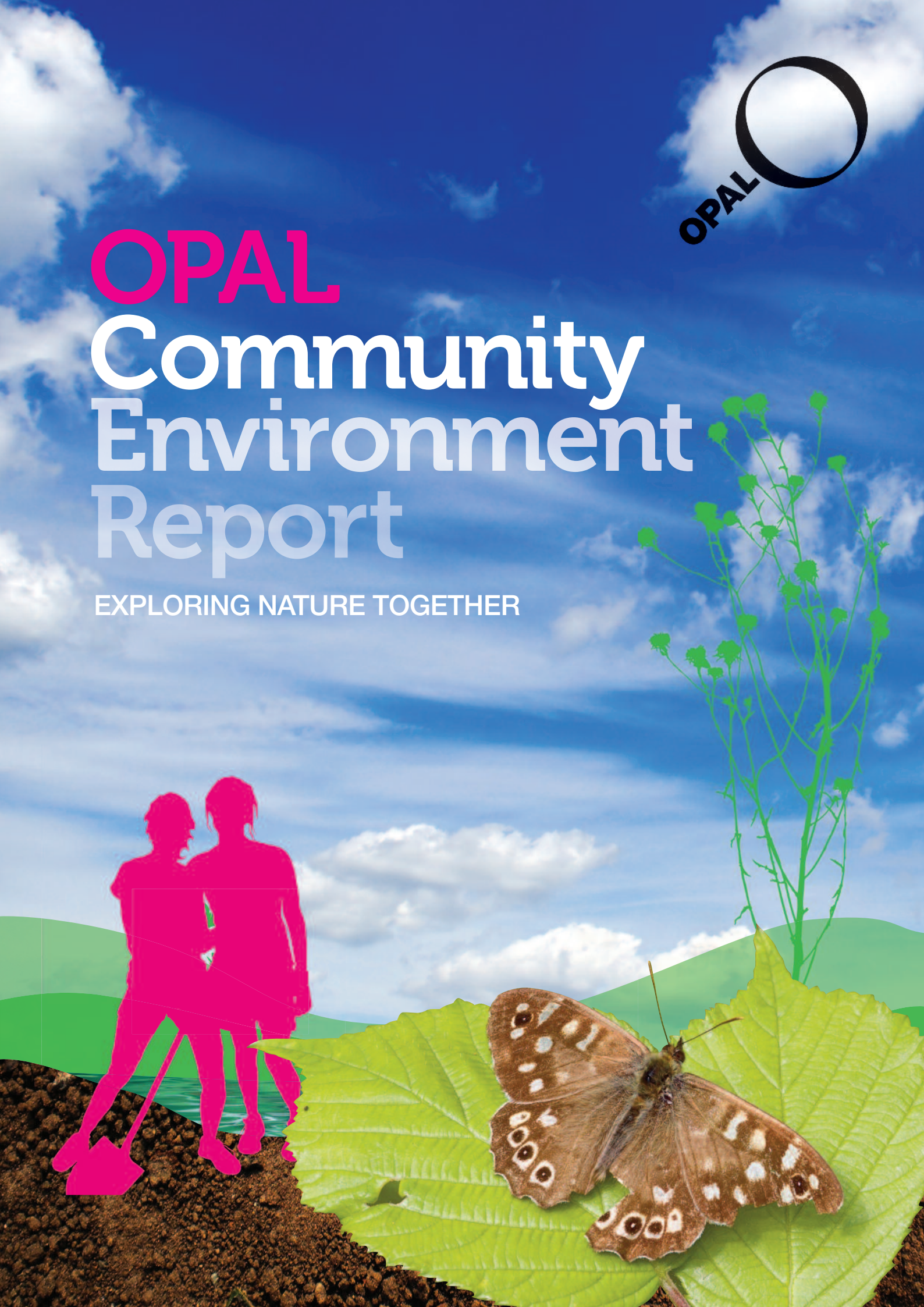
OPAL Community Environment Report

EXPLORING NATURE TOGETHER



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Contents

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Foreword

The Earl of Selborne

"One of the programmes connected with Living with Environmental Change is Open Air Laboratories-OPAL, originally funded by the Big Lottery Fund, which awarded a grant to Imperial College. That is an example of an excellent initiative which has the key objectives of getting more people outside observing and recording the world around them, inspiring a new generation of environmentalists, and encouraging and supporting collaboration between community, voluntary and statutory sectors and academia.

That is the kind of initiative which will do more than any international or national targets to develop and to enhance biodiversity. Regional research programmes and recording schemes, lively natural history societies, and adequate public funding for taxonomy are the basis for an understanding of our biological diversity and they will be the keys to a successful national biodiversity enhancement programme. The reason why I tip, on balance, towards optimism, like my noble friend, is that I believe that the Government has understood the importance of getting wide support from the community. That is to be welcomed".

The Earl of Selborne, speaking at the House of Lords debate on biodiversity, in June 2011[1].

OPAL EXPLORE NATURE

BIG LOTTERY FUND

LOTTERY FUNDED

[1] Lords Hansard 20th June 2011 "Biological Diversity: Question for Short debate. Asked by the Earl of Selborne" [online] http://www.publications.parliament.uk/pa/ld201011/ldhansrd/text/110620-0002.htm#11062017000124

OPAL Director

We know that spending time outdoors is good for our health and well-being. Exploring the natural world is also fun and exciting, and being able to name the flowers, insects and other wildlife we encounter along the way is hugely rewarding. "What's that?" is a question that every parent and teacher frequently hears but how often can we answer it? OPAL set out to change that by providing more people with the knowledge, skills and confidence to become more active and engaged with nature in their neighbourhood. OPAL encourages people to spend time exploring and observing local wildlife but crucially also to learn about the conditions that animals, plants and fungi need for survival: what aquatic invertebrates can live in more polluted waters; which lichens can happily live next to a busy road. We provided a range of outdoor activities, materials and online tools that people of all ages, abilities and backgrounds could enjoy and learn from. In particular, we wanted to work in areas of deprivation with communities that had not previously come into close contact with scientists and where parks and other greenspaces were not always accessible or inviting to newcomers. We wanted to take experts into the heart of these areas to get to know the people and local nature.

Communities examined street trees and hedges, allotments and woodlands, parks, gardens, playing fields and playgrounds. They also discovered havens of wildlife, particularly in towns and cities, which they had not noticed before; the diversity of these spaces and the wildlife they contained – often unexpected – was fascinating and these oases of nature were recognised as an important way of enriching our lives. Getting outdoors not only provided good physical exercise and an opportunity to learn about and be inspired by nature; it also helped us learn more about local places and brought us into contact with new neighbours, bringing communities closer together.

OPAL teams have been welcomed in every part of England and, together with local people, we have gathered lots of information about places that we had not studied before. This information has increased our knowledge and understanding of the world around us and has inspired many people, young and old, to pursue their new interests through the different pathways that the OPAL programme has developed, alongside taking part in the many existing routes, such as natural history societies, voluntary organisations and statutory bodies that have joined OPAL and helped to make it such a success.

The OPAL programme provides evidence that a more informed and active society can make a real contribution towards addressing some of the major environmental challenges facing us today.

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

Linda Davies
OPAL Director

> **"OPAL are making and sustaining clear links with communities in the most deprived areas, enabling participants to explore and understand their localities"**
>
> Donna Hans-Morris,
> Plymouth City Council (g)

Summary

The Open Air Laboratories (OPAL) network is a nationwide partnership comprising of ten universities and five organisations with an interest in the environment. OPAL commenced in December 2007 and is funded by Big Lottery Fund, with grants awarded totalling £14.4 million.

Raising awareness of nature and its relevance to everyday life inspires people to explore their local environment

- Over half a million people have participated in the OPAL programme. OPAL activities are carried out by people of all ages, backgrounds and abilities, including 10,000 people in 'hard to reach' communities.
- OPAL opens people's eyes to the natural world. Nearly half (44%) of OPAL survey participants said that this was the first time that they had carried out a nature survey. 90% of participants have learnt something new.
- OPAL has the ability to change people's behaviour. Almost half (43%) of respondents said OPAL had changed the way they thought about the environment and more than a third (37%) said they will change their behaviour towards it.
- In addition to raising environmental awareness, OPAL also improves personal well-being by motivating people to spend time outdoors doing something positive, while connecting with people and nature.

OPAL designed and delivered an informal outdoor education programme for people of all ages, abilities and backgrounds

- OPAL resources are stimulating, straightforward and informative. Over 800 primary and more than 1,000 secondary schools have registered for OPAL materials. Over 60% of OPAL field data has come from schools.
- OPAL's high quality science programme instils confidence in teachers and students. Over 1,000 people have taken part in OPAL training sessions. 17,000 registered users have used iSpot to improve their identification skills.
- OPAL is broadening people's natural history knowledge and skills. Over 390,000 visits have been made to the OPAL website.
- Outdoor learning is vital to all levels of education to ensure England's natural heritage is recognised, appreciated and protected.

Everyone can contribute to environmental research

- OPAL scientists designed a series of field-based ecological surveys on soil, air, water, biodiversity and climate. 230,000 field packs have been distributed to schools and community groups and over 1,000 training courses delivered.
- OPAL participants have added a wealth of new data and helped to further scientific understanding. The public has surveyed over 25,000 sites across England and entered the information into the OPAL national database for analysis. Communities have also contributed data to local research studies.
- Taking part in a national research programme was a key motivating factor for many participants.
- Scientists have developed strong links with local communities helping the public to gain a greater understanding of what scientists do and the relevance of science to their everyday lives. OPAL scientists have found that working with the public is rewarding and can bring real benefits to their research.
- Greater public involvement in environmental monitoring has created a greater sense of connection and ownership of local spaces. 84% of participants said they would carry out another OPAL survey, showing that they want to continue with their new interest in recording wildlife. The majority of scientists involved want to continue to engage the public in their research.

Governments alone cannot resolve the environmental problems facing society today; we all have a role to play.

- OPAL has worked with organisations from the voluntary sector (54%), the community sector (36%) and the statutory sector (10%), together designing programmes that bring people closer together at the local level, explaining environmental policy and promoting field work.
- OPAL provides support to Natural History Societies awarding grants to over 70 groups to help promote their work, create new online resources and encourage new members. 46% of OPAL grant-funded societies have reported over 10% increase in membership.
- Scientists have worked in some of the most deprived areas of England and with people from disadvantaged backgrounds. Many minority groups have welcomed the OPAL programme and started to record nature for the first time.
- Close collaboration between different sectors of society has resulted in a greater understanding and appreciation of the different challenges each sector faces under changing environmental conditions and identified some of the ways in which we can support each other and contribute to a sustainable way of life.

OPAL has generated new information about the state of England's environment.

Much of the information gathered through regional research and national projects is still being analysed but some preliminary results are included in this report. Early analysis of data from the OPAL National Surveys shows that:

Soil

Gardens are hotspots for earthworms, with higher numbers compared with other habitat types. Gardens also had the highest average number of different species. These and other trends arising from the OPAL Soil and Earthworm Survey and other OPAL-funded research are informing the development of an urban soil strategy to help monitor soil condition.

Air

Air pollution is still affecting lichens on oak trees, with more tolerant species increasing in abundance where traffic pollution is highest, largely in urban environments where traffic pollution causes most health problems, were correlated with nitrogen-loving Xanthoria and Physica lichens. Some lichens considered sensitive to polluted air were found to be returning to towns and cities. The appearance of high numbers of tar spots of sycamore, thought to be limited by transport emissions, was associated with rural areas, supporting existing research.

Water

Urban ponds contained more rubbish than those in rural areas but had less algal bloom. Average pond health score, indicated by the invertebrates present was lower in urban areas than in rural areas. A nationwide survey of pond sediment samples provided by the public show that there are various 'hotspots' of elevated lead concentrations in each region. Overall, the north-west region shows the highest mean value of lead concentrations and south-east the lowest. Another pollutant – mercury - was found to exceed water standards in all lakes examined. Flame retardants, recorded for the first time in lakes in England, were found in all ponds sampled and thought to have accumulated in fish, which may be changing these chemicals into new forms within their bodies. This has implications for the way in which these chemicals transfer along aquatic food chains.

Biodiversity

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. Hedges with better structure also provided more animal food and sheltered a greater animal diversity in both urban and rural areas.

The built environment is a refuge for many groups of invertebrates. Human-made hard surfaces (such as walls, fences and tarmac surfaces) were found to be frequented by bees and wasps, flies and spiders in particular, supporting existing research. Their often exposed location and the speed at which they warm up on sunny days makes them ideal basking locations for flying insects.

Climate

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. These results are also reflected in findings on personal thermal comfort with 50% of participants in dense urban environments reporting feeling warm, compared with only 33% in open field sites.

The scientists, members of the public, schools, charities, natural history societies and statutory bodies learnt so much through being a part of OPAL; Find out more about OPAL at www.opalexplorenature.org

1. Introduction

1.1 Report structure

This report explains the focus of OPAL's research and education programme and shares the findings of this work alongside the impact that it has had on the participants that made it possible. There are six sections to the report.

This first section of the report introduces the project and explains why it was developed and how it is structured. The second section **Exploring the Outdoors** explains how, through OPAL, people have discovered and connected with the natural world and how being outdoors can be beneficial to health and well-being.

The third section **Learning** explores the impact that OPAL has had on formal and informal educational systems. It also examines how OPAL has increased learning for those already engaged with nature.

Section four **Research** provides a summary of the scientific findings so far from across the OPAL portfolio. This includes early results from the OPAL National Surveys, where data are largely gathered by communities, findings from regional research projects and research carried out by the OPAL national centres.

Section five is called **Working Together** and looks at how collaborative working has benefited local communities, voluntary groups, government and the scientists involved in OPAL.

The final section **So what?** summarises the impact of OPAL, the challenges in public engagement in research, and our legacy and hopes for the future.

1.2 Evidence base

Evidence of social impact in the report has been gathered from a number of sources, including semi-structured interviews, focus groups, online questionnaires, independent study, testimonials and case studies. Throughout the report we refer to sources of evidence, denoted by lowercase letters from (a) to (k). For details see Appendix.

1.3 What is OPAL?

The Open Air Laboratories network, or OPAL, as it quickly became known, was launched in 2007 following a successful application to the Big Lottery Fund's £200 million Changing Spaces Programme and an award of £12 million. Directed and managed by Dr Linda Davies from Imperial College London, it was the first time that Big Lottery funding on this scale had been awarded to an academic institution. The portfolio of 32 projects that form OPAL is delivered by 15 partners from across England, each bringing their own area of expertise (Figure 1). OPAL has two associate partners, the Environment Agency (EA) and the Department for the Environment, Food and Rural Affairs (Defra), which have been actively involved throughout, ensuring that OPAL materials are compatible with current environmental policy. OPAL also benefits from its affiliation to Research Councils UK (RCUK) through the Living with Environmental Change (LWEC) programme (www.lwec.org.uk).

Figure 1

National Surveys	
People	**Resources**
Local	Research programme
Regional	Educational programme
National	Training
Community Statutory Voluntary	Materials
Support services	

1.4 OPAL 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 gain the opportunity to become active participants with the knowledge and confidence to debate environmental issues.

3 A new generation of environmentalists

OPAL aims to increase active membership of amateur natural history societies, many drawn from under-represented sections of society.

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 focuses on some of the major environmental challenges facing society today, challenges that need to be addressed if we are to live sustainably: the condition of soil, air and water, climate change and loss of biodiversity. The UK government has regularly acknowledged that it alone cannot secure a more sustainable future but that everyone must play their part[2]. Two key issues that resonate with the OPAL approach were highlighted:

- **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[3].

OPAL provides opportunities for all sectors of society to engage in an outdoor learning programme. The OPAL model brings scientists and the community closer together to explore, record and further our understanding of the places where we live and work. Alongside this, 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 environment[4]. OPAL addresses each of these areas and has integrated them into one cohesive programme for the public.

