still influences the biodiversity of the area today. Restoration of biodiversity has been a key policy objective for local government but how this is best achieved remains uncertain. This project involved many local residents from two villages suffering from rural deprivation in Wakefield. The OPAL Yorkshire and the Humber team researched the effects of different methods for restoration of biodiversity on two old colliery sites, Upton and Fitzwilliam, which are now country parks. Local volunteers were trained to identify and survey invertebrates and plants and they collected information about bumblebees, butterflies and grasshoppers. The formal records of historic restoration methods, essential for interpretation of present biodiversity, were patchy so to gain this important information, local residents participated

in a mapping exercise. This allowed the team to develop a community-based history of the sites since the mine closures, including both formal restoration and other informal activities.

The research found that differences in the way the sites were reclaimed after the mines closed helped to influence the present biodiversity. Upton was left to revegetate naturally for 20 years before any formal recovery procedures occurred. Fitzwilliam was initially landscaped as a golf course, and has had little disturbance since then. This has led to a dominance of grasses and only 33 plant species being found, compared to 91 at Upton. Differences in bumblebees and butterflies between areas of Upton that had been actively reclaimed rather than naturally regenerated were less clear, with bumblebee diversity appearing to be higher in naturally regenerated areas but only small differences in butterfly diversity between the areas. A key feature of both the naturally regenerated areas and the reclaimed areas of Upton was the presence of large amounts of nectar-rich flowers

that are vital for bumblebees and butterflies, and these were probably more important than the specific restoration method.

The results highlighted the biodiversity value of these old mining sites. Several rare species of plants, grasshoppers, bees and wasps were found at the Upton site, some of which were identified from photographs submitted by local residents to OPAL's online identification system *iSpot*. A railway cutting at Upton may have acted as a refuge for species as it was spared from landscaping, allowing species to persist and recolonize after the reclamation work had been completed. Recommendations for the sites to be managed to maintain a wide variety of different habitats, including areas of grassland and bare ground without trees, were made both to the local council and to the local community.

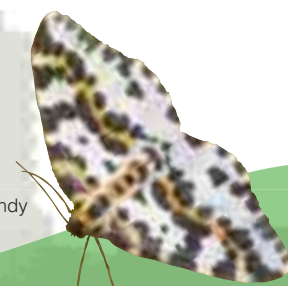
In addition to the research, the team held bat walks, OPAL survey days and two nature discovery days all helping to further public engagement with their local country parks.

Hedgehogs in Hull

PhD research was carried out in Hull to understand how garden management by householders can affect hedgehogs and the ways in which they move around the city. Data from a questionnaire about garden features (e.g. supplementary food, nesting habitat, presence of dogs and the use of horticultural chemicals) was combined with movement data from hedgehogs fitted with radio-tracking collars. 41 members of the public took part in the radio-tracking study, with the total volunteer hours exceeding 500. The results showed that no particular garden feature appeared to influence where hedgehogs spent their time, suggesting that correlations based upon hedgehog sightings alone should be treated with caution. Furthermore, hedgehog habitat did not appear to be restricted by resources. The results suggest that, as a result of good sites for nesting and plentiful food supplies, this type of area, which mainly consists of local authority housing with large, well connected, gardens, is a high-quality habitat for hedgehogs.



Magpie Moth
Photograph: Dave Grundy



OPAL East of England regional project: orchard monitoring

Orchards have played a vital part in the culture and economy of the East of England. Large numbers of small orchards around hospitals and on farms, in addition to some commercial orchards, existed across the region, although many were neglected or destroyed for development. Orchard trees support a range of mosses, liverworts and lichens on their trunks and branches as well as fruit production. These contribute to the overall biodiversity of orchards, which has been of increasing interest due to major losses of old orchards and more recently, the increase in community orchards across the country.

The OPAL East of England regional project examined relationships between mosses and lichens on orchard fruit trees. Other factors such as fruit varieties and the management of the orchards, their age and size were also investigated. To carry out the surveys, members of local orchard groups and local community groups took part. Training was provided to convey the importance of understanding ecological relationships in orchard habitats and to recognise mosses and lichens using hand lenses. Surveys were then completed with the help of groups such as Hertfordshire Orchard Initiative, Bergh Apton Conservation Society and the Friends of Putnoe Wood and Mowsbury Hillfort. The surveys looked at a selection of seven moss species commonly found in orchards in the East of England and also the nine lichens used for the OPAL Air Survey. Identification was facilitated by

illustrated keys to over 20 species of mosses and lichens in orchards developed especially for OPAL. The keys are available to download for free from the OPAL website.

The findings from the surveys across the East of England region have contributed to existing records held by local records centres. This has helped to support the *Biodiversity Action Plans* for orchards, particularly those that are neglected, where continued monitoring will take place. For new community orchards, recording moss and lichen colonisation can also be incorporated into management plans.

OPAL East Midlands regional project: heathlands

The OPAL East Midlands project focused on the threatened heathland habitats in the East Midlands region. Heathlands are a rare but important component of the East Midlands landscape and are of considerable biological and historical significance, both nationally and internationally. Since the eighteenth century, however, the East Midlands has lost over 90% of its heathlands. One reason for this catastrophic loss of heathland habitat is thought to be the detrimental effect of nitrogen pollution from human activities, such as intensive farming practices and burning fossil fuels. If this nitrogen is deposited into heathland soils, it can encourage the growth of fast-growing plant species, such as grasses, at the expense of slower growing species, such as the heather that composes heathland, significantly changing the heathland landscape.

Moss in orchards in the East of England

In an OPAL East of England PhD project, research was carried out on the distribution of mosses on orchard trees in Hertfordshire and Cambridge. Quantitative data were collected on a minimum of 10 trees per orchard. A total of 26 moss species was recorded, ranging from 10-20 species per orchard. Differences were linked with bark chemistry, such as pH and nitrogen, which were then investigated experimentally for four of the moss species. Because orchards are complex habitats other variables including management are also important and may also have an impact on the distribution of mosses.





Heathland in the East Midlands

An OPAL PhD research project investigated the effect of nitrogen pollution on the fragile heathland habitats. This involved conducting vegetation surveys in 26 heathland sites with differing levels of nitrogen deposition, and a controlled heather growth experiment using soil collected from the 26 sites to examine soil fertility levels. The atmospheric ammonia concentrations at the East Midlands heathland sites were also measured.

The research found that the soil fertility was higher in sites that received greater levels of nitrogen pollution. Furthermore, smaller heathland sites appeared to suffer relatively more from the effects of nitrogen pollution than larger sites. However, there was no evidence that this change in soil fertility has led to a change in vegetation composition. This might be because local factors, such as grazing animals for example, could be counteracting the effects of nitrogen pollution. This has important implications for habitat management and future heathland conservation policy.



