Botanic Gardens Conservation International Education Review

roots

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Daring visitors to think

The ethnobotanical approach

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Liliana Derewnicka

FIRST WORD
SCIENCE COMMUNICATION

Science communication is not a new concept. Science at the height of the Enlightenment was characterised by public participation and popularization. However, with its professionalization came its separation from the public sphere. Specialist professional science communicators became visible after the Second World War, when there was concern over public support for, trust in and understanding of science (Broks, 2006). Yet there was, by this point a significant rift between science and the public. Concerns over this grew and, as Gregory and Miller (1998, p.1) explain, in the late 80s early 90s scientists were "delivered a new commandment from on high: *thou shalt communicate*." marking the arrival of the Public Understanding of Science movement. Although this movement has come under criticism for its tendency towards assuming the public to be a passive audience it can be seen to be the birth of the current trends in science communication.

It is when one comes to defining what we mean by science communication and even science that it is easy to come unstuck. I remember during my Science Communication masters programme our lecturer had to sit us down and reign in our wild, nebulous conceptions and reassure us that if there is method there is science and if there is science then the act of opening up a conversation about this with another human being, through any medium, is science communication. Since then, I have found it useful to reign in the definition further and see science communication to be openly discussing both the concepts and the practice of science.

When it comes to science communication in botanic gardens, Haywood, (2015) who investigated family science learning at Royal Botanic Gardens, Kew, noted that while all parents described Kew as a scientific organisation and showed evidence of science learning during their visit, most overlooked its public science communication agenda and did not expect their experience in the garden to have an element of learning about science. "So what?" You might say. If families are learning about science then isn't our job here done? The 2014 study into Public Attitudes to Science found that more than half of the UK population does not feel informed about science (Castell *et al*, 2014). Therefore offering experiences that leave the visitor with a deeper understanding of the world around them is an important goal, responsibility and opportunity for a botanic garden. However, science communication in botanic gardens is more than this. There is a need to deliver successful and overt science communication, which links with trust, transparency and public support.

To remain socially relevant, it is important for a botanic garden to share the stories about its research and conservation. Furthermore, the 2010 Eurobarometer found that 58% of Europeans do not trust scientists to tell the truth about controversial issues (European Commission, 2010). Public visibility and trust comes from showing the world beyond the garden gate that you are relevant and responsible; that you will take public funding and turn it into something worthwhile. This is not achieved by holding the cards close to your chest. This isn't a one way arrangement either. 'The public' is a lot of people, they are experts in their own right. One of the most wonderful aspects of contemporary views on science communication is that it relies on dialogue, on true communication and mutual learning.

By observing moss in the glasshouse at Shenzhen Fariylake Botanical Garden visitors get to understand the research happening at the site. ©Cuiyu LAN

Public engagement with science can be seen as establishing 'a multi-directional dialogue among people that allows all the participants to learn.' *(McCallie* et al*, 2009, p.12)*

This nomadic garden brings plant science and conservation to the people. ©Royal Botanic Garden of Córdoba

Mesure (2007) identified over 1500 active initiatives within the UK alone that come under the umbrella of science communication.

By opening up conversations with visitors (and listening to what they have to say) science communication has the power to inform a botanic garden's work and take it in new directions. Having this attitude towards science communication, not only deepens 'the public's' understanding of science and the work of botanic gardens and can gain support for both, it also cultivates an atmosphere of understanding of and responsibility to each other and the planet.

And so, how we look at science communication and what we understand it to be is important. We must think about how we are communicating science and why. Break it down. Look at who's listening and what they are hearing and, above all, look at who isn't and why. We must think about how we can do it better.

And how does one do science communication? To that, thankfully, there is not a quick answer. The only limitations to the types of activities that can communicate science is our imagination. For example, the Researchers Nights, held across Europe bring together scientists and the public and allow people to explore the scientists' research through hands-on activities (European Commission, 2016). Café Scientifique is a global network of science communication events that encourage public discourse on current research in informal settings (Café Scientifique, n.d.). Bright Club, which takes place in the UK and Australia combines science with stand-up comedy to engage the public through entertainment (Bright Club, n.d. AXNS Collective curate exhibitions, events and workshops which illuminate the intersection between science and art to engage the public with neuroscience research (AXNS, n.d.).