The OPAL programme is suitable for everyone. 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.

A regional programme, developed and led by an academic institution in each region of England, ensures that the programme covers the whole of England (Figure 2). In addition, six National Centres were set up to investigate and provide expert advice on the topics of biodiversity, climate change, and pollution of soil, air and water. A third and equally important aspect of OPAL is its central support services, including the website team that also manages the national survey database, a media communications officer and schools outreach team. Fourth is the relationship with policy-makers, ensuring that OPAL's programme is compatible with environmental policy. Each component of the OPAL structure is vital, integrated and cohesive (Figure 1). The core element that binds the programme together is the National Survey series, delivered with the help and support of all OPAL partners. Each component is explained in more detail below.

"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. (a)"

[2] Office of the Deputy Prime Minister (ODPM) (2006). Securing the future: Delivering UK Sustainable Development Strategy
[3] Diagnostics (2005) Action Potential Amongst Community Groups: Qualitative research.
[4] Moss, S. (2012) Natural Childhood National Trust

Figure 2. Map showing the OPAL Regional Programme with regional projects highlighted

1.4 OPAL Regional Programme

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 basic national infrastructure for the direct community engagement programme. There are two main strands to the regional network. One is to deliver OPAL National Surveys, described in detail in Section 1.5. The other strand is to investigate a particular environmental research theme, specific to that region (Figure 2) 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. Special attention is given to areas of deprivation and to involving people from disadvantaged groups in society.

Leading academics supervise the Community Scientist and, in most cases, also an OPAL-funded research student (PhD) who, although not obliged to do so, often become involved with the community programme and have even received help from local volunteers with their research. 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. Working together builds a solid foundation for collaborative effort and creates a knowledge exchange mechanism for local issues. Groups included in this collaborative approach are local government, government agencies, schools, wildlife and naturalist groups, communities and voluntary sector organisations, all working directly with the academic partner.

The regional programme introduces scientific study to the community. It provides opportunities for the local community to meet scientists and participate in the collection of data for research purposes. 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 what they can do to help. It has also been of great benefit to the scientists who have been given access to new sites to local knowledge.

> **"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!" (a)"**

1.5 National research centres and surveys

The UN-commissioned Millennium Ecosystem Assessment found that over the past 50 years, humans have changed their environment faster and more extensively than in any period in human history[5]. This has been due largely to rapidly growing demands from an expanding population for food, freshwater, timber and fuel. The result has been loss and damage to natural habitats and a substantial and largely irreversible loss in the diversity of life on Earth. More recently, the UK National Ecosystems Assessment[6] has highlighted the importance of protecting the natural world, the goods and services it provides and its value to human well-being. OPAL research topics focus on environmental degradation, loss of biodiversity and climate change.

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

Each centre is also responsible for producing one in a series of six national surveys. Each survey and the preliminary findings are described in more detail in Section 4. The surveys are the primary mechanism through which the public can explore and learn more about their local environment and contribute to scientific research; other opportunities arise through local community projects carried out by the centre. The 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 site observations, identification and recording of wildlife and site condition measurements. Information needed to take part is also 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, 240,000 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 (i).

Using biomonitors to investigate the environment

Biological monitoring is the use of living things, such as plants and fungi, to monitor environmental change over space and time. These living things are known as biomonitors. Historically, change could only be assessed in this way and 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 crops or aquatic species disappearing due to algal blooms. In recent years, we have come to rely more on hi-tech equipment and computer modelling, used by a small number of experts, who 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 underpins the OPAL programme. In some instances, as with soil, we are trying to find out if earthworms can be used as bio-monitors of soil conditions, whilst elsewhere we are using lichens as bio-monitors to track changes in air pollution. Whatever the outcome, we have tried to raise awareness of local wildlife, its importance and the many different ways that we can benefit when we engage with nature.

[5] Millennium Ecosystem Assessment (2006). Millennium Ecosystem Assessment Synthesis Reports.. www.millenniumassessment.org
[6] UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

1.5.1 OPAL Soil Centre

We often do not recognise the value of what is under our feet, but 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 help to 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 to maintain important functions such as decomposition (break down of nutrients) 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 society. To protect it, we need to understand a great deal more about soil and its biodiversity. The Soil Centre, based at Imperial College London, has shared its expertise and knowledge more widely 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 Survey (section 4.1.1).

> **"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."**
>
> Theresa Mason, Manager of Forgotten Garden (g)

1.5.2 OPAL Air Centre

Invisible and all around us, the air we breathe is a fundamental part of life yet, over centuries of industrialisation, millions of tonnes of polluting chemicals have been emitted into the air. 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 to recognise that polluted air is damaging to vegetation. The effects of pollutants on vegetation were the key topic for the OPAL Air Centre, based at Imperial College London's Silwood Park Campus. The Air Centre constructed 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 chambers, the importance of interactions between ozone and climate were also investigated. As well as providing air pollution expertise, the team led on the OPAL Air Survey (section 4.2.1) in partnership with the British Lichen Society, designing a survey to use the presence of lichen, which are sensitive to air pollutants, to indicate changes in air quality.

1.5.3 OPAL Water Centre

Freshwater is an essential resource for humans 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, based at University College London (UCL), 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 biodiversity. The Water Centre also led on the OPAL Water Survey, which included the additional OPAL Metals Survey (section 4.3.1).

1.5.4 OPAL Biodiversity Centres

In its 2008 report, the House of Lords Science and Technology Committee[7] noted that the state of systematics and taxonomy (the study of the diversification of living forms and the skills to correctly identify and classify individual species) in England was unsatisfactory for proper support of our understanding of the connections between the natural world and human well-being. Un-named species are effectively invisible and therefore impossible to conserve. Although putting names to species is fundamental to conservation, education and to science, it is a skill that is largely absent from formal biological education at all levels, leading to a skills gap.[8]

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 wildlife by providing a user-based platform for identification from a photograph of a plant, animals or fungus (section 3.3.2). iSpot includes identification keys, based on the Bayesian concept of probability, to help participants name the species they find. The Open University also led on OPAL's first Biodiversity Survey which focused on hedges as habitats for wildlife (section 4.4.1).

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. They run a targeted programme of support for natural history groups (section 5.4) and an exciting and varied programme of large scale events to raise OPAL's public profile. The NHM also ran OPAL's second biodiversity survey, Bugs Count, which focused on invertebrates around people's homes, schools and workplaces (section 4.4.2).

1.5.5 OPAL Climate Centre

Climate and weather are two of the most talked about topics today but there remain many misunderstandings and misconceptions around this complex area. The OPAL Climate Centre, based 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 monitoring stations to help assess and explain the urban heat island (UHI) effect. The Met Office led on the OPAL Climate Survey (section 4.5.1), 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.

"I think we learned something new about the environment and about how many animals can live in just one yard."

Student from Fordley Primary in North Tyneside, after taking part in an OPAL Survey (g)

[7] House of Lords (2007-08) Science and Technology fifth report http://www.publications.parliament.uk/pa/ld200708/ldselect/ldsctech/162/16202.htm

[8] Boxshall, G. and Self, D. (2010) UK Taxonomy & Systematics Review - 2010 Report to the Natural Environment Research Council (NERC).

1.6 OPAL Support Services

OPAL is made up of a cohesive network of multi-disciplinary scientists, support staff and the broader community. The support network provides both outward-facing and internal support and is essential to the success of the programme.

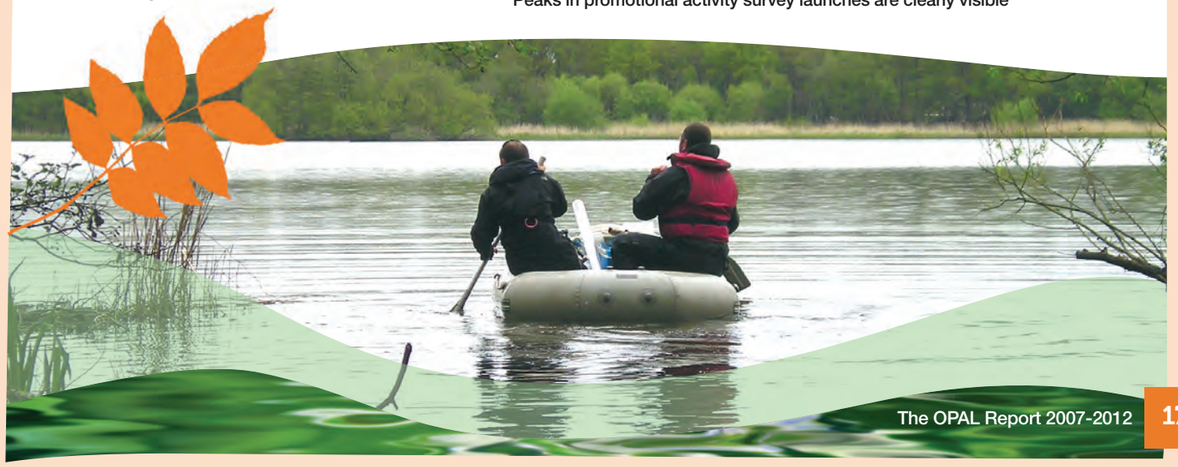
The OPAL website (section 3.3.1), at www.opalexplorenature.org, led, managed and hosted by the NHM, is an essential way of sharing information about OPAL and the place where individuals, schools and communities enter and display survey results and learn more about the environment. It is also home to the educational pathway 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 illustrated in a range of visually exciting ways, helping to make them more meaningful and allowing participants to investigate their own research questions, for example, 'how does the number of dragonfly larvae I've discovered in my pond compare to the rest of the country?' or 'are there more nitrogen-loving lichens in London?' The website also provides a means for sharing news of upcoming OPAL events and relaying community achievements.

The OPAL Communications Officer, based at the NHM, promotes 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 achieved massive media attention with circulation figures at nearly 1 billion (i). Highlights 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. The benefit of gaining media interest to promote surveys is demonstrated by peaks in visits to the OPAL website immediately after a press release (Figure 3 [portal]). Peaks in media circulation figures can also be seen (Figure 4 [media]).

Figure 3. Snapshot of people registering on the OPAL website in 2011. The peak in June 2011 represents the OPAL Bugs Count Survey launch

Figure 4. Snapshot of OPAL media circulation figures in 2011. Peaks in promotional activity survey launches are clearly visible



The NHM supports the regional teams by providing expertise, advice and educational resources as well as developing an OPAL exhibition case within the Museum itself, promoting OPAL and public participation in wildlife recording.

Whilst improving people's abilities to identify wildlife is vital, it is equally important that these findings are then recorded somewhere and where possible shared more widely so that 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) has 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 (Section 5.5). Some OPAL survey data are being made publicly available via the NBN Gateway (online storage of biodiversity data freely accessible for anyone to explore) and on the OPAL website. Through OPAL, the NBN has also developed mechanisms to allow habitat-related information to be displayed with the NBN Gateway's interactive mapping tool, allowing participants to make connections between different species and the spaces they were spotted, e.g. have horseflies been spotted on heathland sites?

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 to lead on the design, printing and distribution of the OPAL National Surveys (section 4). The second is to run a schools outreach and training programme to enable schools across England to participate in all OPAL Surveys and to encourage more outdoor education (section 3.4).

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

1.7 Associates

All OPAL activities have been developed with support from Defra (Department of Food and Rural Affairs) and the Environment Agency, ensuring that they are compatible with environmental policy. OPAL is also affiliated to the Living with Environmental Change (LWEC) programme, which brings together a number of organisations who seek to inform government, providing them with knowledge, insight and the tools to deal with environmental change (section 5).

2. Exploring the outdoors

The OPAL programme is about people and the places where they live and work. OPAL's first objective is to get more people outdoors exploring the world around them.

In this section we explore how OPAL enables people to discover nature, many for the first time, and show that through their discoveries and involvement with OPAL activities, people feel excited and inspired and they realise that being outdoors engaging with nature can be fun. They discover that nature is relevant to their lives and that the way they live can have an effect on the environment. Here we demonstrate how OPAL has enabled people to make a personal connection to nature, how they take their interests further and in some cases, change their behaviour.

2.1 Why being outdoors is important

In recent years, there has been substantial research to suggest that being active outdoors is beneficial to everyone, young people in particular[9]. The benefits are not just related to the increase in physical activity that being outdoors normally brings; experiencing the natural world contributes to a child's personal development and encourages a sense of freedom, which contributes to their well-being (section 2.4). 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 crime[10].

Unfortunately, alongside research that endorses the benefits of being outdoors and experiencing nature, there are numerous studies documenting the decline in time spent outdoors. For example, it has been suggested 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 play[11]. Adults too have found that they are often 'too busy' to visit natural places[12]. With the average UK citizen watching around 4 hours of television per day[13], it can be very difficult to encourage people to spend more time outdoors.

OPAL was designed to encourage people to spend time outdoors by offering a programme that fits into their lives. It allows them to select the place and time that suits them to explore their environment. 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 participant. Furthermore, because OPAL Surveys are divided into short activities, people can choose those in which to participate. This flexible approach appeals to communities (a) and means that OPAL works well for busy families and schools.

> "It's exciting because we've never done that before.
>
> It's like a new experience to go out in the school field and look for bugs."

Pupils from Fordley Primary School in North Tyneside, after taking part in the OPAL Biodiversity Survey (g)

[9] Pretty, J. et al (2009) Nature, Childhood, Health and Life Pathways Interdisciplinary Centre for Environment and Society (iCES) Occasional Paper 2009-2 University of Essex

[10] Church, A., Burgess, J., Ravenscroft, N., et al. (2011) Cultural Services in UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

[11] Report to Natural England (2009) Childhood and nature: a survey on changing relationships with nature across generations. England Marketing

[12] Natural England (2011) Monitor of engagement with the natural environment: the national survey on people and the natural environment. Technical Report (2010-11 survey) (NECR084)

2.2

Inspiring people to spend time outdoors

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 purpose to explore. Getting outdoors is the first step, but it is having a purpose to do something once there that provides inspiration, a sensation reported by many participants, which in turn leads to a greater level of understanding, appreciation and engagement. Many of the statements received from participants indicate that they have discovered new interests and will do outdoor activities again. Many others reported that they simply had a great time taking part in OPAL.

Over half a million people have actively participated in the OPAL programme (i). The length and quality of that engagement covers a broad spectrum from a discussion 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.

Over 1,500 comments submitted via the OPAL website say what a great time they have had, how inspired they have felt or to say what they had learnt or found particularly interesting. 'Fun' was one of the most commonly words used to describe an OPAL activity. A further 2,700 comments provide more information on their survey, indicating that participants are keen to contribute even beyond the requirements of the survey (f). These comments also echo the feelings of participants who have contacted OPAL staff directly to express what a great time they had, or thanking them for their help (examples of which can be found throughout this report).

All participants of OPAL national surveys were asked questions about their experience (d). When asked whether participants had learnt something new, 90% (9801 of 10,891) of people indicated that they had (Figure 5). 85% (9273 of 10,972) said they had developed new skills (Figure 6). Nearly half (5,500 of 12,423) of OPAL Survey participants who answered the question said that this was the first time that they had carried out a nature survey.

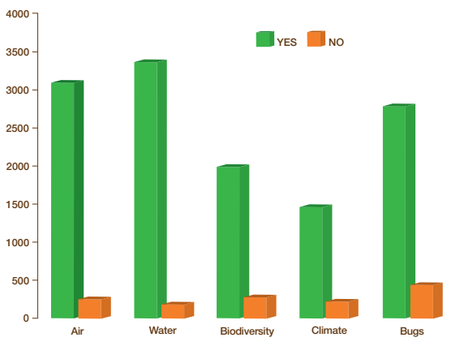


Figure 5. OPAL Survey participants who reported that they had 'learnt something new'. The question was introduced after the OPAL Soil Survey was launched, therefore the soil survey is not included here.