4.5 Climate

The OPAL Climate Survey

The OPAL Climate Survey, led by the Met Office, was launched in March 2011. The survey looks at ways in which humans affect the climate and how the climate may affect us. The survey focused on contrails (the tracks left behind by airplanes in the sky that sometimes do not disappear and turn into clouds), and urban heat islands (UHI) (the difference in weather and climate between an urban environment and its rural surroundings). These are two areas of growing interest in the scientific literature, particularly in the context of our changing climate.

Contrails are quite easy to see; the UHI effect is more difficult to notice as you would have to be standing in two places at the same time to feel it directly. However, both represent ways in which human activities have sizeable impacts on climate and weather. The survey also asked participants to monitor how comfortable they were with the temperature outside, whilst carrying out the survey, and what their preferred levels of warmth and coolness were. The OPAL Climate Survey therefore contributes to the development of our understanding of how adaptable our population might be to climate change, from both natural variability and human activity, and how this might impact on people.

The survey activities include:

- looking for contrails in the sky to help test the accuracy of existing computer models that tell us where contrails should be;

- taking measurements of wind at cloud level, using a cloud mirror (nephoscope) and near the ground, using bubbles, to study how obstacles in our environment, such as buildings and trees, affect the speed and direction of wind;
- asking participants about 'thermal comfort' or how comfortable they were with the temperature outside and their clothing. This provides a snapshot of how the British public perceives temperature, and how climate may influence how we interact with our changeable weather. The thermal comfort activity was re-launched as a single survey in October 2011 to promote participation through the colder winter season.

At the time of writing, more than 2,700 climate surveys have been completed. There are over 19,000 contrail observations and more than 30,000 bubbles have been blown across the country to measure wind speed and direction at ground level. Interestingly, despite most of the surveys being conducted in spring and winter, only 25% of participants wore a coat.

Initial assessment of the results from the OPAL contrail survey shows broad agreement between the contrail observations and what we might expect, based on humidity levels close to the aeroplane. Many spreading and persistent contrails were observed in the West of England, where high humidity was recorded, but mostly short or no contrails were reported in the East where low humidity was recorded. The observations can be used to validate atmospheric models by comparing them to contrail predictions, based upon temperature and humidity data of the atmosphere.





What is a climate model?

To forecast weather for the next few days, or predict how climate will change over the next few decades, climate scientists use models. These are massive computer programmes, run on super-computers, that represent what goes on in the atmosphere, oceans and on land, and calculate how this changes over time. To have confidence in what models predict, forecasts are checked against what actually happens (model validation). Contrails and human comfort are both factors in climate models, and the OPAL data will provide an invaluable resource to validate how well these can be represented mathematically.

The comparison between observations and the predictions suggests that the predicted data set represents the state of the atmosphere fairly well.

The results of the wind speed experiment using bubbles so far show that obstacles such as buildings and trees have an influence on wind speed, with average reported wind speeds being lower for the dense urban environment and woodland and higher for the open field sites (Figure 11). The bubble wind speeds compare well with Met Office estimates of wind speed at heights of 10m. This is an important measurement to allow us to improve how standard meteorological wind data can be used to estimate what pedestrians will experience in various

environments, improving estimates of wind-chill.

The thermal comfort activity suggests that the UHI effect influences both how we feel and what we wear, even when we control for temperature. Findings show that for temperatures in the range 14-16°C, 50% of people in dense urban environments reported feeling warm, compared to 38% for the suburban sites and only 33% at open field sites. Similarly, 8% of the urban respondents wore coats, compared with 22% in the open field sites (Figure 12). The UHI effect, in which cities are warmer than their surroundings, is a well-known phenomenon but these results also show that people 'feel' more than just

the difference in temperature. For example, urban residents may have been less likely to wear a coat because the urban areas were less windy, or because heat emitted from hard surfaces such as buildings or roads also contributed to them feeling warmer than people in more rural areas. More careful analysis is under way to pick apart the competing influences of wind, sun and location and incorporate additional observations made over the winter period.

Figure 11. Average wind speeds reported by participants blowing bubbles for different reported land use types.

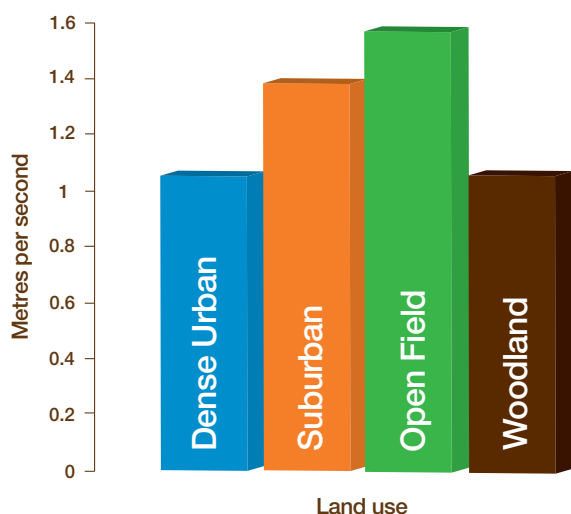
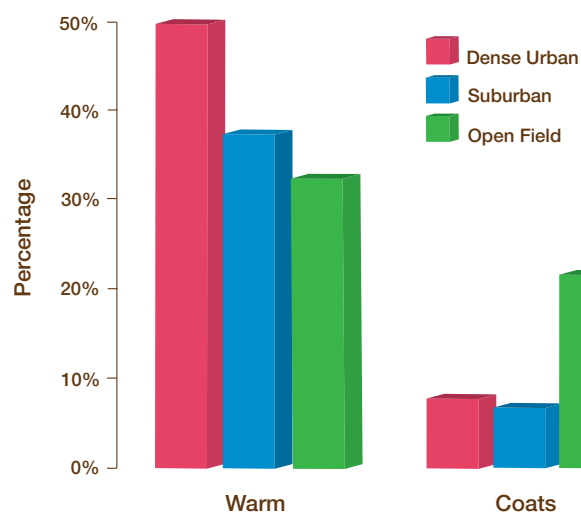


Figure 12: Percentage of people feeling 'warm', and percentage wearing coat for air temperatures in the range 14-16°C during the OPAL climate survey.



OPAL London regional project: the urban heat island

The urban heat island (UHI) is a term used to describe the increase in temperature caused by a built-up area, such as a large town or city. It is caused by higher amounts of concrete, glass, and metal that tend to absorb and hold heat from the sun for longer than, say, fields and trees; more surfaces which reflect less of the sun's energy back into the atmosphere compared to grass or trees; and higher amounts of human activities producing heat. The OPAL London team looked at weather in the urban environment to examine London's UHI effect.

To do this, they installed or upgraded at least one weather station in a school in each London borough, creating what is thought to be the densest network of urban weather stations in the world. Participating schools were given educational packs about weather and weather monitoring and many received weather and climate lessons from OPAL London's *Community Scientists*. The data provided by the weather stations were available to all schools and the general public via the London Grid for Learning website.