The possibilities are endless. Science communication can be effectively carried out by the scientists themselves, or through intermediaries: translators – if you like. Wuhan Botanical Garden and Royal Botanic Garden Edinburgh, as well as others, have dedicated science communication staff who help to package their science in a non-expert friendly way. What is important is to provide an unintimidating space for the public to engage with the science and how it works. Gregory and Miller's (1998 p.224) "Protocol for Science Communication for the Public Understanding of Science" offers important guidance on what to consider when creating these spaces. They stress the need to be clear about motives, respect the audience, establish a basis for trust, acknowledge the social aspects of science and facilitate public participation. Bultitude (2011) updates this list with her 'top tips' and highlights the importance of thinking creatively, evaluating and learning from others.

Above all, it is clear to see that communicating science cannot be achieved alone. It involves us getting together, breaking out of our silos and making a concerted effort to talk (and to listen) to each other (the public, educators and researchers alike) about what science is happening, how we feel about it and where we should take it in the future.

The call for this issue of Roots received much more attention than we anticipated. Botanic gardens, researchers and related individuals from around the world got in touch to tell us about their activities. We have chosen a selection to give a snapshot of the most unusual, creative and far flung activities being carried out by botanic gardens in the name of science communication.

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DARING VISITORS TO THINK ABOUT **THE NATURE OF SCIENCE** IN BOTANIC GARDENS

We live in a world in which personal choices and public discussions rely on scientific understanding. To make decisions we need to evaluate scientific evidence, understand how this knowledge was generated and how reliable it is. As botanic gardens are situated at the crossroads of scientific research and education, they provide excellent opportunities to teach about the phenomenon of science itself. Through the use of thought-provoking questions and by stimulating dialogue and reflection, botanic gardens can drive visiting students to think about both the science of nature and the nature of science.

MISCONCEPTIONS ABOUT SCIENCE

Although the classification of plants is constantly refined and scientists are continuously developing new theories, the public and primary and high school students, in particular, can wrongfully assume the domain of science to be a collection of unquestionable facts. Students often harbour a range of misconceptions about the scientific process, the role of the scientist and the value of scientific claims. For example, they may believe that 'a scientist always knows the truth', 'scientific ideas never change', or 'a scientist is not creative' (Schwartz & Crawford, 2004).

To tackle these misconceptions, students need to understand the phenomenon of science itself: a method to obtain reliable knowledge with its own pitfalls and opportunities, with its own rules, regulations, successes and inconsistencies. In other words, students should be familiar with 'the nature of science'. This entails a focus on the scientist as a member of a community who uses empirical data to develop (creative) scientific ideas. It also requires an understanding that, as scientists continue testing and challenging previous interpretations, scientific answers are seldom final (Lederman & Abd-El-Khalick, 2002).

Our aim is to transform eyes-on or hands-on programs into minds-on activities where students – as well as looking and doing - are motivated to think and talk about their observations and science itself.

Many students wrongfully consider the domain of science as a collection of unquestionable facts.

↑ *Children engage in a discussion after doing an experiment ©Ghent Botanic Garden*

DIALOGUE IN THE BOTANIC GARDEN

In the botanic garden of the Ghent University Museum we are currently adapting and expanding the education program to allow students to increase their understanding of the nature of science. Our main focus is on 9 to 16 year olds. We aim to transform our "eyes-on" or "hands-on" program into "minds-on" activities where students – as well as looking and doing - are motivated to think and talk about their observations and about science itself. Since dialogue and questioning increase thinking, educators play a key role in asking appropriate questions (Clough, 1997). We explored three complementary approaches that aim to stimulate thought about the nature of science:

(1) Thinking by doing. Inquiry-based activities allow students to explore, study and experiment. For instance, students study the process of photosynthesis by performing simple experiments with water plants. These activities allow educators to stimulate reflection; questions such as: 'If you saw it once, are you sure that it will happen next time?', 'how can a scientist know whether what they think is true?' can stimulate students to think about the scientific process itself, rather than simply the results of the experiment. When students present their findings, questions such as 'Do you just think so or do you know it?' elicit them to think about the value of their findings. Though this approach seeds doubt in the students' minds, it allows the students to connect with the uncertainties accompanying scientific investigation, uncertainties that only further investigation may sooth.