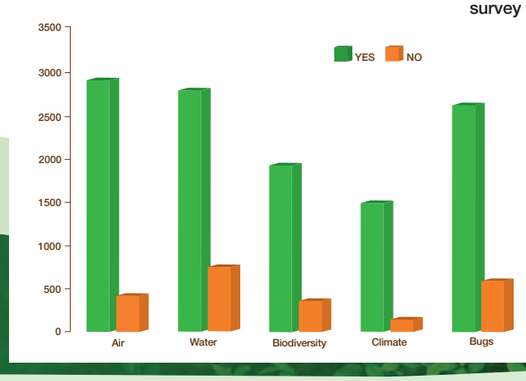


Figure 6. OPAL Survey participants who reported that they had 'developed new skills'. The question was introduced after the OPAL Soil Survey was launched, therefore the soil survey is not included here.

"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 & uncovering the hidden treasure of insects & 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" (f)

Case study

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

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.

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 (h)

Alexandra Palace Park is a large park in the London Borough of Haringey. In June 2010, OPAL teamed up with the BBC's Springwatch Wild Days Out programme, 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 possible breeding population of Stag Beetles, a protected species in the UK.

The response from participants was great. Comments include:

> "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
>
> I enjoyed learning about insects and helping the experts"

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 large variety of techniques to help to engage people of all ages in nature. They have also been important to dispel the myth that all scientists wear white coats and work in laboratories. OPAL staff also attended a number of large-scale science events such as the BBC's "Bang Goes the Theory" Roadshow, the British Science Festival and the annual and prestigious Cheltenham Science Festival.

When children were asked to describe their experiences in our standardised questionnaire (j) given out at events, 95% indicated that they had found the activity inspiring, fun, exciting, interesting or educational.

When asked 'what did you enjoy the most?', children's responses fell into two broad groups: those who enjoyed actively doing something (57%, 163) and those who enjoyed discovering something (30%, 86). Other children indicated that they had simply enjoyed 'being outdoors' and others said they had enjoyed 'everything'.

For those who indicated that they had enjoyed doing something, typical activities included worm hunting, bug hunting or pond dipping. Some were more specific: "measuring the trees" or "holding the worms and digging holes" and some indicated that they had enjoyed using the equipment, "using the tape measure" or "using a magnifying glass".

Of the children who had said that they had enjoyed discovering, finding or seeing something, responses were more specific to what they had found. Typical comments were "Finding the bugs" or "Finding tadpoles" or "Looking at lichens". Other more specific responses included "I liked it when we found a spider"; "I most enjoyed it when I found the snail"; or that they enjoyed "catching mysterious creatures".

Adults were also asked 'what did you enjoy the most?' in questionnaires at OPAL events or activities (j). The results were very similar to those of the children with 39% (86) stating that they enjoyed actively doing something and 36% (78) enjoying learning or discovering something. 7% (16) of people said that they had enjoyed 'everything' (10% (22) of participants did not fill in this question).

Adults were asked some specific questions about the activity in which they had participated. 89% (196) of people felt that they had learnt something new about their local environment and 84% (184) of respondents said that they had developed new skills. These questionnaires indicate that most participants had a positive experience at an OPAL event or activity and mirror results from the national surveys.

It is evident that participants have gained a lot from working with OPAL staff and in particular, OPAL Community Scientists. The approach of teaming experts with the community is described further in section 5.

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! (h)

Research carried out by OPAL's social science team at University of Central Lancashire (UCLan) demonstrates that people's behaviour is changing as a result of OPAL activities. Using results gathered from an online survey carried out by 593 OPAL participants (c), almost three quarters of respondents said that they will try to do more surveys like the OPAL surveys. 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 it. 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 (c).

OPAL has helped people to realise that nature is important and relevant to their lives. Statements and testimonials from people involved in OPAL demonstrate that many people are gaining a passion for doing more outdoor activities. 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 (h).

The Community Scientist for the South West organised two 'children's university lectures' at Forder Valley Local Nature Reserve in partnership with Plymouth City Council. Fiona Sheaff, Extended Services Coordinator at the council, wrote to OPAL after the event, explaining how the activity had opened up new places for families:

"We have had good feedback from parents and young people on these two events. 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 Forder Valley Nature Reserve, who said they would be taking their children there again now that they had been there once". (h)

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 (NEET). 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..." (h)

"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.' (g)"

"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! (b)"

"I am now fascinated [by lichens] and look closely at any I see. (b)"

"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! (g)"

"Thank you for leading the pond survey at St. Gabriel's last week. [...] We really appreciated the hard work you put in and also the training opportunity for staff. We're now going to do some work on improving the health of the pond! (g)"

The experiences of the volunteers demonstrate how OPAL has helped them to raise aspirations. One unemployed young person who came to volunteer with OPAL from Foundation Learning 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.(g)**

Not everyone has access to wonderful spaces such as Forder Valley, but OPAL staff members have supported communities to find spaces on their doorsteps; in some cases, they have even helped them to make their own spaces for nature. For example, four schools that worked with OPAL East Midlands (University of Nottingham) 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 (h). OPAL North East (Newcastle University) rejuvenated Moorbank Botanical Gardens and reopened the space to the public, providing an oasis of nature in the heart of the city.

The chance to take part in real scientific experiments appears to be a strong motivating factor for some people.

A boy working with Scotswood Community Garden in a deprived area of Newcastle, described how he felt at being able to contribute to science as 'unreal' and 'exciting' (g). One young person from Tanfield High School in Newcastle replied to a similar question with 'Quite good actually. Cause they've chosen us, that's kind of good' (g).

Alongside taking part, it is the sense of being able to contribute to scientific research that is an important factor for participants. Steve Gallis, Manager at Baggeridge County Park in Staffordshire, noted:

> **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. (g)**

Case study

The Friends of Greenwich Park 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. (h)

> **...The Hedgerow Biodiversity 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 at Walford and North Shropshire College / Acton Scott Farm Museum (g)

> **...helping scientists was exciting.**
>
> Pupil at Hanley Swan Primary School, Worcestershire (g)

Being able to contribute to research makes OPAL inspiring for people. 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 part of something bigger; it inspires them to take their interest a little 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 genuinely interested in the environment. This is demonstrated by the volume of interest received when each survey is launched or simply that over 25,000 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 Chambers, from Scotswood 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. I think science can be boring, even the title science, can be boring for children and young people. But to be able to do it and actually give them the packs - the whole thing - and say like "this is what we're doing", I think they take kind of ownership of that project'. (g)

> **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. (b)**

2.3 Being inclusive

OPAL aims to be as inclusive as possible, meaning that everyone who wants to take part can. OPAL activities are carried out by people from all walks of life, of different ages, backgrounds and abilities. 28% of OPAL Surveys have been completed by families, friends and voluntary groups (d). OPAL has engaged with over 1,000 organisations, including 500 from the voluntary sector (i). This includes environmental groups, youth clubs, friends-of-parks groups, recording schemes, housing associations, local authorities, natural history societies and museums. Many organisations that OPAL works with have well-established relationships with OPAL staff, are regularly visited for activities and surveys, or work together to hold events.

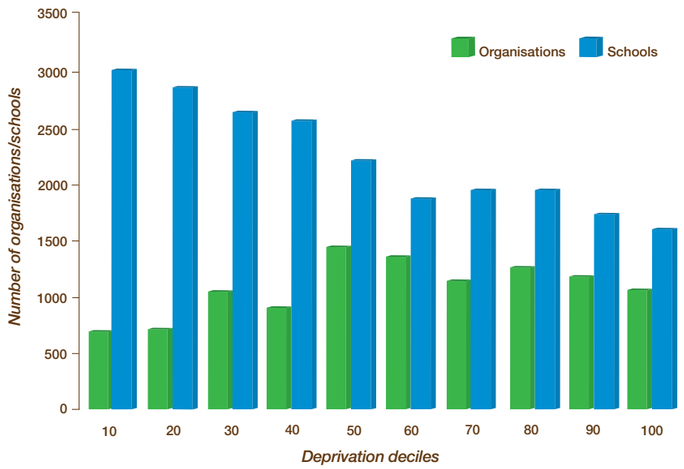
Seeking to introduce new audiences to nature, OPAL has actively engaged with over 100,000 (i) people who are classified as 'hard to reach' (meaning that they are disadvantaged in some way). This represents only one fifth of all people that OPAL has involved; however, proportionately OPAL staff spend much more time with them, working closely in small groups, and working with them regularly to build a strong understanding and trust.

Regional projects use the Index of Multiple Deprivation (IMD)[14] to identify groups from deprived areas. Evidence suggests that the more deprived an area, the more likely it is to experience the worst environmental conditions, such as highest levels of air pollution[15] and people living within these areas have the least access to greenspaces[16]. There is evidence to suggest that they also have the poorest 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 areas[17]. From the start of OPAL, it was recognised that these communities need attention. By dedicating one-to-one time with these communities and carrying out regular visits, OPAL enables 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. OPAL works with a variety of organisations and schools that are located across the range of deprivation deciles (each 10%) (Figure 7). Over 10% of the organisations and schools that OPAL works with, and 6% of submitted OPAL surveys, are located in the 10% most deprived areas in England (i,j).

In Sheffield, OPAL has worked closely with Sheffield Black and Ethnic Minority Environment Network (SHEBEEN) to engage people from local black and ethnic minority communities in OPAL activities. The OPAL Surveys have been used extensively. Here, Maxwell Ayamba from SHEBEEN describes how young people's eyes were opening 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. OPAL air surveys are helping to empower communities to explore, study and find out more about the air pollution in their area and the way the government measures it. (g)"**

Figure 7. Organisations and schools that OPAL has worked with, over the range deprivation deciles



When carrying out the Climate Survey with a group, Maxwell interviewed some participants. Mahmood, who grew up in Pakistan, said:

> **"We learnt from our parents whilst growing up about how the weather impacts on the seasons and therefore food production. In England the younger generation are growing up without an understanding or knowing about the importance of how the climate impacts on them. The climate survey was therefore a fantastic exercise and experience to get young people thinking about climate. It gets them thinking about what the local weather is but also the impact of climate change both locally and globally. (h)"**

[14] Department for Communities and Local Government (2010) The English Indices of Deprivation 2010 [online] www.communities.gov.uk/publications/corporate/statistics/indices2010

[15] Pye, S., King, K., Sturman, J. (2006) Air Quality and Social Deprivation in the UK: an environmental inequalities analysis – Final Report to Defra, Contract RMP/2035 AEA Technology plc http://www.noo.org.uk/uploads/doc/vid_14070_noo_DB_ChildWtSocStatus3_221211.pdf

[16] CABE Space (2010) Urban green nation: building the evidence base Commission for architecture and the built environment (CABE)

[17] National Obesity Observatory (NOO) (2011) NOO Data Factsheet: Child Obesity and Socioeconomic Status [online] www.noo.org.uk/uploads/doc/vid_14070_noo_DB_ChildWtSocStatus3_221211.pdf

Two young enthusiasts from Sheffield, Haleema, age 7, and her older brother Faizan, age 14, spoke at the 2010 OPAL annual conference. Haleema has taken part in many OPAL activities in her area, has been inspired through OPAL and has applied this inspiration to thinking more deeply about the natural world and the importance of protecting it. At the conference Haleema 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 so that they may continue to exist […]. At school we never do practical experiments but I wish we could. (g)"**

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 and helping the members meet new people and improve their social skills.

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. They also enjoyed exploring the gardens and doing artwork inspired by the plants and pond creatures that they found. It was the first time that the group had visited a botanical garden or been involved in any environmental work, and both the young people and their carers had "a fantastic time".

Naveen Naroz from the NAS Newcastle branch 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.(g)"**

Charlie Kennedy NAS Project Officer 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. (h)"**

Charlie 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. (g)"**

Being part of something has helped motivate 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' (g)**

> "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, Derek 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."
>
> Estelle Bryers, teacher at Myerscough College, Preston (g)

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 attending an OPAL committee meeting where they told us that they liked these activities. Staff members at the College have told us that being involved in a national project, and that has a wider purpose, had made them keen to do more OPAL surveys.

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+, have worked together carrying out research on orchards, particularly orchard-dwelling mosses (bryophytes) (see section 4.4.7).

Mary Wilkinson, Leader of the Nature Study Group for 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'. (g)"

2.4 Improving health and well-being

In 2008, The New Economics Foundation (NEF) developed recommendations for improving personal well-being. Four of these are particularly relevant to OPAL activities[18]:

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

> "Definition of well-being*: The extent to which people experience happiness and satisfaction, and are functioning well."
>
> *The Centre for Well-being (New Economics Foundation, 2011)

These four recommendations for improved well-being are integral to the OPAL Programme. OPAL enables people to improve their well-being by motivating them to do something outdoors, allowing them to connect with people and the world around them and learn something new. Testimonials and statements from OPAL participants support this. John Ledson works for an organisation called Community Support Initiatives, based in the West Midlands. John 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."(g)

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." (g)

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 onto other people, be it friends, children or grandchildren."(g)

[18] New Economics Foundation (NEF) (2008): Five ways to Well-being http://neweconomics.org/projects/five-ways-well-being

Learning how to identify wildlife can have a significant positive impact on people. For example, the OPAL Yorkshire and the Humber team run numerous wildlife identification courses (section 3.3.2) and feedback from participants is usually very positive. One participant commented:

"You have all been very generous with your time and help, and I greatly appreciate it. I've found the day confidence-boosting." (g)

The OPAL Yorkshire and the Humber team has also trained volunteers who have existing mental health issues. One volunteer said:

"I've had a great day, the insect walk has given me a purpose to be outside and enjoy the park in other ways" (g)

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"(g)

"It's really fantastic to come to the very core of nature. Long walk by the river, valley, sheep, meadows all are quite amazing to watch. They gave a lot to our mental health. [I have] Become hungry for the next tour."(g)

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. Talking about his experience working with the OPAL East Midlands team, Daniel said:

"The project really inspired me. We worked together and it was lots of fun. It was good to go out and do something positive after being told about the environmental issues. ..The whole experience has been a real confidence booster for me." (g)

"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

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

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 (h).

Giving people the opportunities to get outdoors and explore nature is fundamental to what OPAL does. This can help to improve their health and well-being. But further benefit comes with the additional support that OPAL staff can provide (section 5.2.1). As evidenced by the group from St Mungo's, people value the opportunity to talk to someone in a friendly and relaxed environment. Being asked to contribute to a research project and knowing that the work they do is useful, helps people to feel valued, boosting their confidence and well-being. Neil Rose, the scientist leading the OPAL Water Centre, 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. (h)"

Section summary

Raising awareness of nature and its relevance to everyday life inspires people to explore their local environment

- Over half a million people have participated in the OPAL programme. OPAL activities are carried out by people of all ages, backgrounds and abilities, including 10,000 people in 'hard to reach' communities.
- OPAL opens people's eyes to the natural world. Nearly half (44%) of OPAL survey participants said that this was the first time that they had carried out a nature survey. 90% of participants have learnt something new.
- OPAL has the ability to change people's behaviour. Almost half (43%) of respondents said OPAL had changed the way they thought about the environment and more than a third (37%) said they will change their behaviour towards it.
- In addition raising environmental awareness, OPAL also improves personal well-being by motivating people to spend time outdoors doing something positive, while connecting with people and nature.

3. Learning

Learning about nature and going outdoors to experience it are 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 acknowledge that people will take from the activities what they will. For example, some have told us that they had not noticed lichens before the OPAL Air Survey and now they see them everywhere they go. Others may have learnt that the presence of lichens might tell them something about air pollution.