Using the data collected by the network of weather stations, the OPAL London team carried out research that focused mainly on solar irradiance (the quantity of energy that the earth receives in the form of sunlight). The team developed new techniques to allow comparisons to be made between different weather stations, which would otherwise not have been possible.

Measurements showed that, as an annual average, central London receives 9% less solar irradiance than outer London at midday. Computer models show that this reduction of solar irradiance in central London can be partially explained by increased pollution levels in the city centre. The remainder is attributed to increased cloud cover in the centre, due to raised pollution levels (with pollution providing a surface around which water droplets in clouds condense), or possibly due to the UHI effect increasing convective clouds (clouds driven by surface heating), due to the warm urban surface. The team plans to follow up the research to examine the possible effects of this observed reduction in solar irradiance in central London and its implications for counteracting the UHI effect. The results from this research also have implications for urban solar power generation, another topic being studied by the OPAL London team.

Climate modelling in London


The OPAL London PhD research student developed a new regional climate model for London. This is important; communities find it easier to grasp the relevance of climate change when they see local impacts. The model simulates the current and future weather for London at a resolution of 2km across London. It includes the special features of the urban environment, which is characterised by a land surface that is more reflective, has higher heat capacity and emits less water vapour than the countryside and differences in land use that change the climate of London. The model means that we can now simulate differences between those communities that live in areas with many green spaces and those with fewer – green spaces contribute to a local cooling, making the environment more comfortable during heat waves – and so we can now quantify the benefit of these green spaces during heat waves in future climate change. The model shows that clear sky and low wind conditions favour the creation of enhanced city warming compared to the countryside, i.e. the urban heat island effect.



As well as looking at the annual average, the team also found that the irradiance measured by the weather stations correlated well with measured pollutant aerosol levels over short timescales (3 hours). The weather stations network was able to detect the movement of a pollutant plume out of London. This is a new way of tracking pollutants and could be used when no other traditional measurements of pollutants (i.e. direct measurements of pollutant concentration in a sample of air) are available.

In relation to their work on the UHI effect, the OPAL London team worked with a number of participants on a project that looks at heat stress. Heat stress occurs when the body is unable to regulate its core temperature effectively and can lead to severe illness or even death. Increases in temperature and humidity make it harder for the body to lose heat to the environment to maintain its temperature. As climate change could potentially affect both temperature and humidity we might see a connected rise in the risk and occurrence rate of heat stress. This will be most severe in cities where the UHI effect can make the urban environment warmer than rural surroundings. During exercise, the body produces more heat than at rest, meaning that this can be an issue for athletes, especially those involved in endurance sports such as marathon running.

The team ran a series of educational sessions with communities to talk about the basic scientific principles of heat stress and the increased risks due to climate change. Demonstration of these principles at work was performed by measuring body and skin temperatures in different conditions and states of rest and exercise. Participants were asked to observe these conditions for athletes during the 2012 Olympic Games in London. After the games, using their observations, the participants discussed whether they felt that heat stress was a factor for athletes during the Games (it was not) and to consider if the results of their study would be similar if conducted at the Olympic Games in 2050.



Carbon sequestration in oak trees

Carbon sequestration is the name given to the process of removing carbon from the atmosphere and storing it in soil, rock and living things. This occurs both as a natural process and as a deliberate measure to reduce carbon dioxide emissions.

The OPAL South West PhD research student investigated differences in the carbon sequestration potential in the deciduous English Oak (*Quercus robur*) and the Mediterranean evergreen Holm Oak (*Quercus ilex*) in upland, urban and rural conditions. Growth was monitored at a number of sites across Plymouth and Dartmoor, where local volunteers helped to take measurements. Results show that the Mediterranean Holm Oak is the faster growing of the two and therefore accumulates more carbon than the deciduous English Oak while young. In older trees, however, the English Oak has greater biomass in rural locations. This research has implications for forestry and changing plant compositions of English woodlands with climate change.

Many scientific papers based on the findings from the OPAL research programme have been published and more are in preparation. Analysis of the combined dataset from all six surveys is currently being undertaken and the results will be published in 2013.



5. Working together



OPAL key objective

Stronger partnerships between the community, voluntary and statutory sectors

OPAL has worked with over 1,000 organisations – 53% are classed as voluntary, 38% are classed as community and 9% are statutory.

Of the groups that received an OPAL grant, 46% saw their membership numbers increase by 10% or more.

OPAL's approach has led to the development of a new environmental network across England, bringing together the voluntary, community and statutory sectors, all of whom are working towards the same objectives of improved environments and increased well-being. Over 650,000 people have directly engaged with OPAL staff.

OPAL has invested considerable resources in a programme to support natural history societies directly through grants and indirectly through the development of other resources on the OPAL website, the new Natural History Museum (NHM) web pages (*Nature Groups Near You*) and with new biological recording software (*Indicia*) and mapping tools on the National Biodiversity Network (NBN).

OPAL has achieved part of its quantified objective to increase membership of natural history societies. Of the first 70 groups to receive a grant 46% saw their membership increase by 10% or more. However, it is clear

that there is a lot more work to be done to encourage and support newcomers to biological recording, particularly those from minority groups, to study natural history and join a formal society.

5.1 The OPAL partnership

The OPAL partnership involves 15 organisations that have worked together for over five years as an integrated unit to deliver the projects that form the OPAL portfolio. All OPAL partners bring with them a wealth of experience, expertise and resources and all were already making individual contributions through their work on environmental topics. The OPAL portfolio brought these organisations together, for the first time, into one cohesive multi-disciplinary framework. Speaking about the benefits of working as a partnership, Toni Assirati from The Royal Parks said: "The Royal Parks has grown in its understanding and recognition of the impact of environmental pollution. The multi-agency involvement opened new pathways to partnerships and increased the understanding of many of our staff members."

OPAL's work all over England has brought scientists and communities together, helping the public gain a greater understanding of what scientists do and why, and its relevance to their neighbourhood and their lives. Scientists carry out their research work with the



support of community members enabling local people to explore, monitor and better understand their local area.

OPAL has forged many new working relationships, for example, linking academics to policy-makers, statutory bodies to the voluntary sector and natural history societies to the community.

OPAL has used a range of different approaches:

- *Community Scientists* working directly with local people;
- Regional steering committees: bringing together policy-makers, communities and statutory sector bodies;
- Working groups: multi-disciplinary working groups involving scientists, voluntary sector organisations, policy-makers and the community;
- Advisory boards involving research councils, community representatives, academics and policy-makers;
- Grants schemes: funding rounds for natural history societies;
- Online communities such as *iSpot*, OPAL's online identification tool;
- *Ask the Scientists* online;
- Blogs and social networks, such as Facebook and Twitter.

5.2 Public participation in research

Over the past few years there has been growing interest from central government and Research Council UK (RCUK) in bringing scientists, policy-makers and the public closer together^{27, 28}. OPAL is one of the first major public engagement programmes involving scientists from different disciplines with an interest in the environment. Many had not worked with the public before. This new form of collaboration has brought communities and scientists closer together. Research was conducted by a social scientist to try to understand the impact that OPAL has had on the scientists involved and their careers.