(2) Thinking by stepping into the shoes of a (historical) scientist. By taking the scientist's perspective, students are motivated to think as a scientist. With regards to photosynthesis, for example, students can re-enact the historic experiments of Van Helmont, Priestley and Sachs. Step by step, these experiments reveal the central nutrients of plant metabolism and the changing theories about photosynthesis that have been formulated throughout history. By experiencing the different steps necessary to come to our current understanding, participants realize that scientific truths of today may also change in the future. More immersive drama activities further allow children to experience the world of science. Children can explore the glasshouses as if they are historic plant hunters stunned by the diversity of plants and eager to describe and discern patterns in the Flora. A dialogue with the children about how to classify the variety of plants can help them to explore the relevance and principles underlying the ever changing classification systems.

"The only consistent characteristic of scientific knowledge across the disciplines is that scientific knowledge itself is open to revision in light of new evidence."
NGSS Lead States (2013)

↑ *In a philosophical dialogue an educator facilitates a group conversation by asking questions to encourage debate and inquiry ©Sanne Bijnens*

↑ *Can a rabbit be a scientist?' Big questions can spark philosophical dialogue about the characteristics a scientist should have ©Ruth Van Wichelen*

(3) Thinking by participating in a philosophical dialogue about science. Questions such as: 'What is the difference between a scientist and a magician?', 'Can a rabbit be a scientist?' or 'Can we ever really know how plants evolved?' may sound funny at first, but they can spark an inquiry into what makes science science or a scientist a scientist. A philosophical dialogue aims to elicit the critical reflection of the participants. The educator plays a key role in facilitating the dialogue by asking for explanations and arguments through questions such as: 'why do you think so?', 'What do you mean by the word…?', 'Can you give an example?', 'Is there someone who disagrees?', why?', 'Are you contradicting yourself?' The educator takes what is known as the Socratic stance. This means that they do not intervene with regard to the content of the discussion, but only facilitate the dialogue, thus enabling freedom of speech and thought for the students (Lipman, 1991; Schjelderup, 2009).

FINDINGS AND CHALLENGES

While we were experimenting with the different approaches, we observed that a mix of both hands-on inquiry activities and minds-on challenges can motivate a broad range of students to participate in the dialogue and reach rewarding conclusions. For example, one of our 14-year old participants answered *"Most ideas change, but some remain the same for a long time. We will never know for sure whether what we know is absolutely correct"*.

Our educators reported that it is not easy to ask the right questions and stimulate the thinking process; that it takes time to acquire 'the Socratic stance' to questioning. Therefore, we found a training program was helpful. Once the questioning attitude is honed, however, educators report that it deeply influences their way of interacting with students. It becomes easier to ask appropriate questions and is easier to motivate children to get involved with activities in the garden.

In short, once the educator gets the knack of it, a dialogic approach motivates students to investigate, explore and think for themselves. In this way, we can turn botanic gardens into spaces to think and talk between the plants and to wonder about both the nature of science and the science of nature.

A dialogic approach motivates students to investigate, explore and think for themselves.