3.1 The case for outdoor learning

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 earth[19]. The commitment of signatory nations to survey and document the extent of biodiversity on their own territories made its way into UK policy and put taxonomy (the naming and classification of organisms) on the policy 'map'[20]. 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 rates are still declining or improving[21 22] 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, 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.

[19] United Nations (1992) Convention on biological diversity. Available online at: www.cbd.int/doc/legal/cbd-en.pdf

[20] HM Treasury(2004) Science and Innovation Investment Framework 2004-2014 HMSO

[21] The Royal Society (2003), Measuring Biodiversity for Conservation, Policy document 11/03, ISBN 0 85403593 1

[22] The Royal Society (2004) Beyond Extinction Rates: monitoring wild nature for the 2010 target Conference Proceedings

OPAL was designed to fulfil this and more. It was intended as a 'way in' for people new to nature recording and to help create the taxonomists of the future. It was also meant to be fun. When they discover the fun of being involved with nature, people are inspired to start learning more, to find out the name of what they have just seen. For example, 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 to become strongly involved in the natural world and wildlife identification, they may decide to further their interests by joining a natural history society (section 5.4). They may even decide to pursue formal qualifications.

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 increase development of personal and social skills[23].
Through OPAL's extensive schools programme, over 2,000 schools have received OPAL's Surveys and helping 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', which includes suggested lessons plans and PowerPoint presentations, enable teachers to teach the topic. The toolkit is one of many teaching resources that can be downloaded free of charge from the OPAL website. Through partnering with organisations such as the British Science Association, the first environment-related CREST Star award was introduced for primary-aged children.

This section discusses how OPAL's outdoor learning programme has benefited people of all ages, backgrounds and abilities.

3.2 Making learning accessible for everyone

The words 'education and learning' immediately conjure up the typical education structure: school, college, university and so on. 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 education.

OPAL developed a number of activities that are accessible to everyone, regardless of their age or background, and do not require entry into formal education routes. Here, some of these activities are described, beginning with those that are based outdoors then demonstrating how the internet can provide an interactive education and learning experience to support outdoor studies.

3.2.1 OPAL Weather Roadshow

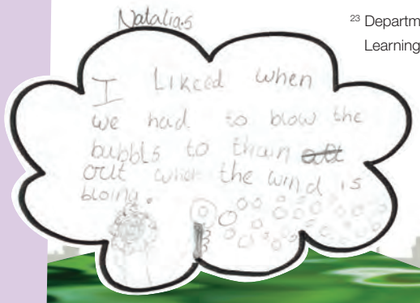
The OPAL Weather Roadshow is a travelling exhibition designed to educate and excite people on weather and climate. The Roadshow has a number of activities, which demonstrate how weather is measured and forecast and how real-life weather phenomena occur. The 'cloud in a bottle' experiment, for example, helps people understand how clouds form, and other activities include demonstrations of air pressure, seeing and touching 'real' tornadoes, simulated 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 allows people to measure and learn about wind, and, most popular of all, get to experience what it is like to be a television weather presenter in the weather studio set up on the Roadshow trailer.

The Roadshow visits a wide range of shows, local events and festivals, travelling around the country from Plymouth in the south, to Newcastle in the north. An estimated 4,500 people have taken part (i).

School groups frequently visit the Roadshow, typically participating 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 about the weather and climate. They have a great time at the Roadshow. One member of OPAL staff working on the Roadshow said:

> **"A high point for all the groups was watching Nathan and Cléa [OPAL Community Scientists] demonstrate how clouds are formed; the children's screams of surprise and delight when the cloud appeared with a loud "pop!" amused passers-by (and the OPAL staff) no end! (h)"**

[23] Department for Education and Skills (DFES) (2006) Learning outsidethe classroom manifesto DFES Publications



A teacher whose class visited the Roadshow in Newcastle said:

> **“On behalf of Archibald First School I wanted to say a huge thank you for the two sessions we attended at the University. The feedback from the children and staff was fantastic. They were truly inspired! Brilliant! (g)”**

At Countryside Live in Lee Valley in September 2011, children attending the Roadshow gave feedback on their experience and overwhelmingly stated that ‘presenting a weather forecast’ was their favourite activity. ‘The tornado’ was another popular activity (j).

3.2.2 Training and identification

As described earlier in this section, there is evidence that the number of people able to name plants, animals, particularly insects, and fungi is declining24,and it is vital to expand the public’s skills in identification and recording techniques if this decline is to be halted. OPAL offers training to everyone in species identification and other topics such as weather, showing them how enjoyable and rewarding it can be. This section presents some examples of the training that has taken place across the OPAL project.

In the Yorkshire and the Humber region, the OPAL regional team has increased the capacity of community groups and individuals through a variety of courses, helping people learn how to carry out the OPAL Surveys and how to identify wildlife more broadly. The team has trained over 500 people, 36% of whom are classed as hard-to-reach (i). Many of the trained group leaders use their skills to train others. Promoted in partnership with the Yorkshire Naturalists’ Union (YNU), wildlife training courses have included fungi, birds, moths and plants. Feedback from participants is always excellent. As well as improving people’s nature skills informally, the courses have benefited the YNU by increasing membership by more than 10% (i).

In the South West, regional researchers investigated methods for teaching and learning about plant identification in response to the growing problem of taxonomic illiteracy, or ‘plant blindness’, and the loss of plant knowledge25. 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 Foundation Learning, the Plymouth Environmental Action Youth Group and 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. Sessions were designed to be fun, with informal teaching methods, such as the use of word associations and pictorial card games to remember plant names and features. 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. Overwhelmingly, the groups also 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 and fun way, plant identification can be engaging for all26. Two young males who are classed as NEET said they wanted to do more sessions like it, and asked for pictures of the plants so they could revise them after the session. Group leaders have since noticed that these two participants now actively seek the plants during outdoor activities. Others commented:

> **“[The session] makes plant identification seem less overwhelming and I can see how to build my plant knowledge bit by bit” (g)**
>
> **“I’ve never done anything like this before and learnt a lot. (g)”**

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.

The OPAL West Midlands team trained volunteers in other areas of their research, who have since gone on to further training. Two volunteers, who worked full-time on bee and bat projects, advanced their environmental education via Masters programmes at Imperial College London and Oxford University and 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 going a step further and is undertaking a PhD at Oxford University.

In the East of England, members of community groups were trained to identify and record seven species of bryophyte (commonly known as mosses) plus the nine lichens in the OPAL Air Survey (section 4.2.1) to assist with orchard-monitoring research. Training events in local village and church halls included field visits and the use of microscopes and keys to identify and recognise bryophytes and lichens. OPAL keys to bryophytes 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 new community orchards that are gradually becoming important habitats for biodiversity.

It is not only species identification training that OPAL has offered. The Royal Parks works in partnership with the Met Office to provide training to a number of 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 monitoring pollution. The volunteers 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 Online learning resources

3.3.1 The OPAL website

The OPAL website is an essential part of the OPAL programme. Here, newcomers can learn about OPAL, 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. People can download free educational resources to help them with fieldwork or simply learn more about the environment. Visitor numbers to the OPAL website are over 390,000, with over 9,000 registered users and nearly 140,000 identification guides, survey packs and activity sheets have been downloaded.

Maddie Wilson, Science teacher at Eggbuckland Community College in Plymouth, comments 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). (g)”**

[24] The Royal Society (2003), Measuring Biodiversity for Conservation, Policy document 11/03, ISBN 0 85403593 1
[25] Schussler E and Olzak L (2008) It’s not easy being green: student recall of plant and animal images. Journal of Biological Education. 42(3): 112 – 118
[26]

Comments from people using the OPAL website include:

> **Fantastic idea, good website, very fun and enjoyable (f)**

> **I would recommend your website to friends and families and we learnt a lot from your site. (f)**

Coinciding with the launch of the OPAL Climate Survey, web pages for the OPAL Climate Centre went live. As well as a fun 'test your climate knowledge quiz', the website team provided some innovative learning opportunities, including the 'Ask the expert' section, where users submitted over 200 questions to the Met Office about climate change. The most frequently asked question was "why are we so worried about carbon dioxide when there are so many other significant factors?"

Encouraging people to develop their learning and take it in new directions is an important part of the OPAL programme. The OPAL Educational Pathway web pages are designed to be a 'one-stop-shop' for OPAL resources and a guide on where participants could go next with their learning journey. The OPAL e-learning programme gives people the opportunity to learn how to take part in OPAL Surveys in a fun and interactive way.

More recently, a mobile phone app was developed to accompany OPAL's sixth survey, Bugs Count (section 4.4.2). This free app combines an invertebrate identification guide with the ability to take a photo of a Species Quest 'bug' (one of the six species selected because its distribution is changing) and submit it to the OPAL website in real time, from any location that has 3G coverage. It utilises the inbuilt camera and GPS capability of modern phones to create an instant and accurate biological record of what was found, where and when. The app has been downloaded over 5,000 times. This type of mobile technology is likely to play a vital role in the future of wildlife recording and it is fantastic that OPAL has been able to facilitate and freely share such a technological development. The app is currently used as a model for mobile-based recording by several UK natural history societies.

3.3.2 iSpot

iSpot .org.uk

The iSpot website www.ispot.org.uk , created and managed by The Open University, has been a massive 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. More than 250,000 people have visited the website and 17,000 are registered users.

"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." (g)

"[…] 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 likeminded people. I have also noticed how helpful everyone is and the odd laugh too." (g)

"[…] I am new to iSpot and have to say that having a community of people with the knowledge and enthusiasm to help with the identification of all the creatures people come across is a brilliant thing." (g)

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 8).

iSpot has as unique reputation system at its heart, recognising, developing and rewarding people's expertise in identification. Not only does this improve people's skills but it makes the whole experience as user-friendly as possible.

iSpot has nine areas of reputation. Points can be earned for every observation or comment made and scores for successful identifications made in each of the eight iSpot Groups: Amphibians and Reptiles, Birds, Fish, Fungi & Lichens, Invertebrates, Plants, Mammals and Other organisms.

iSpot is supported by a whole host of experts from many different nature societies (over 80 different organisations are officially represented), meaning that anything a user observes and uploads to the site, will nearly always be verified by an expert. An official 'iSpot Expert' is someone verified by the iSpot team as an expert in a particular area of nature.

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 (see opposite page) and the extraction of biological data to pass to recording schemes.

As a testament to the success of iSpot, the website won a Wildscreen Panda Award in 2010, in the new media category. Testimonials from users in the online iSpot discussions forum demonstrate its impact. Wildlife recording societies much appreciate the increase in observations that they receive. 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, adding to the wealth of information about UK biodiversity held there. iSpot has received so many observations for some species that the data have become a valuable and unique scientific resource. For example, photographic observations of shieldbugs reflect recent northward and inland spread of species, most probably due to climate change. The spread of invasive species such as the Harlequin ladybird is also being recorded through iSpot.

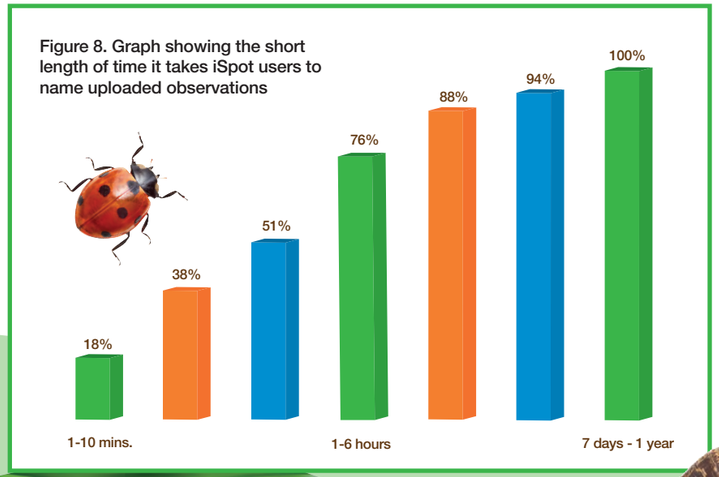


Figure 8. Graph showing the short length of time it takes iSpot users to name uploaded observations

> **In October 2009, six year old Katie Dobbins from Berkshire found an unusual looking furry moth on her windowsill. Intrigued, Katie's father posted a photograph of the moth on iSpot. Insect specialist Martin Harvey 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 the moth is native to Asia. Katie and the moth created a significant amount of press interest. (h)**

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 representatives are badged on iSpot.

The team of OPAL Biodiversity Mentors (section 5.2.2) that works face-to-face with people all over England has enabled iSpot to reach new audiences. These dedicated nature enthusiasts help people with their identifications on iSpot, but spend much of their time outdoors, encouraging people to get involved with the natural world and to use iSpot.

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). The keys are available on iSpot and mobile devices that can be as easily taken into the field or lab.

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, and will produce more for some of my other specialist groups this winter if I may. (h)"**
>
> Dr Tim Rich, National Museum Wales.
> Tim produced a key to a set of plants (the Northern Hawkweeds) that are known to be difficult to identify.

OPAL's learning resources have enabled people to explore the outdoors. In summary, these resources are:

- The OPAL website, holding a wide range of resources to help people learn about the natural environment. Over 390,000 visits have been made to the website and over 9,000 people are registered. Almost 140,000 surveys, identification guides and activity sheets have been downloaded. The online educational pathway and the OPAL e-learning programme gives people the opportunity to development their learning even further.
- iSpot, the wildlife identification website, providing an online social network for species identification and recording using photography. Over 100,000 photographs have been sent to iSpot. More than 250,000 people have visited the website and 17,000 are registered users.
- The OPAL Weather Roadshow, with state-of-the-art equipment and technology and exciting challenges and activities, helping people to learn about weather and our changing climate. 4,500 people have visited the Roadshow.
- OPAL's six National Surveys, providing people with a complete package that enables them to go outdoors and explore the world around them (section 4).

3.4 Formal learning programmes

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. 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. Here follows evidence to show how OPAL has made a big difference to the education of young people and helped teachers with outdoor learning.

3.4.1 Schools

OPAL has worked with nearly 2,000 schools (1032 secondary; 813 primary) as well as a number of Pupil Referral Units (PRUs) and schools for children with special educational needs (SEN) (i). Of these schools, 13%, including 23% of the primary schools, are in the top 10% most deprived areas in England[27] (i). Over 66% of the national survey data submitted to the OPAL website is from school children, contributing new information on over 1000 sites (d).

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 OPAL survey and, of these, over 20% have taken part in all six surveys (i). To ensure that children with fewest opportunities could explore outdoors, the FSC targeted schools in areas of deprivation (IMD 2010). This resulted in 15% of schools with whom they worked with or delivered surveys to being in the top 10% most deprived areas in England (i).

The FSC's OPAL Education Officer delivered nearly 400 outreach sessions over the course of the OPAL project 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 (i).

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

Feedback from students after receiving an education visit from the FSC (g):

> **"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

[27] Department for Communities and Local Government (2010) The English Indices of Deprivation 2010 [online] www.communities.gov.uk/publications/corporate/statistics/indices2010

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. One of the schools with whom the FSC work is Blessed Edward Oldcorne RC Comprehensive School in Worcester, which has found using OPAL to be immensely beneficial to them. Teacher Rebekah Hodson 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.." (g)

Rebekah also reported that when asked by National Strategies, part of the Department for Education, how they achieved such a high uptake in biology, the school said: **"…we show them [children] real biology outside, it's not textbook, it's not PowerPoint, it's the real world". (g)**

The OPAL North East team achieved a great deal for science education in Newcastle. Over 150 pupils from across Newcastle City centre participated in 'Plant Masterclasses' at Moorbank Botanic Garden, where the OPAL North East team designed classes in collaboration with local teachers, which provide a range of 'hands on' science-based activities to learn how plants can adapt to different environments. One popular activity includes a 'Forensic Botany workshop' whereby children and adults learn how plants could be used to solve a 'murder mystery' 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. Mr Harbinson, Headteacher 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. (g)"**

Mr Harbinson and other local head teachers indicated the important role that OPAL played in helping the region achieve a 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.(h)

Such are the remarkable achievements of the OPAL North East team that they were cited in the Science Excellence and Innovation Partnership (SEIP) report to Newcastle City Council in 2010-2011.