The lead scientists, *Community Scientists*, and students in OPAL were found to be enthusiastic about the programme. For the scientists, some of whom had spent decades working in the environmental field and others who had only recently started their journey, it provides an opportunity to meet people and enthuse them about subjects that they care so much about, that makes OPAL such a positive experience for them. OPAL has been instrumental in changing scientists' attitudes towards public participation in research.

“ On a personal note I've really enjoyed getting out and doing the outreach. I didn't think I would, [...] but actually it's been really good fun and I've found it very rewarding and enjoyable. ”



They have seen OPAL as a new and boundary-expanding experiment. At the project's inception, no-one knew whether it was possible to reach out to so many people, from so many different backgrounds, including those considered hard to reach, and deliver meaningful scientific research at the same time. OPAL has demonstrated that this is possible and, from the experience of the participating scientists and *Community Scientists*, lessons and projects for the future have been identified. OPAL has worked hard to integrate the public engagement function with research, leading one OPAL Scientist to comment: "OPAL is ahead of the game here, you know, we're doing stuff that we'd like to see happening much more widely, but we're doing it in a framework that doesn't recognise the value of part of what we're doing."

The success of OPAL has shown that these types of projects can work both on the public engagement and the research side.

In working together with members of the public, some scientists reported that they now look differently at the value that the public can bring to science. OPAL has not only brought the public closer to science, but also scientists closer to the public. This brings its challenges, however, because the scientists had to design new methods for gathering data. OPAL plans to share this learning through a series of publications.

The OPAL programme built a unique role into its structure, that of the *Community Scientist*. The *Community Scientist* is someone with an academic science background, who works with communities, schools, local government and other organisations. The *Community Scientist* is based at a university so has access to leading scientists and facilities that they can bring to the people they work with. Their work has made a very important contribution to the success of the OPAL programme.

Throughout this report there are numerous examples of OPAL *Community Scientists* who involve the public in research and education programmes. There is evidence to show that this one-to-one contact makes a real difference to the way in which people learn and the benefits they gain from being involved in a programme such as OPAL.



Comments recorded by OPAL's social science team in focus groups:

"I think what helped was having this network of people, so actually [the East Midlands *Community Scientist*] came and explained it all to us, and that really made a difference."

“ “The people who've been running [OPAL activities] have been very helpful. They haven't been condescending at all. That can sometimes happen, and if you are talking to an academic and you feel you're being condescended, that can really put you off. They've been really approachable.” ”

“For the Air survey, and also Water, OPAL sent a guy to work with us [a home-education group], and he was brilliant. Having access to somebody with that much more experience - I mean, I can look stuff up in books and we work stuff out together, but sometimes it's nice to have somebody there who just says 'oh yes, that's a ...'. And I think particularly for the boys - home-ed tends to be mainly mums - and having a session led by men can be quite encouraging for the boys, and particularly inspiring for those who are interested in science.”





OPAL Community Scientists

Community Scientists gain a real understanding of what does and does not work when involving people in OPAL activities. They learned how different groups had different requirements and needs and how different abilities and levels of interest could affect the learning of the whole group. Most importantly, *Community Scientists* understood that a personable and relaxed approach to learning is the most important part of the activity. The OPAL South West team in Plymouth explains: "Some groups that OPAL SW has engaged with can be considered 'hard to reach' owing to disempowerment arising from bad experiences of more formal education. These can be significant barriers to engagement. We learnt that creating an informal learning environment, with no resemblance to a school one, and an informal, humorous approach with young people, treating them as equals that could help us with our environmental monitoring was very helpful. The most successful format for a day's event was a series of short sessions, starting with a comfort element (for example a hot drink), outdoor activity, indoor teaching session, followed by informal discussion and relaxation. Allowing time in the day's plan for these things meant that the young people didn't feel pressured and were able to learn and ask questions in their own time."

“ I have been teaching for 11 years and have coordinated science in school for the past five years. I found the sessions outstanding. Bringing ‘Scientists’ into the classroom to share their wealth of knowledge and expertise with the children truly transformed the unit of work being covered. ”

Teacher, Rydon Primary School, Plymouth

“ A big thank you from everyone at Greenfield! The Wrens and Owls classes really enjoyed the pond dipping activities you did with them, and you have inspired the teachers to make greater use of our school pond! Fantastic! Thank you so much for leading these activities on our Eco Day. ”

Teacher, Greenfield Lower School, Bedfordshire

“ My granddaughter, ever since she were a little tiny thing she's wanted to be a vet, but now she said she wants to be like Sarah, a scientist, telling people about interesting things. ”

Recipient of an OPAL Community Award 2010, talking about the Yorkshire and Humber *Community Scientist*, York



5.3 Networking and partnerships

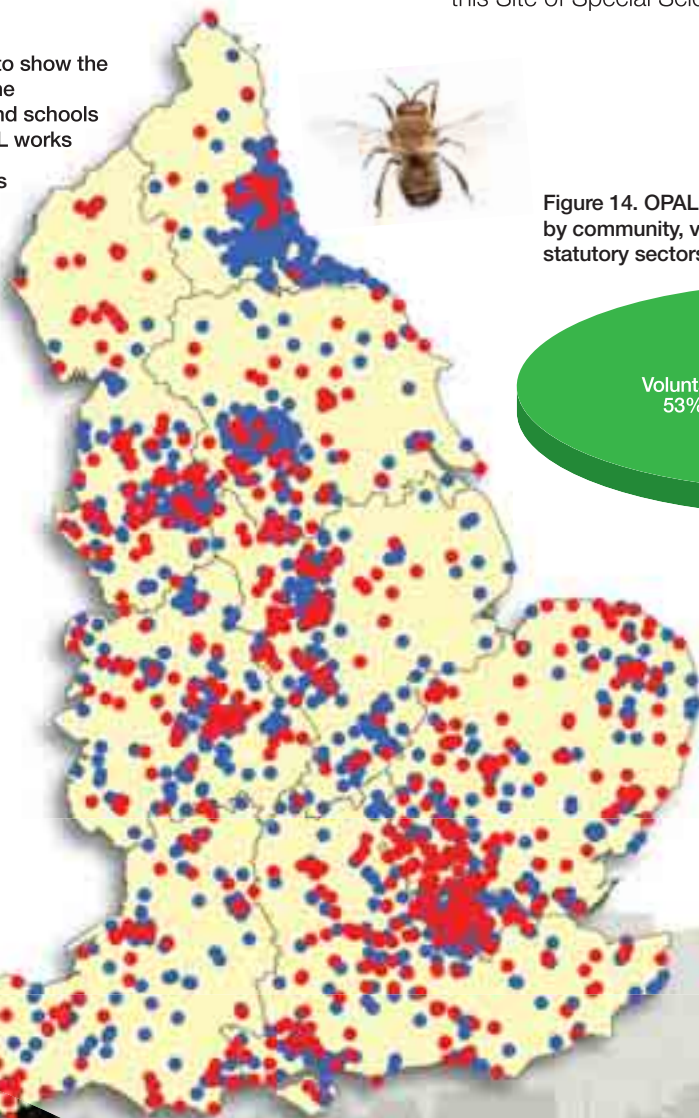
When OPAL partners were asked to report on their main achievements from the previous four years, the vast majority cited the development of a network of some kind, or the formation of 'strong partnerships', or simply that they had connected with so many different groups.