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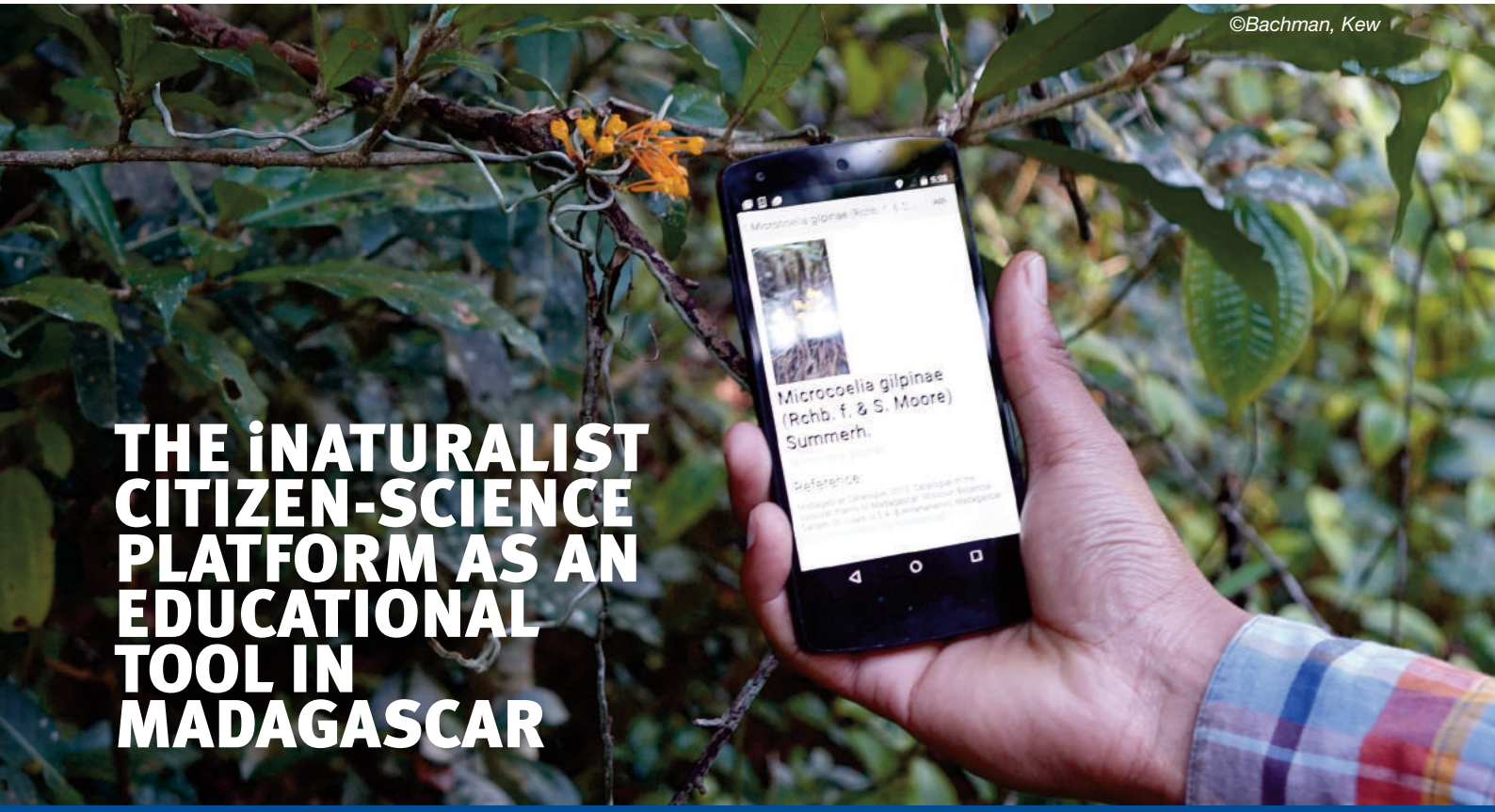
← *Children explore the greenhouses of the botanic garden as if they were plant hunters in tropical forests ©Ghent Botanic Garden*