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 (www.plymouth.gov.uk/steppingstones), 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

The OPAL East Midlands team at the University of Nottingham also found that OPAL changes young people's perspective on studying science subjects. They found that teachers often comment how scientists visiting from the university help to raise aspirations (particularly in schools where university uptake is low) and give students opportunities to use technologies and equipment they could otherwise not experience. 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 (g)"**

Engaging with OPAL has a significant lasting impact for many schools, with some embedding outdoor work into their lessons. In a filmed interview, one teacher from Heald Place Primary School, 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. (g)"**

Another teacher from Heald Place Primary 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. (g)"**

"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 in 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!" (g)

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

A teacher from Feversham College in Bradford told the FSC in an interview that since participating in OPAL, there will be 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". (g)

Students also value working with OPAL scientists and using the surveys.
A student from Tanfield Secondary School in Durham told the OPAL North East Community Scientist that he had taken the cloud chart from the OPAL Climate Survey home with him. He commented:

"People say science is rubbish and boring, but come to think about it everything has something to do with science. It's really interesting, even cars and engineering have something to do with science. Other people might say "oh, why do stuff in the hedge" and then I would just say "it's full, you never know what you could find. Inside the hedge you can find a beetle, you can find a spider, you could actually find a ladybird". (g)

Another student from Tanfield Secondary School said:

'It's getting us to be more scientific and more adventurous and we might decide that it is a career choice when we're old'. (g)

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. Mike Randles, Head of Science 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." (g)

Evaluating environmental education in Yorkshire and the Humber
One OPAL research project looks at the practice of 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.

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 (i), and twilight sessions in particular received some very positive feedback. Giving teachers this confidence in biodiversity identification enabled OPAL surveys to reach more people than the OPAL team would normally have the capacity to reach.

In interviews with Primary School teachers about the OPAL Surveys (e), 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 topic:

"Good "wow factor" to start a unit and then focus down afterwards". (e)

Another teacher from a Primary School in Plymouth noted how useful they were for teachers:
"It was not only the children that benefited from the experience; I and the other teachers that took part in the sessions really learnt a lot". (g)

Leaving a legacy for environmental education in the East Midlands

Leaving behind 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. Some feedback from the day includes:

"… inspirational. One of the best events I have attended (g)"

"I've gained a better understanding of a wider range of environmental education (g)"

Linking with their regional research, 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 (http://www.opalexplorenature.org/EastMidlands).

"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. I would not have done it before attending this course."

Comments from teachers attending

"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, does make 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". (g)

3.4.2 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.

Gill Buckeridge, 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."(g)

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 statemented children 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" (e).

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 mini-beasts, pond-dipping, and small-mammal trapping. The York team found that they were reluctant to talk about their experiences but were willing to communicate their thoughts and feelings through other means and so the they were encouraged to take photographs and build a scrapbook (h).

> **"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. (g)"**
>
> Teacher from Walford and North Shropshire College

Oswestry Pupil Referral Unit (h)

Oswestry Education Centre, situated on the Oswestry campus of Walford and North Shropshire College, is a Pupil Referral Unit catering for up to 18 pupils aged 12-16 years old. Pupils referred to the centre require additional help and support to develop their skills as successful learners. As well as helping pupils complete their education, the centre aims to improve their confidence, hone their personal and social skills and boost their self-esteem. Pupils who attend this centre have a range of social, behavioural and learning disabilities including autism, ADHD and phobias.

Pupils from this group participated in each OPAL survey and enjoyed the opportunity to work outdoors. Taking part in the various 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.

Speaking of their experience with OPAL, one pupil said 'I enjoy working outside – it's better than being stuck in the classroom.' A teacher said: '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.'

OPAL's universities

10 of the 15 organisations within the OPAL partnership are universities so teaching at university level is an inevitable part of OPAL's educational programme. Here is a selection of the programmes in which OPAL is included:

- Urban ecology – the regional focus of the OPAL West Midlands team – is used as part of their undergraduate courses at the University of Birmingham;
- The OPAL Soil Centre, based at Imperial College London, works with a number of students on the MSc Environmental Technology course, using the OPAL Soil and Earthworm survey as part of their research projects;
- OPAL Air Surveys are used in MSc projects at Imperial College London;
- The University of Hertfordshire use 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 field work as a measure of water quality assessment and as part of a post-graduate aquatic science course;
- The OPAL Yorkshire and the Humber regional team, based at University of York, have engaged a number of MSc students to use OPAL for their projects and also use the OPAL Surveys as a large part of undergraduate teaching.

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 (section 3.2.1), 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 (h).

The Royal Parks team has worked in partnership with the Holly Lodge Centre to engage young people in each of the six OPAL surveys. The Holly Lodge Centre is for people with special needs, some of whom are very severely impaired. The team used the basis of the OPAL surveys to encourage interest in the environment and involvement with the activities. While the information collected was of limited scientific value, the sessions proved enormously beneficial to the young people participating (h).

3.4.3 Further and higher education

As part of the programme of research, OPAL funded ten post-graduate PhD students, with an additional student funded via the Engineering and Physical Sciences Research Council (EPSRC). Nine students were based in regional centres, focussing on research topics of local interest. Two students were based in national research centres - the OPAL Soil Centre (section 4.1) and the OPAL Water Centre (section 4.3).

The Open University developed a short course called Neighbourhood Nature, giving students an introduction to nature recording and other field techniques.
As part of the course, students devise and conduct a small field study and write about it to be assessed at the end of the module. They learn how to make observations and use iSpot (section 3.3.2) to record these. One of the students commented:

"I really enjoyed the course and would recommend it to anyone interested in getting in touch with nature. Lichens are everywhere and I have never been aware of their presence and diversity in my very neighbourhood. It gave me a good start into the subject (observing methods) and got me ambitious to find more." (g)

3.5 Other educational methods

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 were sent to 785 schools and clubs that are part of the CREST Star 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 was particularly excited about working with OPAL as previously CREST Star had no environmental activities. At the time of writing, information on how the activities are used is still being collated but one teacher, from Larmenier and Sacred Heart Catholic Primary School reported:

> **"I have used the 'Tree for Life' activity. I found the first session great, as we went to the local park and studied the trees and what we found living in and around them. (g)"**

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 nitrogen oxide 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. (h)

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 NHM and British Lichen Society were able to help and the school was invited to exhibit their work at the prestigious Royal Society Summer 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 (i). Such was the interest in the climate and weather in particular, that OPAL sponsored the re-launch of the Scout Associations' Weather badge, and through a visit by the Weather Roadshow to a Cub Scout camp in 2012, OPAL helped over 150 young people with the weather experiments they needed to complete to earn their Weather badge (h)

The NHM 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 (NCS). 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 (h).

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 about nature. 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:

- St Osmund's Primary School in Salisbury
- Osbaston Primary School in 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, James Ruse, 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, 4 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.

The trip to the Natural History Museum was amazing. A number of the children hadn't been to London before so it was a huge occasion for them. We all felt proud and our Year 4 children still mention the day". (h)

Section summary

OPAL designed and delivered an informal outdoor education programme for people of all ages, abilities and backgrounds

- OPAL resources are stimulating, straightforward and informative. Over 800 primary and more than 1,000 secondary schools have registered for OPAL materials. Over 60% of OPAL field data has come from schools.
- OPAL's high quality science programme instils confidence in teachers and students. Over 1,000 people have taken part in OPAL training sessions. 17,000 registered users have used iSpot to improve their identification skills.
- OPAL is broadening people's natural history knowledge and skills. Over 390,000 visits have been made to the OPAL website.

4. Research

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 history[28]. 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.

The challenge now is to improve the way we interact with our environment and learn to live and work in a more sustainable way. The scientists leading the OPAL programme designed their research with maximum public participation in mind: they want to continue with their research, which addresses some of the environmental challenges, but also to provide an opportunity for the public to participate in and learn about research and its value to society and to gain new skills and knowledge along the way. 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 discuss their work with people of all ages, abilities and backgrounds.

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** deliver research in air, water and soil, in which there are varying levels of public participation. These range from visits to research sites, lectures, data gathering with experts, discussion and information provided on the OPAL website.
- **Regional research programmes** offer local people opportunities to participate and/or learn about research carried out in their locality.

Increasing people's confidence in recording and identification is an important part of OPAL. Our evidence suggests that we have successfully done this. The following statement is taken from a focus group about OPAL Surveys:

"When I started I was a bit unsure… but then after that I realised that it's not that difficult. I would say that having done one survey, I would feel more confident in doing another one, even though it might not be the same type of survey. I'd think 'well, I've done one, and it's not as difficult, so I would feel more confident in doing another". (b)

[28] Millennium Ecosystem Assessment (2006). Millennium Ecosystem Assessment Synthesis Reports. www.millenniumassessment.org

"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."

Chairman of the Friends of Sandall Park (g)

The research topics for the national ecological surveys were agreed at the inception of the programme: soil, air, water, biodiversity 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 a further 25,000 downloaded from the OPAL website. The surveys alone have contributed scientific data on almost 25,000 sites across England. 84% of participants said they would carry out another OPAL survey, indicating that they want to continue with their new interest in recording wildlife (j).

Preliminary results are presented at the start of each Section followed by other associated research, either carried out by the OPAL National Centre or another OPAL project sharing research interest in the topic.

4.1 OPAL Soil Research

4.1.1 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, and probably in the world. Members of the public contributed survey results from all manner of places but particularly from their back gardens (25% of surveys), locations normally out of the reach of scientists.

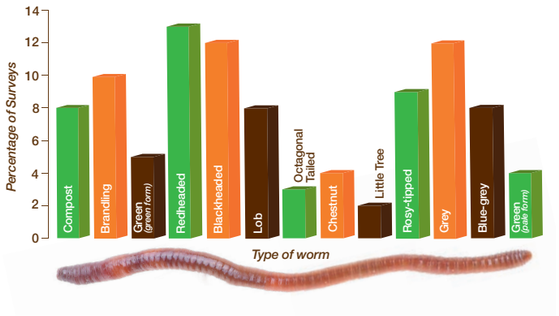
The Soil and Earthworm Survey involved:

- digging a soil pit (20 cm x 20 cm x 10 cm depth);
- recording soil characteristics: number 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 affect soil productivity by influencing soil pH, structure, water holding capacity and water flow); and
- counting all earthworms in the pit and identifying the adult earthworms using OPAL's 'Key to Common British Earthworms'.

Since the launch of the Soil and Earthworm Survey in March 2009, results from over 4,000 surveys have been received and more continue to arrive. Of these, 63% of surveys were returned by school groups. The most surveyed habitat type was gardens, which represent one quarter of surveys, followed by playing fields at 22% (reflecting the high level of input from schools).

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. The rest were juvenile earthworms which were not identifiable because they have not yet developed the anatomical features which allow you to tell 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 found earthworm was the Redhead worm (Lumbricus rubellus) (Figure 9).

Figure 9. Graph showing the worm species found in OPAL Soil surveys. The redhead worm was most commonly found, closely followed by the black-headed worm.



Everyone is familiar with earthworms, which are common in gardens. The survey results reveal that 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 earthworm abundance and species richness or diversity compared with other urban habitats. This may be because gardens make good homes for a wide variety of earthworms. 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. For example, a garden may have a grass lawn, flower beds, compost heaps, and rockeries, all of which may attract worms with different preferences in where they live. 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, which 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 earthworms and gardeners.

Woodlands in towns and cities can provide valuable habitats for many species of plants and animals, and can be important in increasing urban biodiversity. 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 (Allolobophora chlorotica), the Grey worm (Aporrectodea caliginosa), and the Rosy-tipped worm (Aporrectodea rosea). By contrast, the Octagonal-tailed worm (Dendrobaena octaedra) is most common in woodlands but rare in grasslands. The Redhead worm (Lumbricus rubellus) is probably the most widely distributed earthworm, found in most habitats.

Construction material was the most commonly found foreign object, reported in 18% of surveys. In the majority of surveys (64%), no objects such as cut wood, glass, and coal were found in the soil. Garden sites were found to contain a higher number of objects than other habitats, and sites in urban environments were found to have higher numbers than those in rural or suburban settings; this was not surprising, considering that gardens by their nature are adjacent to buildings of human activities, and urban environments are areas of greater density in human activity.

The pH of the soil (i.e. how acid (0-6 pH) or alkaline (8-14 pH) it is) 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 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). The topsoil pH reported by OPAL participants identified the same broad-scale patterns as found by scientists in earlier surveys. It identified the more alkaline soils of the South and East of England and the more acidic soils of the North and West of England, (Figure 10). 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 solid 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. They do not have the extreme characteristics and behaviour of pure clay (solid and mouldable) or sandy soil (crumbly), and are easier to dig and plough. Gardeners and farmers like soil of this type as it is the best for growing seeds and plants.

During the OPAL project, the Soil Centre's earthworm scientist attended more than 60 events, held numerous earthworm identification courses across the country and carried out training sessions for allotment holders, teachers, community groups and others.

The results of the Soil and Earthworm Survey have provided scientists with a greater understanding of soils and earthworms in otherwise rarely studied areas. The data submitted by members of the public have identified four large areas of England of interest for more detailed study, and allowed scientists to study the interaction between earthworms, soil properties and pollution. The OPAL Soil Centre involved two PhD students and 14 MSc projects, on topics ranging from soil pollution and earthworm ecology to public understanding of environmental issues.

The OPAL Soil and Earthworm Survey and further research by the Soil Centre (section 4.1.2) have provided a unique look at the soils and earthworms of England. It has encouraged thousands of people to go out into their local environment and learn about soils and the earthworms living in them1. The good news is that because of the varied soils and microhabitats that they contain, gardens have been discovered to be the great homes for earthworms meaning that people and earthworms make fantastic neighbours for one another.

Figure 10. Map showing soil pH distribution across England.

[29] Bone, J.et al (2012) Public participation in soil surveys: lessons from a pilot study in England. Environmental Science and Technology, 46 (7), 3687–3696

4.1.2 OPAL Soil Centre research programme

The research undertaken by the OPAL Soil Centre covered a diverse range of topics surrounding the protection of soils. 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 the wider negotiations of soil protection policy in the European Union in order to understand how best to protect and improve this important part of the environment.

The results from the OPAL Soil and Earthworm Survey helped the OPAL scientists to identify areas of England that seemed interesting due to the numbers of earthworms found. Research in these areas involved working with farmers, land owners and managers to collect detailed information on earthworm species, soil properties and pollutants on their land, in order to investigate those interesting trends identified by the public.

The results from this work described differences in earthworm numbers across habitat types, as well as providing an insight into the factors influencing earthworm populations, and how pollutants move through the environment. This work has generated a large amount of new information about soil properties and earthworm populations in the areas studied such as which soil properties have most influence on earthworms being present.