Community Scientists have been instrumental in creating such environmental networks with voluntary, community and statutory groups to run events and activities and create educational resources all across England (Figure 13).

Building these networks is important and helps achieve OPAL's objective to connect people. Of the 1,000 organisations that OPAL has worked with, 53% are classed as voluntary, such as clubs and friends groups, 38% are classed as community, such as local recording schemes and societies and 9% are statutory (this figure does not include schools), such as parks services (Figure 14).

Figure 13. Map to show the distribution of the organisations and schools with which OPAL works

- Organisations
- Schools

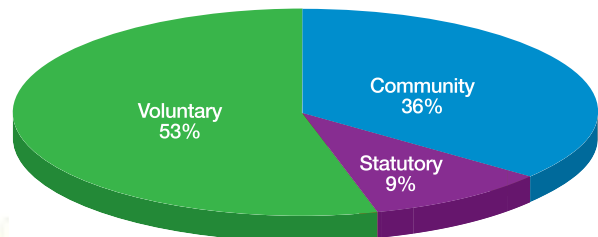


There are many benefits from partnership working, particularly in research, where new findings can be fed back directly to local people in order to enable immediate local action.

The OPAL Soil Centre worked with a number of organisations who helped to compare information the public reported in the OPAL Soil and Earthworm Survey with their existing data. They worked with the British Geological Survey, the Field Studies Council and the Natural History Museum on the development of the Survey and more closely with the Environment Agency on the analysis of the results. The Soil Centre were able to access sites for detailed fieldwork due to the support of local farmers, landowners and property managers and the results of the research from their sites are being fed back to them.

Immediate feedback of relevant findings to local people can result in swift action. As part of their research, the OPAL Water Centre discovered an invasive species of crayfish in Fleet Pond in Hampshire. The rangers were not aware of the presence of the invasive crayfish before the OPAL team surveyed the lake. They now plan to address the issue, helping to prevent loss of other important organisms in the pond. This, and other research carried out by the OPAL Water Centre, underpins a new £0.5m restoration project for this Site of Special Scientific Interest.

Figure 14. OPAL organisations by community, voluntary and statutory sectors



Case Study

The OPAL North West team forged a strong partnership with the biodiversity team at Manchester City Council. Together, they organised events such as the *OPAL Weather Roadshow*, in Wythenshawe Park, Manchester and developed strategies for public engagement towards the delivery of the *Manchester Biodiversity Action Plan*. The Council's Biodiversity Engagement Officer commented: "I work in the Environmental Strategy Team for the City Council, and the delivery of the city's natural environment strategies. One of the key elements is managing our environment sustainably, and involving people with their natural environment ... Manchester is a special team, delivering on a project that delivers massively to establishing a biodiversity evidence base – and inspiring a new generation of nature-recorders ... OPAL has not just been 'here's the kit, off you go', it's been 'we will provide a training resource, to support your communities and schools' ... OPAL presses all the right buttons in relation to delivering those objectives. The concept of OPAL, of getting people to look at nature in a simplistic way, but actually contributing to hard science, is absolutely ground-breaking, and fantastic for the city. We're in a position where we want to find out the extent of our biodiversity, and OPAL can really help us find that out."

All OPAL national surveys were developed with the support of the government and government agencies to ensure that they are compatible with current policy approaches in environmental protection. The Environment Agency built some new *ad hoc* networks by using the OPAL surveys. Some of their frontline teams used them for team building events. Individual staff, including directors, completed the surveys with friends and families. Some were so inspired that they introduced the surveys to the schools attended by their children. The Environment Agency also took the initiative to give copies of the surveys to government ministers.

Throughout the project, the Agency helped OPAL staff to make links and understand policy implications for their work. They worked closely with the OPAL Soil Centre and the OPAL Water Centre and hope to use the results from the OPAL Water Centre's research towards the *EU Water Framework Directive*, noting that there are very few other studies which focus on lakes.

5.4 Supporting amateur natural history societies

Across the UK, an enthusiastic and dedicated group of over 100,000 people called 'amateur naturalists' spend their spare time studying, recording and protecting wildlife and natural spaces. The OPAL grants scheme funded a wide range of projects and activities, including electronic identification guides, survey equipment, family fun days, specialist identification training courses, publicity materials, displays and banners – even puppet shows. This resulted in over 46,000 members of the public coming into contact with amateur naturalists in their local area to explore nature together, spreading OPAL's message further to inspire a new generation of nature lovers and train and support future naturalists from all walks of life.

Equipping these groups with the facilities, field kit and outreach resources they need, ensures that their expertise is shared in a locally relevant way for years beyond OPAL. 46% of grant-funded societies saw their membership numbers increase by 10% or more. Local partnerships were developed with neighbouring voluntary groups, councils and universities, providing added value and in-kind contributions to their projects, and establishing contact networks that can sustainably support future activities.

Many natural history societies have supported OPAL national surveys and events across the country. Some groups helped with the development of the national surveys as well as through



supporting the regional work of OPAL *Community Scientists*. To recognise and champion their work, OPAL, through the Natural History Museum (NHM), designed a funding programme to support them and bring them closer to the public.

The first step was to confirm the areas where help was most needed. So, in late 2008, OPAL began a consultation with natural history societies to understand the challenges they face and to identify the most effective ways in which OPAL could help. Key underlying factors that limited the successful development of these groups were identified, including:

- lack of time and active members;
- lack of funding;
- lack of expertise in publicity and web development;
- poor promotional materials to attract new members;
- poor networking and collaboration between groups.

One society's contribution to OPAL

The British Lichen Society helped to design, test and promote the OPAL Air Survey, helped to train *Community Scientists* in lichen identification, contributed to the training materials (PowerPoint and video), worked with community groups, developed a series of one day training courses, and designed a 'next steps programme'. They supported the Royal Society Schools programme resulting in a Royal Society Summer Science Exhibition by La Sainte Union, a North London School, about lichens and air pollution and continue to analyse and promote OPAL survey results.



The consultation results supported the anecdotal evidence of an ageing membership with an average of 39% of members aged 65 and over, and a further 40% aged between 45 and 64. Some groups expressed concerns that this could result in a loss of expertise over time. More positively, the alleged decline in society membership was not supported by groups responding to the consultation, with 81% of groups maintaining membership at the same level, or growing. These statistics suggest that societies are reasonably successful at recruiting new members from within older age categories but less successful at recruiting from younger generations, a challenge that OPAL seeks to address.