Authors: Hélène Ralimanana, Romer Rabarijaona, Steven Bachman and Stuart Cable



THE iNATURALIST CITIZEN-SCIENCE PLATFORM AS AN EDUCATIONAL TOOL IN MADAGASCAR

Royal Botanic Gardens, Kew and their local team in Madagascar created an iNaturalist project. iNaturalist links field observers with specialists and enables rapid inventories and effortless dissemination of information to the public. The original idea was to use smartphones and the iNaturalist citizen-science platform to record observations of Madagascan plants. What developed was a local community of amateur and professional botanists sharing knowledge and resources to develop a uniquely Malagasy resource. https://www.inaturalist.org/projects/zavamaniry-gasy-plants-of-madagascar

In July 2014, Steve Bachman of the Royal Botanic Gardens, Kew (Kew) teamed up with the citizen-science project iNaturalist and Kew's local team in Madagascar, the Kew Madagascar Conservation Centre (KMCC); the aim of the collaboration was to explore an exciting new direction in biodiversity monitoring, conservation and outreach. The original idea was to use smartphones and the iNaturalist platform to record observations of Madagascan plants to inform IUCN Red List assessments of extinction risk and support conservation efforts on the ground. The idea also comprised inspiring a new generation of tech-savvy naturalists. What developed was a local community of amateur and professional botanists sharing knowledge and resources to develop a uniquely Malagasy resource: Zavamaniry Gasy (Plants of Madagascar). The project links people making observations of plants in the field with specialists who provide identifications. This enables rapid inventories and effortless dissemination of information to the public and the conservation and research communities. Importantly, Zavamaniry Gasy is evolving as a fun way for citizens, and even for experienced botanists, to enhance their skills and knowledge of plants and build awareness of plant conservation. The Strategy for Plant Conservation 2011-2020 and the Mexican Strategy for Plant Conservation 2012-2030 both highlight this.

Importantly, our data and knowledge can be shared rapidly to new audiences such as students, conservationists and citizen scientists.

Just 18 months after the project start the platform has 82 members and 4537 observations have been made, about 12% of the Madagascan flora.

The Cadereyta Regional Botanic Garden (CRBG), consistent with this, has carried out educational activities that promote the use of the flora of the region under the principles of sustainable use.

KNOWLEDGE OF PLANTS AND EXTINCTION RISK IN MADAGASCAR

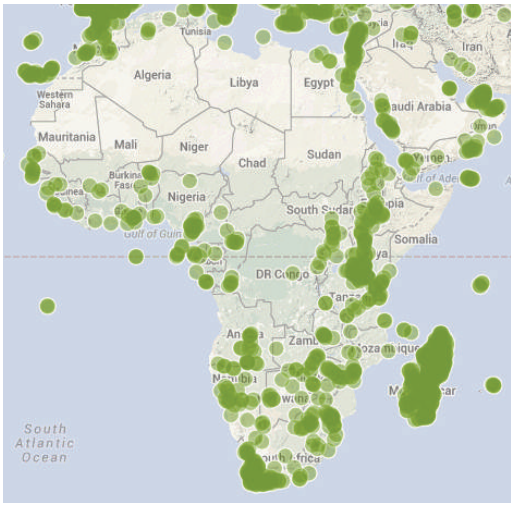
On a global scale, little progress has been made in assessing the extinction risk of plants; only ~6% of the world's plants have been assessed for the IUCN Red List, the global standard for extinction risk assessments (IUCN, 2012). For Madagascar, where threats to biodiversity are very high, only 960 species (IUCN, 2015), equivalent to 6-7% of the island's flora, are listed. One of the challenges facing scientists is the lack of data available for the assessment – some species haven't been seen in the wild for years. Dedicated botanists are already scouring the multitude of habitats from the humid forest of the eastern escarpments to the spiny forest of the south and everywhere in between. However, documenting and monitoring the sheer diversity of plants in Madagascar remains a challenge. It is in this context that the idea of scaling up the gathering of data was developed. The innovative approach was to promote the data collection through the use of smartphones and opening this out to a non-scientific audience – the citizens of Madagascar. The aspiration was to gather more data that could be shared and subsequently used to enhance new IUCN assessments.