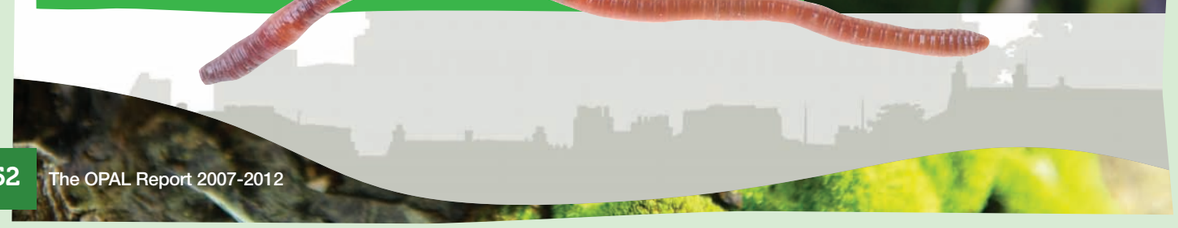
A further research theme of the Soil Centre aims to understand how humans might put pressure on the soil system and how it might change because of this pressure, exploring whether human activities have a positive or negative effect on soil and its biodiversity; and how these activities might affect the wider environment. This phase of the Soil Centre's activities includes an investigation of the environmental impact of spreading waste and by-products, such as municipal compost and by products from paper recycling, on agricultural land. Whilst finding potential usages for waste and by-products has significant environmental benefits, a practice known as amendments, some concerns have been expressed in the past over this practice releasing pollutants. The OPAL scientists are carrying out a study of greenhouse gas emissions from amendments spread on land to understand how waste management decisions can influence climate change. A further detailed investigation is currently under way into the influence of different amendments 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.

Citizen science in soil protection policy

Research into the role of citizen science in soil protection was carried out with funding from the Engineering and Physical Sciences Research Council (EPSRC). 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 how soil quality is assessed. Using OPAL Soil and Earthworm Survey data, the research showed that some areas of England have higher numbers of earthworms than others. This finding directed fieldwork to compare areas of the country that appear to have higher or lower numbers of earthworms and understand what might be causing these patterns. This involved collecting earthworms, soil properties and soil samples from these areas, which were subsequently analysed for a number of types of pollutant: metals, poly aromatic hydrocarbons and pesticides.

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 could be due to leaf litter, stem flow (flow of intercepted water down the trunk or stem of a plant), and/or throughfall (wet leaves shedding excess water onto the ground surface). 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.

PhD project – Soil



4.2. OPAL Air Research

4.2.1 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.

Air pollution affects the quality of our lives. 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 (N) have increased, mainly as a result of agricultural activities, such as the manufacture and use of N-rich fertilisers, and asa consequence of burning fossil fuels for vehicles and heating. Whilst N is essential for plant growth, large amounts in some forms can be harmful (N-pollution). Consequently, we need to understand what is happening so the impacts of manmade N on the environment are the focus of much scientific attention.

Directly monitoring air pollution is expensive and requires specialist knowledge and often costly equipment: Scientists use networks of monitoring sites to measure pollution levels in the air and also create computer models to estimate pollutant concentrations and deposition over large areas. These measurements and models are used by the government to meet European Limit Values established to protect our health and that of the environment. This approach to air quality management was explained in the OPAL Air Survey. Organisms such as lichens respond to local air pollution and can provide also us with some indication of changing atmospheric conditions. Recording sensitive organisms such as lichens can alert us to important changes in our local environment and 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 (neutral) lichens);
- the presence of green and orange coloured algae;
- the presence of the nine indicator lichens on tree twigs; and
- 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). They are fascinating and unique organisms and they are also extremely helpful to humans in understanding 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 what 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 since these times, lichens are still one of the most widely used biomonitoring systems today. The OPAL Air Survey focused on lichens that grow on trees. Trees are among the longest living organisms on the planet; they are, therefore, subject not only to current atmospheric conditions but may also show a legacy of effects of earlier pollution levels.

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 develops large black spots 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 surveys of lichen had been submitted to the OPAL website, with data from over 14,000 trees. Analysis of data on oak trees shows a negative relationship between total lichen diversity and raised levels of N-pollution, i.e. as the amounts of N-pollution in the atmosphere increase, the number of different types of lichens decreases. 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.

As expected 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 controlled and air quality has changed. We expected lichens to return to our cities and the OPAL survey has confirmed this to be the case with nitrophytes (nitrogen-loving species) most frequent and abundant. Interestingly, nitrophytes were also widely recorded just as frequently in rural areas, suggesting that different forms of N-pollution are affecting their distribution.

Results from the OPAL Air Survey also clearly show that climate (temperature and rainfall) can affect the types and quantities of lichens. Areas with higher temperatures and rainfall have fewer lichens and a less diverse community. These findings support published data and indicate that, if climate change predictions of increasing temperatures and changing patterns of rainfall occur, lichen communities could be more at risk in the future.

When examining the effect of N-pollution on Tar Spot fungus (Rhytisma acerinum), the main factors controlling

its distribution were the amount of N deposited in rainwater (as opposed to being 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, demonstrating that public participation in research provides valuable data that can help us to understand the impact of pollution on our surroundings.

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

4.2.2 The OPAL Air Centre research programme

The Air Centre is located at Imperial College's Silwood Park Campus in Berkshire; the Centre itself has teaching rooms, laboratories and other facilities for visitors, including facilities for disabled access. The site was host to a wide range of different communities from very young children visiting for annual fun days to local authorities and other specialists, wanting to know more about pollution and vegetation. It has also hosted summer schools for children of all abilities and backgrounds, introducing them to the concepts behind air pollution, its link to human activities and its impacts on the natural environment.

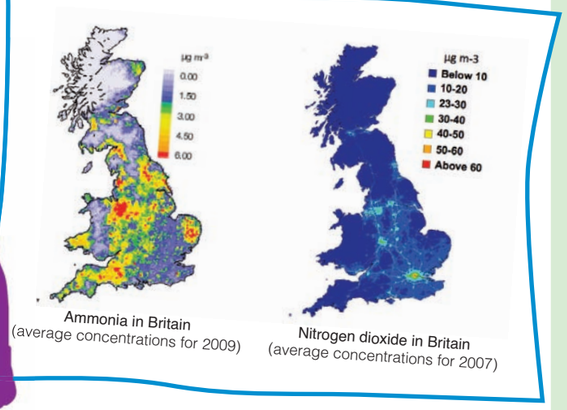
The research team investigated the effects of the air pollutant ozone on vegetation, using semi-open top fumigation chambers. These allowed measured levels of ozone to be applied to plants in a controlled manner. Different watering regimes were also used to simulate the effects of drought, in order to assess how predicted future changes in rainfall patterns (perhaps as an effect of climate change) will affect plant communities (the diversity and abundance of different types of plants that commonly grow together) and their response to ozone. Investigations were carried out on a variety of typical acid grassland plant species, including clover, plantain, bird's foot trefoil 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 foodstuffs 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 reduced plant growth; the magnitude of growth reductions varied between species, resulting in large changes at the plant community level. Research carried out at the Air Centre has provided important new insight into the likely impacts 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 experiment on spinach and onions show that they can be affected by ozone, showing both visible damage on their leaves and reduced plant performance such as growth rates, even over relatively short exposure periods.

Maps of Ammonia and Nitrogen levels in Britain



Ammonia in Britain
(average concentrations for 2009)

Nitrogen dioxide in Britain
(average concentrations for 2007)

4.2.3 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 day, in 2008[30]. These vehicles emit a suite of pollutants, including nitrogen dioxide (NO_2), a form of N-pollution. The potential for impacts of air quality on (sub) urban 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 NO_2 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. Other activities included educational school visits and talks to community groups.

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. Further analyses established which of the measured environmental variables are most likely to influence plant species composition, biodiversity and plant growth at each site.

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.

[30] South East of England Development Agency (SEEDA) (2010) The South East of England profile SEEDA

4.3 OPAL Water Research

4.3.1 The OPAL Water Survey

The OPAL Water Survey, led by University College London, was launched in May 2010. Good water quality is essential for the many animals and plants that live in and around our lakes, ponds and rivers. Water is easily affected by pollution from agriculture and industry, waste we throw away, and air pollution.

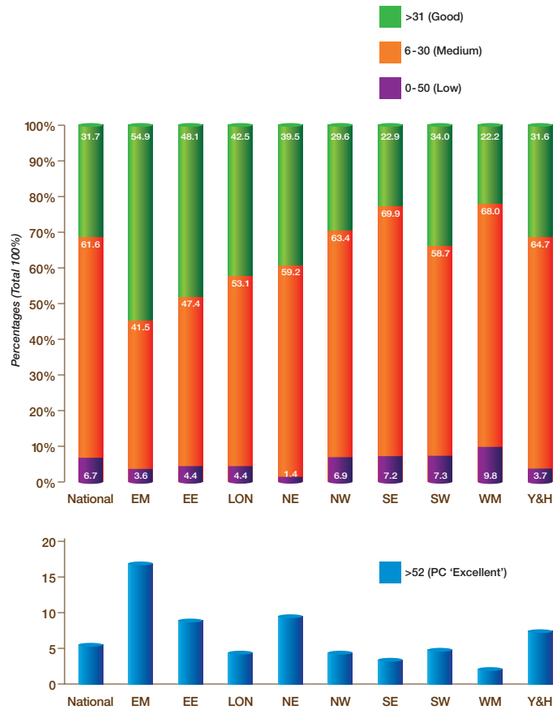
The survey included four activities:

- 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 system previously developed by Pond Conservation[31]; and
- 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.

By the end of 2010, 3,098 responses had been received with an additional 877 by the end of 2011. These surveys were well distributed across the country. 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 from 2010, 6.7% of surveys reported poor water quality, while 62% were intermediate. 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 are available for anyone to explore on the OPAL website; for example, you can compare the relationships between invertebrate species and site information, such as water pH. www.opalexplorenature.org/InteractiveInvertebrateGraphs

Figure 11. Water quality results nationally and by region. The upper panel shows the scores for the whole country (left hand column) and then for the 9 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, considered 'excellent' water quality.

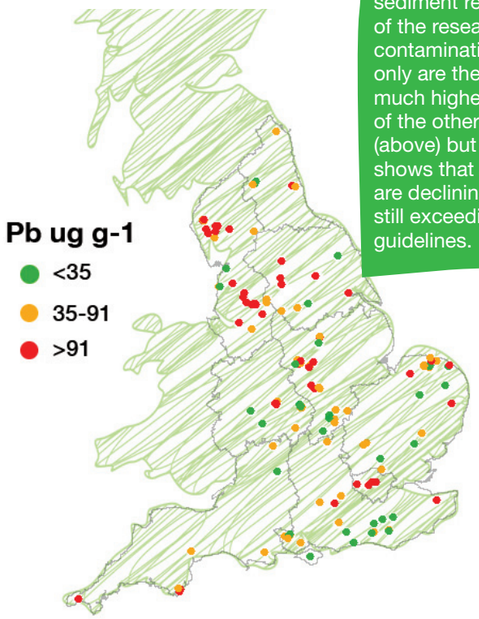


[31] Pond Conservation (2009). The development of the Big Pond Dip invertebrate survey method. Pond Conservation

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 appears to be the first of its kind, certainly the first in the UK. Interested 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 (Pb), cadmium (Cd), copper (Cu), zinc (Zn) and nickel (Ni), using X-ray fluorescence (XRF). Mercury (Hg) was also analysed, using atomic fluorescence spectroscopy (AFS). 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 database[32], which holds extensive national records of soil and stream geochemistry. A series of calibration experiments was also undertaken to assess how these littoral (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 12 shows the distribution of these categories across England for lead (Pb). As expected there are various 'hotspots' of elevated Pb concentrations; these occur in each region. Although there is a wide range of Pb concentrations within each region, the north-west region shows the highest mean value and south-east the lowest.

Figure 12. Distribution of lead (Pb) in lake and pond littoral mud. Red symbols represent concentrations above the probable effects concentration (PEC) (91 µg g-1) 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) (35 µg g-1) at which biological effects are rarely observed. Yellow 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 (above) but the sediment record shows that although concentrations are declining (i.e. improving), they are still exceeding sediment quality guidelines.

4.3.2 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 (POPs) 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).

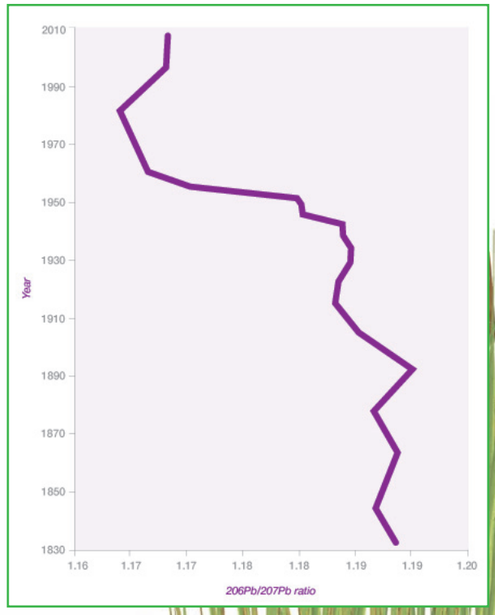
[32] British Geological Society Data holdings [online] www.bgs.ac.uk/gbase/data.html

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 decadal and centennial time-scales. The team carried out sediment core analysis of chemical and biological parameters at each of the monitoring lakes to see these long-term changes. Each core was dated using radio-isotopes (210Pb; 137Cs) 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 13 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 Pb emissions have declined significantly since the 1970's, due to not only the removal of Pb 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 Hg) and persistent organic pollutants (POPs) 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 POPs 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 Hg (>790 ng g-1) were found in a pike (Esox lucius) from Marton Mere (north-west region). Pike are piscivorous (fish-eating) and therefore tend to accumulate Hg 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-isomerisation[33]. This finding has major implications for research into the way in which these chemicals are thought to transfer along aquatic food-chains.

Figure 13. Pb concentration and Pb isotope ratio for a sediment core from Crag Lough. Increasing Pb concentration and simultaneous decline in the isotope ration indicate an increase in anthropogenic contamination. The reversal in recent years (decline in Pb concentration and increase in isotope ratio) indicates the start of a recovery.



[33] Harrad, S et al. (2009). Current-use brominated flame retardants in water, sediment and fish from English lakes. Environmental Science & Technology 43: 9077 – 9083.

4.4

OPAL Biodiversity research

Two OPAL surveys concentrated on biodiversity. The first, the OPAL Biodiversity Survey, 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 OPAL Biodiversity Survey, 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. Each survey is described in detail below. There were a number of regional research projects on biodiversity, also described below.

4.4.1 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 (eg, 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; and
- 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 surveyed 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%.

Delivering the OPAL Biodiversity Survey

The Open University's OPAL iSpot Mentors (see section 5.2.2 for further description) played a key role in delivering the Biodiversity Survey. Mentors distributed over 6,000 survey packs at various events and activities to groups and individuals interested in exploring hedgerows as havens for wildlife. Group leaders were facilitated to run Biodiversity Surveys with their groups through 'Train the Trainers' events run by Mentors across the country. Schools were particularly keen to do the survey, for example, Colin, Biodiversity Mentor for the South East, worked with the South East Grid for Learning (SEGFL) who used the survey as part of their Hedgewatch Day for schools across the South East. Participating schools were supplied with OPAL survey packs and submitted their results to the OPAL website. SEGFL also designed a self-contained microsite for Hedgewatch microsites2.segfl.org.uk/view_project.php?id=357 and streamed video on the day, which allowed schools to show their videos to each other and ask Colin questions.

The three most common hedge species 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's not clear why this difference arises, and this may just reflect variations in how the hedges were sampled on particular occasions.

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 those who added their results to the OPAL website received feedback, explaining the meaning of the scores, could explore the results further through interactive graphing, and were provided links to the extensive information and hedge management advice available through the Hedgelink website.

4.4.2 The OPAL Bugs Count Survey

The OPAL Bugs Count survey investigates how the built environment affects different groups of invertebrates. It also raises 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 to help map their changing distributions. These include the Green Shieldbug, whose distribution is believed to be expanding northwards as a result of climate change and the Tree Bumblebee, a pollinator that is relatively new to the UK and increasingly common in urban areas. The survey is supported by a detailed identification guide.

This is probably the first UK survey to look at the full range of terrestrial invertebrates. In just one year since its launch, more than 5,400 completed surveys were submitted and an amazing 808,000 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.