Groups tended to be male biased, particularly where there was a specialist taxonomic focus, and the reliance on a few key active members to run a society was also a key issue. One participant involved in the consultation said: "People enjoy coming to meetings but don't want to commit to being an officer and doing the work necessary to keep the group together. People pay their subs and want to be entertained."

The baseline data from the consultation allowed OPAL to target its resources and support measures to best effect. To address the issues associated with lack of funding for societies, the OPAL grants scheme was launched, distributing small grants of between £500 and £5,000. Over the course of the first three rounds of funding, 74 grants were awarded to over 70 different groups, totalling over £175,000. A full list of grants and funded projects can be found on the OPAL website. The grants scheme was to reach out to and support groups who do not usually receive funding from other sources. Just over 44% of OPAL grant recipients had never received funding of this kind before, and the mentoring and high degree of support provided gave them the confidence and experience to apply to other funding sources in the future.

The scheme encourages societies to expand their reach, and inspire and train a new generation of environmentalists. It brings long-lasting benefits to natural history groups who described the funds as 'a god-send' and 'life-blood', enabling them to move 'into our next 100 years with a bang!'

The Earthworm Society of Britain

Each OPAL survey was developed in partnership with at least one natural history society. This collaboration was not only essential for ensuring expert involvement for rigorous science, but also meant that societies gained direct promotion to a new public.

However, there was one notable exception. No society for earthworm enthusiasts existed to support the OPAL Soil Survey so a new group was set up with OPAL's support. The Earthworm Society of Britain now has around 70 members, an active programme of events and activities, a website and they recently launched a children's book.



Comments made by natural history societies that have been funded through OPAL:

"With this gear available, we are already making forays outside the confines of the Group. We are making inroads into the local schools, running a 'Design a Teme Valley Wildlife Group logo' competition. We are hopeful that this will help get our message over to the younger generation. It's amazing how a small injection of cash can make such a difference."

Teme Valley Wildlife Group

"This has been very successful and our training programme has resulted in several active new members. We have been particularly encouraged by the take up amongst younger people, especially postgraduate students, at some of our recent courses. This bodes well for the future!"

Dipterists Forum (a group that records flies)

"The event [Butterfly Recording Conference]... enabled us to 'reach out' to people who don't normally engage with the branch. OPAL has helped to build up a huge amount of momentum behind the Sussex Butterfly Atlas project – something we'd never have been able to do without OPAL's support."

Butterfly Conservation Sussex Branch

5.5

New software for recording wildlife

The National Biodiversity Network (NBN) developed recording software for OPAL that enables people to create their own wildlife recording website. This software, called *Indicia*, has enabled many groups associated with OPAL to begin formal recording and is freely available to everyone. *Indicia* works by providing the basic kit to build a wildlife recording website. Training courses and workshops were held to enable groups to experience the software first hand under the guidance of experts.

Indicia is being used by a rapidly increasing number of organisations for data gathering:

- the British Dragonfly Society uses *Indicia* for its online recording;
- Plantlife uses *Indicia* for its 'Wildflowers Count'. In 2011, the website had 2,249 registered users, many of whom enter data using *Indicia*;
- the BBC Breathing Places website utilised *Indicia* to gather ladybird data in summer 2010;
- the Corfe Mullen BioBlitz engaged around 100 members of the public with 762 species being recorded, including 320 flowering plants, 75 moths and 14 different mammals. The event was supported by the East Dorset Community Partnership and experts and local people of all ages joined in the hunt for wildlife;
- The Black Squirrel project, which launched in February 2012, allows members of the public to submit sightings of the black squirrel.

Indicia is continually developing. Following the success of *Indicia*, *Instant Indicia* was created; this provides users with an even easier way of putting their own recording website together.

OPAL survey data are being made publicly available via the NBN Gateway (an online biodiversity data warehouse, freely accessible for anyone to explore) and on the OPAL website.

Habitat-related information for the NBN Gateway's interactive mapping tool was also developed using OPAL funds. A particular feature of the new interactive mapping tool is a 'Getmap URL' function, which enables maps showing site-related information (as well as other data) generated from the NBN Gateway to be easily embedded in other systems. This means that you can look up records of a particular organism and see in which types of habitats they have been found – a great benefit to investigating our environment.

OPAL has worked hard to bring different sectors of society together and to provide the resources and support to maintain the relationships formed. Through working with established local organisations and by providing the resources and support needed to embed the OPAL programme we hope that the relationships will continue to develop and strengthen over the coming years. It was recognised, for many coming to the study of natural history for the first time that there are few opportunities to develop skills and confidence to the level felt necessary to join a formal society. This area remains a challenge for the future.



Photograph: Natural History Museum.



6. Conclusion

Local knowledge is important



England's environment is changing and like most areas of the world, is affected by issues such as loss of biodiversity, degradation of air, water and soil and changes to the climate. The condition of the places where we live, work and spend our leisure time is negatively affected and this in turn affects our well-being and the future of the natural world, on which we all depend.

What can we as individuals do to minimise the impact that these factors can have on our lives? OPAL was designed to give everyone an opportunity to better understand the natural environment and to play a part in protecting it.

In order to participate, people new to studying the environment need information, so we designed a fun and exciting outdoor learning programme about soil, air and water, biodiversity and the weather. We organised events, activities and training courses to encourage people of all ages, abilities and backgrounds to get outdoors and start exploring towns, cities and the countryside. We used the latest technology to design interactive websites such as the OPAL website, *iSpot* and new recording software, *Indicia*. Through leading experts, like the Natural History Museum, we also explained complex topics such as taxonomy. We designed a series of surveys so that communities could investigate their local environment and, if they so wished, to share that information with the wider community for research purposes.

OPAL has appealed to all sectors of society, particularly those considered hard to reach, as well as people already engaged with nature, many of whom through OPAL have expressed interest in new areas of natural history and increased their understanding of issues like pollution. Substantial support for natural history societies has raised their profile with the public and increased their membership, helping to ensure that their essential biological recording work continues into the future.

Thousands of people now record animals, plants and fungi, many for the very first time, and gather information about the condition of their local soil, air, water and climate. That in itself is satisfying and important but, by submitting data to the OPAL national database, participants contribute valuable information that scientists can use to monitor environmental change and help to conserve nature.

We now have a more skilled and knowledgeable community, with the tools and support services to develop their expertise further. Some participants now also aspire to become the scientists of tomorrow.

OPAL shows how research is conducted, how that research can be used to protect the world around us and how everyone can make a contribution to it. Barriers to engaging people in research (not just science) have been lowered by OPAL. The OPAL approach is distinct from simply communicating science to the public, which may catch people's interest but does not necessarily lead on to real engagement. OPAL provides a doorway through which the public can access science and research activity in a friendly and well-moderated way. The role of *Community Scientists* has been vital.