COMMUNICATION CHALLENGES AND PROGRESS

Although citizen science has been adopted elsewhere, in particular in the USA, it was uncertain whether it would work in Madagascar. Communication using technology and social networking has developed immensely in recent years and software is becoming more varied following the digital innovations. The field of botanical research is rapidly evolving as new technologies are embraced. In particular, social network technologies have facilitated innovation and knowledge dissemination. Just a few years ago, we could not take photos without lugging expensive rolls of film into the field and later on we could only produce grainy images with first generation digital cameras. Nowadays we can take high-quality photos with our mobile phones and with a 3G connection we can share them over the internet almost instantaneously. Just a few years ago, we had to search for information in physical libraries and track-down obscure journals, often taking many weeks, while now we can find scientific papers and data online.

People like taking pictures of plants or animals in the wild. It is human nature, our hunting-instinct, to search for the rare or interesting. However, it is too easy to let these photos sit on computer hard-drives, never seen by the rest of the world. Importantly, our data and knowledge can also be shared rapidly to new audiences such as students, conservationists and citizen scientists. Photos, with basic meta-data for location, time and date, represent records of a species occurrence and can hold important information on distribution, migration or dispersal.

← *Participants of the Bioblitz fieldtrip in Andasibe – Mantadia National Park ©Bachman, Kew*



↑ *The locations of observations made as part of the iNaturalist project ©Bachman, Kew*

Even in Madagascar where threats to biodiversity are very high, only 960 species are on the Red List, equivalent to 6-7% of the island's flora.

↑ *Smartphones are used for data collection in the field ©Bachman, Kew*

CURATING THE PROJECT AND NURTURING THE COMMUNITY

At the beginning, iNaturalist Zavamaniry Gasy consisted of 10 members/contributors mostly from KMCC. After the project launch in Madagascar in February 2015, the number of members did not increase much. The reasons could be due to the concerns of people related to the publication of their data on the site, the copyright of the photos or the confidentiality of exchanged data. Considering these problems we have given free choice to the person posting data as to whether geographical coordinates of the observations are shown to the public or not (private or hidden). The photos posted are copyrighted to the person making the observations. Geographical coordinates of threatened or CITES species such as orchids are hidden to protect against illegal collections.

BOTANICAL BIOBLITZ – ENGAGING, EDUCATIONAL AND ENHANCING BASELINE DATA

To optimize the impact of the platform, a workshop was organized by KMCC and Kew in September 2015 in Antananarivo, Madagascar. Many institutions participated, including the two national herbaria (TAN Herbarium and TEF Herbarium), Missouri Botanical Garden (MBG Madagascar), California Academy of Science (CAS Madagascar, who kindly hosted the workshop), Rebioma (WCS Madagascar), Conservation International (CI Madagascar), University of Antananarivo, and Madagasikara Voakajy, a Malagasy biodiversity organisation. The workshop included IUCN Red List training followed by a two-day visit to the national parks of Andasibe and Mantadia.

Here we held our first iNaturalist Bioblitz, which entails an intense biological survey to record as many species as possible in a short period of time. After the bioblitz, participants uploaded their observations and then contributed to the identification of photos or approved the identifications that others had made. The team made over 1,000 observations of around 250 species and the identification work is ongoing.

Just 18 months after the project start the platform has now 82 members, composed of Malagasy and foreign scientists and amateurs, and the number of records has increased to 4537 observations (c. 12% of the Madagascan flora).

Apart from sharing data, iNaturalist enables the creation of simple identification keys for groups of plants and animals. We have created keys for palms and orchids for several sites and these are available for anyone to use. Follow-on bioblitzes were organised at Tampoketsa, located in the Central Highlands, and Antavolobe, located in the eastern part of Madagascar. These bioblitzes had a strong educational role, improving knowledge of the floras and helping site managers by mapping species' distributions.

