OPAL Science Summary

What is citizen science?

Citizen science is defined as 'scientific work undertaken by members of the general public, often in collaboration with, or under the guidance of, professional scientists and scientific institutions'. Citizen science projects take many forms, but OPAL has aimed to create 'citizen science for everyone' regardless of age, background, knowledge or ability. A major element of the OPAL programme has been a series of national surveys on different environmental topics. Major features of these surveys are:

- Nationwide surveys that can be completed anywhere
- Low barrier to entry – no training is needed prior to recording
- Simple methods adapted for use by those with no previous experience
- Use of bioindicators – organisms that are sensitive to particular features of the physical or chemical environment

Around one million people have taken part in OPAL activities. Each OPAL survey has engaged tens of thousands of people, raising their awareness of some of the major environmental challenges facing society with over 60,000 records submitted in total across the UK. The OPAL surveys have also been particularly successful in reaching people from 'hard to reach' backgrounds and those who would not normally participate in such scientific studies. However, how useful have OPAL's surveys been in providing new environmental information and new environmental science? Here, we summarise some of the main science outcomes of the national OPAL surveys, focussing on eight surveys - Soil, Air, Water, Biodiversity, Bugs Count, Tree Health, Polli:Nation and New Zealand Flatworm.

How good are the data?

A vital question when interpreting data collected by citizen scientists is how reliable the information is – this is particularly important given the lack of training and experience of many OPAL participants. Many groups were guided through the surveys by OPAL Community Scientists, or others trained by them, but some surveys were also carried out by untrained individuals and groups. We have therefore placed a lot of emphasis on checking the quality of the data, using a variety of methods including:

- Comparison of accuracy of species identification by participants with that of experts
- Comparison of accuracy of groups of different age and experience
- Identification of species or groups that participants found more difficult to identify e.g. smaller invertebrates in the Water survey and certain lichens in the Air survey
- Use of a mobile phone app to allow confirmation of species identification with photos
- Assessment of variability in recording between individual participants and between individual experts
- Use of self-assessment quizzes to confirm quality of identification
- Data screening to remove duplicate entries (e.g. from a group of children doing the same exercise) and impossible values

Data analysis and interpretation took account of these data quality assessments, with less reliable data being giving less weight.

Below, we summarise each survey in turn and identify findings from them.

Air

Our citizen scientists recorded the cover of lichens that are sensitive or tolerant to large amounts of nitrogen pollution on oak, ash and sycamore trees. They also recorded the number of black tarspot symptoms on sycamore trees. We found that:

- The air pollutant nitrogen dioxide reduced the number of tarspots on sycamore, once it exceeded a threshold concentration; previously, this disease was only thought to be sensitive to sulphur dioxide
- Nitrogen tolerant, but not nitrogen sensitive, lichens are less common on oak than on ash and sycamore, possibly because it has a more acidic bark
- In areas with high levels of atmospheric nitrogen from agricultural sources, there was lower cover of tree bark by nitrogen sensitive lichens
- In areas with high levels of atmospheric nitrogen from combustion sources, and close to busy roads, there was greater cover of tree bark by nitrogen tolerant lichens

Soil

Our citizen scientists recorded the abundance of juvenile and adult earthworms from a soil pit. They identified the adult earthworms using a simple taxonomic key and also noted simple soil characteristics. This was the first ever national public earthworm survey in England. We found that:

- Domestic gardens were hotspots for earthworms, with high numbers compared with other habitat types. Gardens also had the highest average number of species
- Rural gardens had a greater number of earthworms and a greater number of species than urban gardens. However, urban gardens had more earthworms than other urban habitats
- The worm species reported at the greatest number of sites were the grey worm, redhead worm and lob worm
- Man-made materials were present in the topsoil in over a third of survey locations and these were predominantly composed of construction material

Water

Our citizen scientists surveyed the water quality of local ponds using a simple bioindicator system and also collected sediment samples from the edge of local ponds or small lakes, which were analysed at a laboratory in London for metal contamination. We found that:

- Although the majority of sample ponds were clear with good water quality, a significant minority of ponds in every region of England had poor water quality
- Metal concentrations in the sediment samples from the one point at the edge of small water bodies were representative of the wider water body. Samples from large lakes were however not representative of the wider water body
- Metal concentrations in some ponds in every region of England were above thresholds for probable ecological effects, due to current urban activities or a legacy of historical contamination

Biodiversity

Our citizen scientists surveyed hedges, noting the key features and components of the hedge, for example, hedge structure and length. They estimated the amount of food sources present in the hedge, noted any evidence of animals living in the hedge and recorded the invertebrates living in the hedge. We found that:

- Trees and plants differed between urban and rural hedges. Blackthorn, bramble, dogrose, elder and hawthorn occurred more commonly in rural hedges, whereas beech, holly, ivy, privet and yew occurred more commonly in urban hedges

- The most common invertebrate groups also differed between urban and rural hedges. Blowflies, caterpillars, harvestmen, spiders and weevils were commonly found in rural hedges, whereas ants, earwigs and shieldbugs occurred more frequently in urban hedges
- The presence of hard surfaces, such as roads, adjacent to hedges reduces the amount of food available to wildlife and the diversity of invertebrate species in them

Bugs Count

Our citizen scientists participated in three 'challenges' where they recorded as many invertebrates as possible on human-made surfaces, soft ground surfaces and taller plants within a specific timeframe. They also looked for six particular species of invertebrate. We found that:

- More invertebrates were found on soft ground surfaces than on plants or human-made hard surfaces
- Despite initially seeming inhospitable to invertebrates, human-made surfaces such as paving, fences and walls were heavily used by certain invertebrate groups such as ants, spiders and woodlice
- Gardens were found to be associated with more invertebrates that feed on dead organic matter (particularly woodlice), parks and grasslands were associated with more pollinators, and woodlands were associated with more herbivores and predators
- Nearly four times more small tortoiseshell butterflies were recorded in rural areas than in towns and cities. In contrast, tree bumblebees show a strong association with urban areas

Tree Health

Our citizen scientists made general observations on tree species and also height and girth and they helped to map the frequency and distribution of selected pests and diseases of oak, ash and horse chestnut trees. They also looked out for and reported six new pests and diseases of most threat to the country. This was the first OPAL survey where the activity directly supported official government policy, specifically to engage the public with tree health and to support official surveillance. We found that:

- Over two thirds of people who participated in the survey said it was their first experience of working with trees
- The horse chestnut was found to be the least healthy of the three tree species surveyed, with the highest incidences of pests and diseases recorded
- The distribution of pests and diseases across the country largely corresponded with results of other surveys
- Two of the official 10km grid squares in which *Chalara* ash dieback was confirmed were found by OPAL participants

Polli:Nation Survey

Our citizen scientists taking part in the Polli:Nation schools programme participated in a two part survey on pollinators and their habitats. In the first activity, they recorded the feeding, nesting and shelter habitats available to pollinating insects within a survey site and more broadly in the local area. In the second activity, participants recorded the pollinating insects visiting a quadrat within their survey site. The survey encouraged people to make habitat improvements in their green spaces and repeat the survey the following year, with two thirds of participants committing to making such changes. We found that:

- The flowers associated with the greatest number of pollinators were bramble, buddleia and cow parsley, although these were not the most common flowers overall in the survey (which were daisy, buttercup, dandelion and clover)

- The percentage flower cover and sunshine were important factors in determining the number of pollinators seen

New Zealand Flatworm

Our citizen scientists helped to identify and record sightings of New Zealand flatworms, thus helping to map the spread of the New Zealand flatworm across the UK. Verified sightings have been transferred to the official national database (the National Biodiversity Network), leading to an over 20% increase in the total number of records nationwide. We found that:

- Most of the reported sightings of the New Zealand flatworm came from the northern half of the UK, although confirmed records came from as far south as Birmingham and near Luton
- Five other non-native flatworm species were also recorded, principally the Australian flatworm
- There was a strong correlation between presence of New Zealand flatworms and the absence of earthworms, showing that the presence of New Zealand flatworms has an impact on the earthworm population
- There were fewer molehills where New Zealand flatworm was present, suggesting that the loss of earthworms after New Zealand flatworm invasion had also impacted on moles, which prey on earthworms

In summary

The OPAL national surveys have demonstrated that, with careful assessment of the quality of the data, valuable scientific information can be produced using a 'citizen science for everyone' approach. As so many people have been engaged in the OPAL surveys, they have provided data across the UK at a level of spatial detail that is missing from many formal scientific projects. Furthermore, because most of our citizen scientists live in towns and cities, they have provided new insights into the UK urban environment, which is often poorly monitored in other national surveys. Our data have contributed to national databases, such as the National Biodiversity Network and are relevant to national policy concerns. To date, we have published 44 academic papers, 12 of which used data from OPAL surveys (see www.imperial.ac.uk/opal/publications).

The OPAL programme, and the army of citizen scientists who it has inspired, together with the experience of designing effective survey materials, provides a platform for the future. The existing national OPAL surveys will continue to provide valuable new information about the UK environment, and how it changes over time. In addition, new surveys and activities can be developed to raise awareness and collect information to address new environmental issues and threats.

If you are a scientist interested in using our existing data, or in developing a new survey, we'd love to hear from you at opal@imperial.ac.uk