Initial results highlight the importance of the built environment as a resource and refuge for many groups of invertebrates. Human-made hard surfaces (such as walls, fences and tarmac surfaces) were found to be frequented by bees and wasps, flies and spiders in particular. Although the overall diversity (at a taxonomic group level – e.g. the bee family rather than the bumblebee species) on such surfaces was lower than for other habitats, the number of individuals within the groups that were present was often very high. The data support existing information that vertical structures such as fences and building walls provide excellent habitats for spiders. Their often exposed location and speed at which they warm up (especially on sunny days) also makes them ideal basking locations for flying insects. A greater diversity of invertebrate groups was found on both soft ground surfaces (including short grass and exposed soil) and taller plants. Unsurprisingly, leaf-litter and soil specialists such as worms, centipedes and millipedes were particularly frequent in the former and true bugs and pollinating insects like true flies (e.g. hoverflies), bees and butterflies on the latter.

65,000 Species Quest sightings were registered. Some of these records are supported by a photo, allowing identification to be readily checked and confirmed. Five natural history societies benefit directly from these data and use the information to support wider efforts to map the current UK distributions of the six species.

Bugs Count events and activities run by the Natural History Museum's OPAL team included themed days in inner city schools, events at major festivals such as the BBC "Bang Goes the Theory" festival in Bradford and a wide range of outreach activities within the Museum and other London venues.

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.

4.4.3 West Midlands regional project: city ecology

The OPAL West Midlands (WM) 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. They 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.

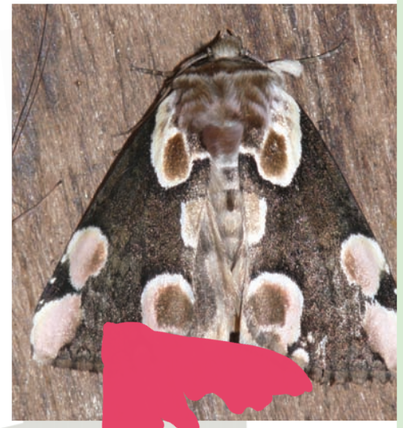
Accommodating people and wildlife in cities is crucial because of the many services that green spaces provide for us, including helping to improve our emotional well-being[34]. All research carried out by OPAL WM has included some community involvement, whether intensive training in scientific survey methods of bats and birds (Sections 4.4.3.1 and 4.4.3.2), 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 (GMS) and community volunteers to study the effectiveness of a variety of garden moth traps and the effect that garden character and landscape context have on the moth faunas throughout Britain.

4.4.3.1 The effect of urbanization 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 cities[35]. 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 faunas 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 nesting habitat for aerial nesting solitary 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.

4.4.3.2 The effect of urbanization on moths

The Garden Moth Scheme (GMS) is a national survey of the moths in volunteer's 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, urbanization 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.



[34] Sadler JP, et al. (2010) Getting life into cities: the importance of greenspace for people and biodiversity. 230-260 in Gaston KJ (ed.) Urban Ecology. Cambridge University Press, Cambridge.

[35] Bates AJ, et al. (2011) Changing bee and hoverfly pollinator assemblages along an urban-rural gradient. PLoS ONE 6(8): e23459 Available on-line at: www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0023459

4.4.5 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 re-vegetate 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 iSpot (section 3.3.2). 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.

4.4.7 East of England regional project: orchard monitoring

Orchards have played a vital part of 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 (bryophytes), liverworts and lichens on the tree trunks and branches. These contribute to the overall biodiversity of orchards, which has been of increasing interest due to major losses of old orchards and now 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 bryophytes 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 bryophyte species commonly found in orchards in the East of England and also of the nine lichens used for the OPAL Air Survey. Surveyors used prepared samples to make comparisons in the field and samples were also taken indoors for examination using microscopes. Identification was facilitated by illustrated keys to over 20 species of bryophytes 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 bryophyte and lichen colonisation can also be incorporated into management plans.

4.4.9 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 18th century, however, the East Midlands 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, the release of nitrogen-containing compounds into the atmosphere by human activities, such as intensive farming practices and burning fossil fuels. If this nitrogen is deposited into heathland soils, it could 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 bryophytes on orchard trees in Hertfordshire and Cambridge. Quantitative data was collected on a minimum of 10 trees per orchard. A total of 26 bryophyte 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 bryophyte species. Because orchards are complex habitats other variables including management are also important and may also have an impact on the distribution of bryophytes.

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 of heathland sites was related to modelled quantities of nitrogen deposition. In other words, 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 has yet 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.

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'). Results from the OPAL Climate Survey have helped scientists validate their climate models.

4.5 OPAL Climate Research

4.5.1 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. Contrails and urban heat islands (UHI) are two areas of growing interest in the scientific literature, particularly in the context of our changing climate. The former are quite easy to see; they are tracks left behind airplanes in the sky that sometimes do not disappear and turn into clouds, representing a way in which our activities can have implications for climate. The UHI effect is more difficult to notice: it is the difference in weather and climate between an urban environment and its rural surroundings, meaning that you would have to be standing in two places at the same time to feel it directly! It is, however, another clear way in which human activities (the building of towns and cities) 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 people.

The survey activities include:

- looking for contrails in the sky to help to test the accuracy of existing computer models that tell us where contrails should be;
- taking measurements of wind at cloud level and near the ground to study how obstacles in our environment, such as buildings and trees, affect the speed and direction of wind in the spaces where we spend time; and
- asking participants about their level of thermal comfort and 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. 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 the humidity close to flight level. For example, the expected 'east-west' divide in contrails was also observed. Many spreading and persistent contrails were observed in the West of England, but mostly short or no contrails were reported in the East. The analysis of humidity at flight level for that day also showed high humidity in the West, consistent with an expectation for contrails, and low humidity in the East that would not be expected to support persisting contrails. The daily, annual and regional variation of contrail reports depends more on the times and locations that people reported contrails, rather than the actual variation of contrail occurrence. This made it difficult to draw conclusions about the temporal and spatial distribution of contrails. However, the observations can be used to validate atmospheric models by comparing them to contrail predictions, based upon temperature and humidity data of the atmosphere. 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 14). The bubble wind speeds compare well with Met Office estimates of wind speed at heights of 10m. The bubble wind speed measurements were on average one-third of the wind speed at 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, improving estimates of wind-chill for different environments.

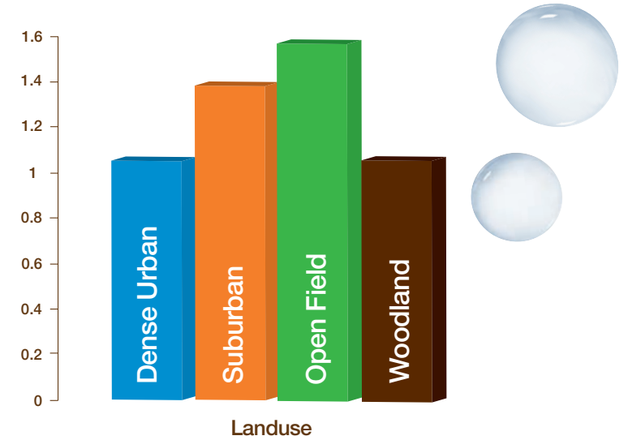
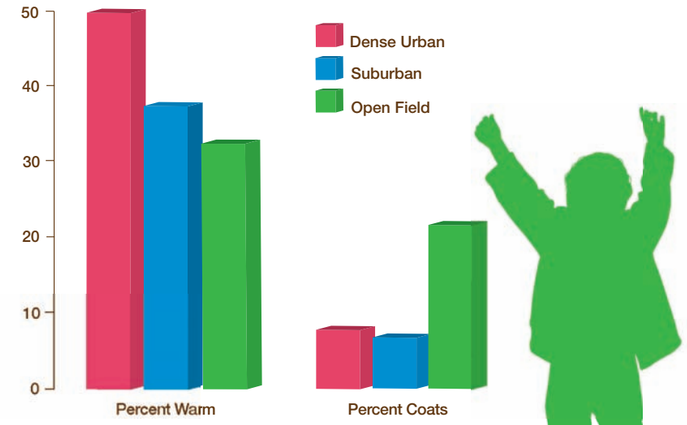


Figure 14. Average wind speeds reported by participants blowing bubbles for different reported landuse types.

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 14-16oC, 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 15). 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. The results from the wind speed experiment for example, can be used to determine whether such localised wind measurements improve estimates of the local 'wind-chill' factor, compared with standard Met Office data.

Figure 15: Percentage of people feeling "warm", and percentage wearing coat for air temperatures in the range 14-16oC during the OPAL climate survey.



4.5.2 London regional project: the urban heat island (UHI)

The 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; 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, a total of 43 across London.
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 (http://weather.lgfl.org.uk/)
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% (+/- 3%) 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 aerosols acting as nuclei 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 relatively large uncertainty in the result could also be an important factor. 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 urban heat island effect. The results from this research also have implications for urban solar power generation, another topic being studied by the OPAL team.

Climate modelling in London

The OPAL London 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 and the model simulates the current and future weather for London at a resolution of 2 km across London. The model includes the special characteristics 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, 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 dissipate heat to the environment to maintain its temperature. As climate change could potentially affect both of these attributes (on average, in the long term) we may expect a connected rise in the risk and occurrence rate of heat stress. This will be most severe in cities where the urban heat island effect can make the urban environment warmer than rural surroundings. Further to this, 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 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 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 and photosynthetic efficiency in the deciduous English oak (Quercus robur) and the Mediterranean evergreen Holm oak (Quercus ilex) in upland, urban and rural conditions. Growth and photosynthesis were 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.

Section summary

Everyone can contribute to environmental research

- OPAL scientists designed a series of field-based ecological surveys on soil, air, water, biodiversity and climate. 230,000 field packs have been distributed to schools and community groups and over 1,000 training courses delivered.
- OPAL participants have added a wealth of new data and helped to further scientific understanding. The public has surveyed over 25,000 sites across England and entered the information into the OPAL national database for analysis. Communities have also contributed data to local research studies.
- Taking part in a national research programme was a key motivating factor for many participants.
- Scientists have developed strong links with local communities helping the public to gain a greater understanding of what scientists do and the relevance of science to their everyday lives. OPAL scientists have found that working with the public is rewarding and can bring real benefits to their research.
- Greater public involvement in environmental monitoring has created a greater sense of connection and ownership of local spaces. 84% of participants said they would carry out another OPAL survey, showing that they want to continue with their new interest in recording wildlife. The majority of scientists involved want to continue to engage the public in their research.

Working together

In this section we discuss why working together is important and how OPAL's approach has led to the development of a new environmental network across England. OPAL has brought together the voluntary, community and statutory sectors, all of whom are working towards the same objectives of improved environments and increased well-being.

5.1 Why collaborate?

The OPAL partnership includes 15 organisations that have worked together for nearly 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 research to address major environmental problems. The OPAL portfolio brought all of 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."(g)

OPAL worked with over 1,000 organisations. By working with people in their local communities, sharing knowledge and skills, OPAL makes a difference towards improved environmental knowledge and action. OPAL aimed to make more people aware of environmental issues and provide an opening for people to become involved in helping to address them. This approach was to create a more informed and empowered society and to ensure that everyone worked towards the same goals.

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. Scientists carry out their work with the help of community members and explain how to take measurements to record, monitor and better understand their local area. Each region has a 'Community Scientist' who helps deliver their project's research but ensures the links between the research and the local community organisations and schools, arranging activities and delivering the national surveys. These strong regional relationships help the national centres to reach out to local people and act as a point of contact for people to get in touch. A bottom-up approach has been effective in engaging with local people and is recognised and promoted as an effective means of working (Localism Act 2011[36]). OPAL brings together the statutory, voluntary and community sectors under one umbrella.

[36] Great Britain. Localism Act 2011 (Chapter 20). Publisher: The Stationery Office

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. For example, through the Gill Stevens Awards (inside back page), OPAL brings schools and natural history societies together.

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, Trusts and Friends of Parks Groups;
- Online communities such as iSpot;
- Ask the Scientists online;
- Blogs and social networks, such as Facebook and Twitter.

5.2 Public engagement in research

Over the past few years there has been growing interest from central government[37] and Research Council UK[38] (RCUK) in bringing scientists, policy-makers and the public closer together. 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 community and scientists closer together so we conducted some research to try to understand the impact that OPAL has had on the scientists involved and their careers (k).

The scientists, Community Scientists, students and volunteers in OPAL are enthusiastic about the concept of OPAL; for them, some of whom who had spent decades working in the environmental field, others who had only recently started their journey, it is an opportunity to meet people and enthuse them about subjects that they care so much about that has made the project such a positive experience for them. OPAL has been instrumental in changing scientists' attitudes towards outreach:

> **"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. (k)"**

OPAL scientists have also felt a real need for this communication to occur: the topics addressed by OPAL are important, and projects like OPAL can help build a sense of urgency that biodiversity and climate are under threat.

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 harder 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. One lesson relates to the integration of outreach activities within existing institutional structures. OPAL scientists have often felt that university career structures as well as the general institutional setting did not reward outreach activities like OPAL as much as they should, and a few therefore struggled to satisfy both the public engagement and the research goals of OPAL at the same time, having to choose to focus on one or the other. One OPAL Scientist commented:

> **"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. (k)"**

[37] Dept. for Business Innovations and Skills (BIS) Science and Society [online] http://interactive.bis.gov.uk/scienceandsociety/site/

[38] Research Council UK RCUK Public Engagement [online] www.rcuk.ac.uk/per/Pages/Home.aspx

This suggests that future interactions with universities and public engagement projects need to be based on earlier and meaningful dialogue; the success of OPAL will be an invaluable pointer in these discussions that these types of projects can work both on the public engagement and the research side if supported by an institutional commitment.

Another lesson learnt through OPAL relates to breaking down the boundaries between science and the public. 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 and so 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 invent and test new ways of interpreting and using public data, which is gathered through different mechanisms than scientists are used to utilising. However, these innovations will prove invaluable for the design of future projects. There are still some remaining doubts and anxieties over convincing the wider scientific community that this type of science produces worthwhile results, and here the demonstrable scientific successes of OPAL will be crucial as a springboard for bringing public generated data and research into the scientific mainstream.

5.2.1 The role of the Community Scientist

The OPAL programme built a unique role into its structure, that of the Community Scientist. The Community Scientist is someone with a science background, some with a PhD (qualification awarded to a scientist following a unique piece of research), 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. OPAL-funded PhD students, whilst not Community Scientists themselves, often worked alongside their Community Scientist in their region with community groups and schools and thereby have made a huge contribution to the project.

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. OPAL's social science team have found this from comments made 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. I think if I'd just been sent he survey form, I might have given up halfway through! (b)"**

> **"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. (b)"**

> **"The people who've been running it [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". (b)"**

The FSC worked with the Naseby Battlefield Project. The Naseby Battlefield site is one of significant historical interest as the site of a decisive battle in the English Civil War in 1647 but it is also a wildlife haven with ancient hedgerows, ponds, farmland and woodland. The FSC has organised outreach at Naseby for visiting local schools on six different occasions since the start of the OPAL project. The results from these surveys were used by the Northamptonshire Natural History Society to consider which animals and plants to include on the information boards. (h)
This is an excellent example of how a successful partnership between OPAL, the Naseby Battlefield Project and the Northamptonshire Natural History Society proves that working together and combining interests can be beneficial for all parties and the local community.
Ian Dexter, Naseby Battlefield Project Trustee, talks about the day when a nature trail was launched:

'Without OPAL's superb support, the opening of the Naseby Nature Trail on 28 September 2011 would not have been the great success that it was. The organisation of 150 local primary school children by [Community Scientists from the East Midlands team and the OPAL Education Officer from the FSC], and the high level of interest shown by the children, was extremely impressive. [The] advice and expertise and liaison with the Northamptonshire Natural History Society in planning the event were invaluable.' (g)

> **"I have been teaching for 11 years and have co-ordinated Science in school for the past 5 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. (g)"**
>
> Teacher, Rydon Primary School, Plymouth

> **"Thank you so much for this opportunity, you have opened my eyes to a world that is incredible and literally on my doorstep! You and the bugs have changed the way I view the world and it really is beautiful and magnificent. (g)"**
>
> Student, York

> **"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. (g)"**
>
> Teacher, Greenfield Lower School, Bedfordshire

> **"...My granddaughter, Jess, 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 [community] scientist, telling people about interesting things. (g)"**
>
> Recipient of an OPAL Community Award 2010, York

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 in detail here:

"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 hot drink), outdoor activity, indoor teaching session, followed by informal discussion and relaxation worked well. 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". (h)

Building up trust and confidence in people is integral to the success of OPAL Community Scientists; this trust and confidence is evidenced by the statements from participants noted throughout section 2.