OPAL has a toolkit through which to reach this level of engagement: national surveys launched every six months, *Community Scientists*, a data entry portal and the website. This could be perceived as a complete methodology for engaging the public. OPAL is not the first to demonstrate that the public can contribute to science but certainly the first to do so in such an in-depth way and to repeat the investigations in so many different areas of environmental science.

The growing demand for the use of surveys suggests that OPAL and its survey packs have caught the attention of many organisations and individuals. There are clearly wider social benefits being gained, including increased social cohesion.

The OPAL approach could be one way for local people and community wildlife groups to gather information on the condition and trends in the local environment, which could help deliver localism or the *Big Society*²⁸. The

current lack of consistent methods to help local people and local authorities to make decisions relating to their environment is of real concern. Local knowledge collectively can make a powerful contribution to our understanding and management of environmental change.

OPAL provides a robust national framework in which local information can be gathered and used for decision-making. Its outcomes go far beyond just introducing people to nature.

The OPAL approach has generated new information about the state of England's environment that can be used in research, contribute to our understanding of environmental change and help us to conserve and protect the natural world on which we all depend for our well-being. Mechanisms for harnessing and applying local knowledge in environmental management require further consideration. Benefits of involving the wider public have been clearly identified.



OPAL has created a valuable resource base

- An outdoor learning programme, which includes an extensive range of resources for all ages, backgrounds and abilities
- New online resources:
 - The OPAL website – www.opalexplornature.org, including the Educational Pathway and OPAL e-learning programme
 - *iSpot* – www.ispot.org.uk – the wildlife identification website
 - *Indicia* – new biological recording software, free to download from www.nbn.org.uk
 - Nature Groups Near You – a directory of natural history societies
- New public exhibitions, including:
 - An exhibition on the biodiversity of The Royal Parks
 - A permanent exhibition about public participation in biological recording at the Natural History Museum
- A variety of local impacts and benefits as a result of the OPAL regional programme. A selection includes:
 - Enabling communities in Yorkshire and the Humber to manage their local areas e.g. Wildlife Habitat Protection Trust sites in Selby, and Upton and Fitzwilliam Country Parks in Wakefield
 - Extensive training and educational resources to enable teachers to communicate the importance of heathlands in the East Midlands region to their students
 - The transformation of the once neglected Moorbank Botanic Garden in Newcastle to a thriving research and community outreach facility
 - A network of urban weather stations in London schools and associated teaching resources, focused on topics such as the Urban Heat Island effect
 - New identification keys to mosses and lichens found in the East of England and new local recording groups
 - A new environmental network that brings the community, statutory and voluntary sectors closer together to create a more sustainable way of life

OPAL has enabled communities to become more informed, active and skilled and has empowered them to make a real contribution to their local environment. The challenge now is to sustain this growing interest in the environment and continue to engage and reconnect more people with nature, promote the benefits that the natural world provides and its importance to our well-being.



Lessons learned

Throughout OPAL many lessons have been learned about public participation in science. OPAL partners have gained a wealth of experience that will be shared through a series of best practice guides. Here are some of the issues:

Community engagement:

- Many sectors of society are not engaged with nature therefore it takes time and enthusiasm to build new local and national networks, particularly in areas of deprivation. Once established, relationships with local communities need to be supported and valued.
- Staff turnover in the voluntary sector is high, particularly under current economic conditions; collaborating with other statutory and voluntary bodies proved an effective way of providing ongoing support to existing groups as well as for making new contacts.
- Adapting OPAL resources to meet local needs and taking a flexible approach in their work were important to the success of the work of the *Community Scientists*.



- Confidence in OPAL resources was achieved by involving a leading team of scientists in the design and delivery of the programme, contributing to the high uptake of the national surveys in schools and providing teachers with outdoor learning materials they can trust.

Data

- The majority of OPAL participants did not enter their findings into the OPAL database although over 10% of surveys distributed resulted in full survey returns. The main reasons given were that participants:
 - do not like entering data when they get back home/to school
 - do not have regular access to a computer (we offer a freepost service)
 - did not complete the full survey
 - do not think their results are good enough for a national research programme
- Data entry increased for simple records (sightings) when we introduced text messaging and apps.
- Participants contribute a great deal of time and effort in the gathering of data for OPAL surveys and although they learn from the activity they rightly want to know how their data will be used and what their data means. OPAL used a range of feedback mechanisms developed and managed by the lead scientists

so that participants were aware that their data had been received and that it was of value. This was of particular importance for schools.

- Data quality can be maximised through careful survey design and validation systems.

Communications

- OPAL's three tier approach to communications proved successful and important. Having locally based staff working with local people on local issues was most effective in introducing new audiences to local environmental issues. A national and regional media strategy helped to promote OPAL across a wide range of media from TV to the local press and contributed to the success of the OPAL brand and the website and OPAL national surveys provided an opportunity for all sectors of society to participate in the programme.

Collaboration

- Close collaboration across this unique partnership of environmental expertise is a key feature of the high impact of the OPAL programme.



Acknowledgements

We would like to acknowledge the funding and support of Big Lottery Fund England and the *Changing Spaces* programme, without which OPAL would not exist.

We would like to thank all OPAL staff, past and present, students and volunteers for their dedication and hard work over the past five years.

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

We are very grateful for the guidance provided to us by the members of the OPAL *Portfolio Advisory Board*: Dan Osborn (Chairman), Helen Pontier, Richard Walmsley, Maxwell Ayamba and Tony Fox.

Finally, we would like to express our sincere thanks and gratitude to everyone who has taken part in the OPAL programme.

We would also like to thank the following people and organisations:

Debbie Alston, Vanessa Appleby, Paul Appleton, Yoseph Araya, Jim Bacon, Tristan Bantock, Graham Banwell, Glenn Baptiste, Katy Barnard, Declan Barraclough, Alan Bedford, Barbara Belford, Sara Bellis, Karen Bennett, Anne Bhogal, Richard Billingsley, Daniel Bissessar, Stefan Bodnar, Susan Booth, Keith Bowey, Mark Boyd, Pippa Bradley, Sarah Briley, Mike Brogan, Steve Brooks, Christine Brown, Corinna Brown, Sophie Bryant, Claire Bunford, Graham Burton and team, Veronica Carnell, Dan Carpenter, Brian Chambers, Mark Chambers, Margaret Cooney, Kate Cole, Robert Coleman, Stacey Cougill, Mark D'Arcy, Rachel Devereux, Alf Dimmock, Pat Ealey and volunteers, Paul Eggleton, Keith Elder, John Ellis, Jen Estwick, Alison Fairbrass, Darren Fanner, Ali Finn, Sam Finn, Dee Flight, Robert Ford, Dave Fox, David Garrett, Mike Gee, Paul Gilbertson, Rachel Gillies, Zoe Goss, Alicia Grande Cristóbal, Nick Grayson, Helen Greaves, Gemma Gregory, Jane Griffiths, Jan Gronow, Dave Grundy, Katie Hadwin, James Hale, Martin Harrison, Tom Hartman, Damian Hatley, Martin Head, Deborah Hedgcock, Colin Higgins, Sarah Hill-Daniel, Barbara Hilton, Dan Hoare, Steve Hodgkinson, Stewart Holmes, Martin Horlock, Mike Houghton, Mohini Howard, John Hughes, Caroline Hutton, Heather Jackson, Rupert Johnson, Jim Jones, Amanah Kadri, Jon Kean, Andrea Kelly, Charlie Kennedy, Roger Key, Martin Kincaid and team, Albert Knott and team, Nick Lane, Brian Langley, John Lawlor, Kate Lewthwaite, Rose Little, Andy Lowe, Chris Lowe, Mary MacLachlan, Varinder Mahay-Paul, Penny Marriott, Paul Martin, Tom Mathews, Paula McMillan, Harriet Mentor, John Millar, Penny Moore, Julia Morris, Nik Muhammad, Sam Neal, Kerry Netherway, David Nicholls, Adam Noon, Jo Oliviant, Odhran O'Sullivan, Marina Pacheco, Sarah Pierce, John Pilgrim, Jane Plant, Alison Porter, Clive Potter, Mark Powell, Steve Prentice, Hannah Pritchard, Terry Quinn, Paul Raikes, Mike Randles, Nigel Reeve, Ian Reeve, Beverley Rhodes, Rachael Rhodes, Debs Richardson-Bull, Chris Robinson, David Rolls and team, David Roy, Helen Roy, Trudy Russell, Orland Rutter and team, Cathy Scheib, Jemma Sharman, Emma Sherlock, Nicky Simpson, Pam Smith, Sue Southway, Zoë Stevens, Robin Stevenson, Lynn Taylor, Jan Tomlinson, Bob Usher, John van Breda, Lynn Victor, Leilah Vyner, Mangaprabha Waggott, Richard Walmsley, Naomi Wells Smith, Belinda Whittle, Ruth Wilson, Pat Wolseley, Rob Wolton, David Woolley, and Chris Wright.



ADAS (Environmental Consultancy)
 Amateur Entomologists' Society
 Amphibian and Reptile Conservation
 Antony House
 Bees, Wasps and Ants Recording Society
 Biological Records Centre
 Birmingham & District Allotments Association
 Birmingham & the Black Country Living Landscapes
 Birmingham City Council
 Blackpool Council Ranger Service and Junior Rangers
 Botanical Society of the British Isles
 British Arachnological Society
 British Bryological Society
 British Dragonfly Society
 British Geological Survey
 British Lichens Society
 British Myriapod and Isopod Group
 Broads Authority
 Bruce Castle Museum
 BTCV York
 Buglife
 Butterfly Conservation
 Castle Vale Nature Conservation Group
 City of London Corporation
 City of York Council
 Conchological Society of Great Britain and Ireland
 CSV Environment
 Dartmoor National Park
 Derbyshire and Nottinghamshire Entomological Society
 Derbyshire County Council
 Devon Wildlife Trust
 Dipterists Forum
 Earthworm Society of Britain
 Edge Hill University
 English Martyrs High School
 Environment Agency
 Esme Fairbairn Foundation
 Exmoor National Park
 Federation of City Farms and Community Gardens
 Fleet Pond Society
 Fordley Primary School
 Friends of Balaam's Wood LNR
 Friends of Cannon Hill Park
 Friends of Chapmans Pond
 Friends of Greenwich Park
 Garden Moth Scheme
 Garden Organic
 Garden Organic Ryton
 Get Walking Keep Walking
 Gloucestershire Country Council
 Groundwork Greater Nottingham
 Hart District Council Rangers
 Hedgelink
 Holt Hall Field Studies Centre
 Ideal for All

Imperial College London
 John Muir Trust
 London Grid for Learning
 Metamorphosis at Martineau Gardens
 Milton Keynes Parks Trust
 Moor Trees
 National Autistic Society
 National Trust at Hadrians Wall
 Natural England
 Natural History Museum
 North and East Yorkshire Ecological Data Centre
 Northamptonshire County Council
 Northumbria Mammal Group
 Nottinghamshire Wildlife Trust
 Oak Tree SAFE
 Open University Mentors
 Orthoptera Recording Scheme
 Peak District National Park Authority
 People's Trust for Endangered Species
 Plymouth University
 Pond Conservation
 Roots and Shoots - Growing for the Future
 Royal Meteorological Society
 RSPB
 Scotswood Natural Community Garden
 Shropshire Wildlife Trust
 Sited
 Slapton Ley Field Study Centre
 South East Mansfield School
 St Cuthbert's High School
 Staffordshire Wildlife Trust
 Starbank Primary School
 Stepping Stones to Nature/ Plymouth City Council
 Steward of Bury Meadow CWS, Isle of Ely
 Stockholm Environment Institute
 Tanfield High School
 Terrestrial Heteroptera Recording Scheme
 The Holly Lodge Centre
 The Royal Parks
 Thoresby Estate
 UK Ladybird Survey
 University of Central Lancaster
 University of Nottingham
 Wild About Perton
 WildDerby
 Wildlife Gardening Forum
 William Shrewsbury Primary School
 Winterbourne House and Garden
 Woodgate Valley Urban Farm
 Woodland Trust
 Worcestershire Wildlife Trust
 Yarner Wood National Nature Reserve
 Yorkshire Naturalists' Union
 Yorkshire Wildlife Trust
 Young Diverse Minds



Appendix: Evidence Base



- 100 participants: interviewed by a social scientist (semi-structured interviews);
- Six focus groups with a broad cross section of society, run by a social scientist;
- 593 OPAL participants volunteered feedback in an extensive online questionnaire;
- 17,619 participants answered our online questions when they submitted their national surveys. Questions were not compulsory therefore the number of responses per question varied. Not all participants answered the full set of questions;
- 14 classes of primary-aged children were involved in an independent study on the use of OPAL resources in primary schools from reception to year 6;
- 4,700 comments in the OPAL online open comments boxes on the OPAL website;
- Testimonials (verbal, reports, email or letter);
- Case studies provided by OPAL staff;
- Data provided by OPAL staff on a monthly basis. These include number of participants, surveys carried out, training sessions held and the number of organisations and schools worked with including their postcode for mapping;
- 503 questionnaires completed by participants after an outdoor activity (219 adult questionnaires and 284 child questionnaires);
- 42 interviews with OPAL scientists and staff.

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Gill Stevens

Gill Stevens, OPAL's Deputy Director, died in January 2011. Gill, a great naturalist and much loved colleague, was passionate about nature and wanted everyone to know more about it and to enjoy it. Gill was particularly keen to encourage young people to study wildlife and to experience the sense of wonder and excitement that natural history can impart. Recognising the massive contribution that Gill made to OPAL, The Gill Stevens Awards have been set up to bring young people and naturalists together to inspire a new generation of nature lovers.



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