5.2.2 Biodiversity Mentors

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. In the East of England, the regional mentor has had success in stimulating public interest in local wildlife: a prize discovery in the region, posted and identified on iSpot by a five year old boy at the RSPB Titchwell Marsh reserve, turned out to be a rare sawfly (Cimbex luteus).

In the South West, one family from Helston attended two bat walks as part of an Exploring Nature series led by the region's mentor. One member of the family said:

"I never thought that so close to becoming a teenager, my son would be so excited about going out with the family to an event like this, he is so excited about getting his own [bat] detector for Christmas (g)"

In the north, the 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 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… (g)"

5.3 Bringing community, statutory and voluntary sectors together

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.

The examples from section 5.2.1 demonstrate how instrumental community scientists have been in creating such environmental networks with voluntary, community and statutory groups to run events and activities and create educational resources.

The regional steering committees help to support these networks. Held approximately twice a year, these committees allow organisations to come together and discuss ideas and priorities in their area, as well as allowing regional OPAL teams to inform them of local and national OPAL initiatives. Building these networks is important and helps achieve OPAL's fifth objective, which is to connect people. Of the 1000 organisations that OPAL has worked with, 54% are classed as voluntary, such as wildlife clubs and friends groups, 36% are classed as community, such as recording by the local schemes and societies and 10% are statutory, (this figure does not include schools) such as parks services (Figure 16) (i). The various types of organisation are shown in Figure 17.

Linking science, policy and the community is important. Through OPAL, representatives from Defra, the Environment Agency, Living with Environmental Change (LWEC) and the community meet at the OPAL Project Advisory Board twice a year. The board provides OPAL with general guidance and advice.

There are many benefits from partnership working, particularly in research, where new findings may be relevant to local people and require immediate local action. Papers published in academic journals take time to produce and often are not easily seen unless publicised through the press but, through collaboration during the research phase, local input to both research design and benefits from early research results can be important. OPAL staff work in partnership with many organisations and involve people living where they conduct their research. This may be through disseminating leaflets, by giving talks to local groups or just by chatting with local people. The relationships have proved to be beneficial.

The OPAL Soil Centre worked with the Environment Agency and British Geological Survey, using their experience in running established soil surveys to develop the OPAL Soil and Earthworm Survey, together with the Field Studies Council and the Natural History Museum. The Environment Agency also worked very closely with the centre to compare what the public reported with their existing understanding of soils in England. The Soil Centre collaborated with these organisations on the research programme, where they gave input into experimental design and results analysis. Sites for detailed fieldwork were accessed by working with farmers, landowners and property managers, with results from the sites they looked after fed back to them. Research into spreading waste and by-products to land took place in collaboration with the Environment Agency and ADAS. These partnerships across the range of project activities brought together the public with applied geoscientists, policy makers, and agricultural and environmental researchers to improve understanding of the soil ecosystem.

Figure 16. Breakdown of OPAL organisations by Community, Voluntary and Statutory

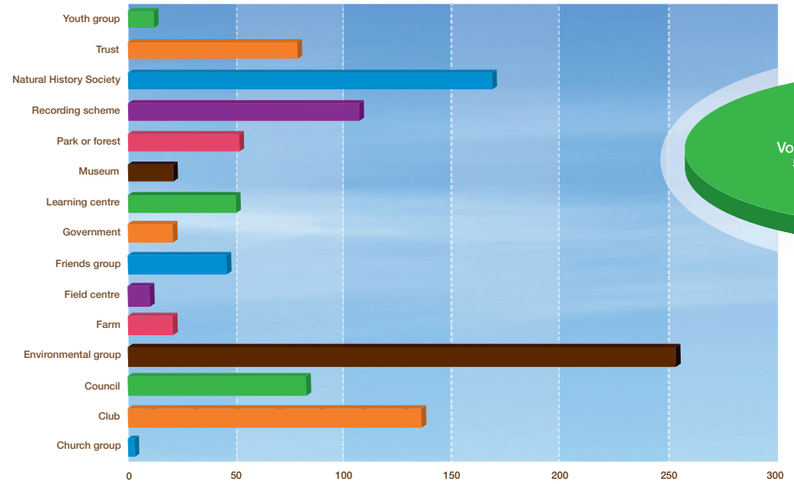


Figure 17. Breakdown of organisations that OPAL has worked with

The Soil Centre also led a number of earthworm identification courses, to help people learn how to identify worms. The courses were hosted by the Master Composters, volunteers who encourage people 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. Jane Griffiths, 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 the Master Composters 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. (g)"**

As part of their research, the OPAL Water Centre (section 4.3.1) discovered an invasive species of crayfish in Fleet Pond in Hampshire, which led the local rangers to take immediate action, helping to prevent loss of other important organisms in the pond. The rangers were not aware of the presence of the invasive crayfish before the OPAL team surveyed the lake. This, and other research carried out by the OPAL Water Centre underpins a new £0.5m restoration project for this SSSI lake (h).

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 Dave Barlow 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". (g)

The OPAL London team worked in close partnership with the London Borough of Haringey at Bruce Castle Museum. Bruce Castle in Tottenham, North London was the home of Luke Howard who, in 1803, recognised that clouds changed according to the weather and attributed names to clouds, which still exist today. In recognition of this, the OPAL London team commissioned a film about the life of Luke Howard and clouds. The film is now shown as part of a permanent exhibition at Bruce Castle Museum, along with other displays that the OPAL London team put together and a quiz, which involves cloud observation. The team held 'weather days' for local schools, and the OPAL Weather Roadshow visited the site. Liz Sutherland, Education Officer at Bruce Castle Museum, wrote to the team after one visit to express her thanks:

> **"I am sorry I have not thanked you before now for the wonderful Weather Station equipment and the sessions you provided for Bruce Castle Museum and our local schools. I think the week was a real success (g)"**

Linking science and policy, 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 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 Engaging with 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. Natural history societies are run on a voluntary basis and many have supported OPAL national surveys and events across the country. Some groups helped with the development of the national surveys as well as through the supporting the regional work of OPAL Community Scientists. To recognise and champion their work, OPAL, through the Natural History Museum (NHM), designed a programme to support them and bring them closer to the public.

There are hundreds of natural history groups in the UK, and many were believed to be struggling to survive, however, there were very few hard facts to support this assumption when OPAL began.

In late 2008, OPAL began a consultation with natural history societies to separate fact from fiction, to understand the challenges they face, and to identify the most effective ways that OPAL could help. Over a period of four months, information was gathered from 166 groups via questionnaires, workshops and in-depth interviews. The consultation allowed OPAL to draw out key underlying factors that limited the successful development of these groups, 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; and
- poor networking and collaboration between groups.

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, and 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, 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, the NHM launched the OPAL Grants Scheme, distributing small grants of between £500 and £5,000. Over the course of three rounds of funding, 74 grants were awarded to over 70 different groups, totalling over £175,000.

The scheme aimed to encourage societies to expand their reach, and inspire and train a new generation of environmentalists. It has been a resounding success, bringing 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 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! All 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 fun and locally relevant way for years beyond OPAL.

How one society contributed 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, designed a 'next steps programme', redesigned their membership form to make it more appealing to newcomers, supported the Royal Society Schools programme resulting in a Royal Society Summer Exhibition for schools, and continue to analyse and promote OPAL survey results.

The grants brought enormous benefit to these groups. 46% of grant-funded societies saw their membership numbers increase by 10% or more (h). 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.

One of the greatest achievements of this Grants Scheme was to reach out to and support groups who do not 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, a wonderful legacy for the project.

Here are just some of the 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." (g)
Teme Valley Wildlife Group

"We feel that 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 post-graduate students, at some of our recent courses. This bodes well for the future!" (g)
Dipterists Forum (a group that records flies)

'An unexpected good outcome was the need for some of the members to liaise to a closer extent [with other members] than is normal within the Society… [and] got to know one another better.' (g)
Horsham Natural History Society

'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' (g)
Butterfly Conservation Sussex Branch

Just a few examples of OPAL grants scheme-funded projects are given below; a full list can be found on the OPAL website (www.opalexplorenature.org/Societyfunding):

- Orpington Apiary Club built a new demonstration beehive in a public green space, which has been visited by several thousand adults and schoolchildren. School trips to the Environmental Education Centre in the park will include a visit to the observation hive in future.
- Sorby Natural History Society ran wildlife identification courses covering diverse topics, including ichneumon wasps, mammal bones from pellets, snail-killing flies and botanical illustration. A number of university students attended the courses then joined the Society and have since become active members.

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.

5.5 New software for recording wildlife

The NBN holds the national database, called NBN Gateway, 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, 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 to recording.

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 used by a number of organisations for data gathering, including (i):

- the British Dragonfly Society uses Indicia for its online recording;
- Plantlife uses Indicia for their '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 around100 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;

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.

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.

Indicia

Section summary

Governments alone cannot resolve the environmental problems facing society today; we all have a role to play.

- OPAL has worked with organisations from the voluntary sector (54%), the community sector (36%) and the statutory sector (10%), together designing programmes that bring people closer together at the local level, explaining environmental policy and promoting field work.
- OPAL provides support to Natural History Societies awarding grants to over 70 groups to help promote their work, create new online resources and encourage new members. 46% of OPAL grant-funded societies have reported over 10% increase in membership.
- Scientists have worked in some of the most deprived areas of England and with people from disadvantaged backgrounds. Many minority groups have welcomed the OPAL programme and started to record nature for the first time.
- Close collaboration between different sectors of society has resulted in a greater understanding and appreciation of the different challenges each sector faces under changing environmental conditions and identified some of the ways in which we can support each other and contribute to a sustainable way of life.

So What

Making a real difference to people and the environment

England's environment is changing. England, like most areas of the world, is affected by issues such as loss of biodiversity, degradation to 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 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.

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 the 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 and some people, so they tell us, 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 that research. 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 and keen volunteers has been vital.

OPAL has a toolkit through which to reach this level of engagement: National Surveys launched every six months, Community Scientists, data entry 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.

Valuable benefits accrue to the people and communities engaged in OPAL. 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 in some places.

OPAL provides leadership in the area of citizen science and public engagement with research. 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'[39]. The current lack of consistent methods to help local people and local authorities to make decisions relating to their environment is of real concern.

[39] Cabinet Office Big Society [online] www.cabinetoffice.gov.uk/big-society

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

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 to conserve and protect the natural world on which we all depend for our well-being.

OPAL has created a valuable legacy:

- A new environmental network that brings the community, statutory and voluntary sectors closer together to a more sustainable way of life;
- A new outdoor learning programme, which includes an extensive range of resources for all ages, backgrounds and abilities;

Increased membership and new resources for natural history societies;

New online resources including:

- The OPAL website www.opalexplorenature.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

A series of Guides that draw upon lessons learned and best practice from OPAL (to be published in 2013). Topics include:

- Public engagement in research;
- A guide to taxonomy;
- Developing and maintaining community science;
- Working with hard-to-reach groups;
- Running outdoor learning activities with schools;
- Creating an environmental survey for the general public.

New public exhibitions, including:

- An exhibition on the biodiversity of The Royal Parks;
- A permanent exhibition about public participation in biological recording at the NHM.

A variety of local impacts and benefits as a result of the OPAL regional programme. Too numerous to name them all, 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 bryophytes and lichens found in the East of England.

OPAL has helped to build stronger relationships between scientists and the public. This mutually beneficial partnership has contributed to a greater understanding of the state of the natural environment in England and also to the value of research to society. By bringing communities into existing networks, creating new ones and providing them with resources and training, 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 their environment, promote the benefits that the natural world provides and its importance to our well-being.+

Throughout OPAL, many lessons have been learned about public engagement in science. OPAL partners have gained a wealth of experience and have developed many examples of best practice. Here are some of the key lessons that have been learned along the way:

- It takes time and enthusiasm to build local and national networks, particularly in areas of deprivation; once established, relationships with local communities need to be nurtured and cherished.

- Working closely with other voluntary and statutory bodies is the most rewarding way of making new contacts and supporting existing groups.

- Turnover in the voluntary sector is high, particularly under current economic conditions, so developing and maintaining contact with local communities has become progressively harder and resources need to be sustained and strengthened.

- OPAL engaged leading scientists in the design of its resources, which has been a very important factor in building confidence in the OPAL branded materials, contributing to the uptake of the surveys in schools and providing teachers with outdoor learning materials they can trust.

- The majority of OPAL participants did not enter their findings into the OPAL database (an estimated 1 in 10 entered data). When we investigated the reasons for this, many said that they did not have access to a computer so offering a 'Freepost' service was essential. Others said they enjoyed going out exploring but did not think their results were good enough for scientists or did not complete all aspects of the survey. Whilst this was not a major issue for OPAL where our first objective was to engage, educate and inspire, it is something that needs to be addressed in the design of future surveys. Mobile apps and other accessible technologies may help to resolve this issue.

- Building the OPAL brand required consistent use of guidelines and frequent release of new resources and activities to maintain momentum.

- Participants contribute much time and commitment to carry out their research and rightly want to know what it means and that their efforts are valued. Using a range of methods to thank participants and to explain what their work means is important.

These and many other lessons learnt will be shared through a series of Best Practice Guides to be published in 2013. Please visit the website to download your free copy **www.opalexplorenature.org**

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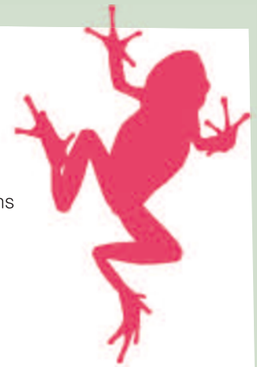

ADAS (Environmental Consultancy)
Amateur Entomologists's Society
Amphibian and Reptile Conservation
Antony House
Bees, Wasps and Ants Recording Society
Biological Records Centre
Birmingham & District Allotments Association
Birmingham & the Black Country Living Landscapes
Birmingham City Council
Blackpool 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
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
Northamtonshire 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 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

a) Semi-structured interviews (100 participants, interviewed by a social scientist)
b) Focus groups (Six focus groups with a broad cross section of society, chaired by a social scientist)
c) Online questionnaires (593 OPAL participants volunteered feedback in an extensive online questionnaire)
d) Online questions associated with national surveys (Questions were not compulsory therefore the number of responses per question varied. The maximum was 17,619 participants. Not all participants answered the full set of questions)
e) Independent study on the use of OPAL resources in primary schools (14 classes of primary-aged children, from reception to year 6)
f) Online open comments boxes on the OPAL website (4,700 comments received)
g) Testimonials (verbal, reports, email or letter)
h) Case studies provided by OPAL staff
i) 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.
j) Questionnaires completed by participants after an outdoor activity (219 adult questionnaires and 284 child questionnaires completed).
k) Interviews with OPAL scientists and staff (42 interviews carried out).

Gill Stevens

Gill Stevens was OPAL's Deputy Director who sadly passed away in January 2011. Gill, a great naturalist and much loved colleague, was passionate about nature and wanted everyone to know 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.