We have only just begun to realise the potential of Zavamaniry Gasy as an educational tool. Currently the main beneficiaries are the botanists, conservationists and park managers who need to know their local floras. Our next step is to encourage more students to use and benefit from this tool, building their own online profiles in iNaturalist while learning about Madagascar's flora. We firmly see it as a tool for the future for promoting the understanding and conservation of the flora of Madagascar to the wider general public and engaging the public in ensuring that Madagascar persists as a globally important biodiversity hotspot. Zavamaniry Gasy is most definitely a tool for citizen scientists.

↑ *The rare Warneckea masoalae. Photo uploaded by an iNat. Zavamaniry Gasy member ©KMCC*

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THE ETHNOBOTANICAL APPROACH

The mission of our garden is to develop harmonious relationships between people and nature. To achieve this, we have created innovative programmes to interpret the results of scientific research. These activities make it possible to involve local community members in scientific research. In each case we aim to make emotional and social connections to the scientific content to ensure that the public see its relevance to their lives.

At the Botanical Garden of Tver State University, we aim to open up the plant world and its diversity to visitors to show them the importance of biodiversity conservation and to promote it. This may be achieved if people support scientists and for this reason we have developed projects that interpret research results for ordinary people and involve them in the garden's activities, including research. These activities include: discussions, interactive tours, hands-on experiments, role-playing games, interdisciplinary studies, ethnobotanical and ecological camps, themed family festivals, interactive exhibitions, and much more. Our projects always include research and scientific experiments but we develop them to appeal to people's different interests and prior knowledge. Here we present our ethnobotanical project Back to the Roots as a case study.

This project was created in 2006 and looks at regional native flora through the revival and conservation of regional ethnobotanical traditions and environmental management. This is a family-based research project, practical and educational at the same time. The project has several steps to involve families from the local community in scientific experiments and practical work.

↑ *Tasting local herbs at a family festival*
©Botanical Garden of Tver State University

The first stage is guided discussions, ethnobotanical expeditions and ethnobotanical and sociological studies. At this stage the garden staff and local community record information about the distribution and natural habitats of useful, medicinal and ornamental species of native plants and discuss and share their traditional uses. Unfortunately, people who retain traditional knowledge often suppose it is not interesting to the general public and do not believe in the necessity of this conservation. They believe that most people prefer to trust industrial methods of producing food and medicine. How can we convince these people that their knowledge is not just fairy tales and myths?!

The next stage of the project involves displays of living plants that are grown using traditional organic farming principles, learnt from the local community. We invite those who have shared their traditional knowledge with us to act as consultants. These people are directly involved in the organization of experiments based on traditional plant growing techniques. The community, both children and adults, participate by growing indigenous plants, as well as preparing composts and monitoring the process of its formation. They also monitor earthworms and pollinators and are involved in experiments on biological methods of pest control and disease. If people who shared their knowledge during our scientific and ethnobotanical expeditions for some reason (e.g. elderly persons) can't come to our garden themselves, our employees go to them for practical training, and then implement this knowledge and expertise in the garden. When the holders of traditional knowledge see that our communication is not just 'talk', but leads to creation of real ethnobotanical displays, it gives them a sense of importance.

To engage a wider audience, we have developed culinary and sensory garden tours. Garden staff developed specific routes, during which participants learn, taste, smell, touch and compare plants, which are used in local traditional cooking, medicine and crafts. We not only introduce the indigenous plants to the people, but we also give samples to take home.

And here we come to the next difficulty - how to make the families not just observers or temporary assistants, but direct participants in the ethnobotanical conservation.

The following two steps help us:

1) We recommend that people use the traditional ethnobotanical knowledge and methods of organic farming they have learned in our garden in their private gardens and support them in this by providing plants and training.
2) We organize ecological and ethnobotanical summer camps at the garden and in the countryside. This is done in collaboration with social nonprofit organizations and interested families and schools. We invite experts and scientists to guide children through scientific experiments involved in a wide range of research, e.g. soil science, ornithology, bryology, mycology, ecology and horticulture. Life in these camps is based on a more traditional way of life. Therefore people may take aspects of this home with them.

← *Folklore is communicated through traditional regional games during a family festival ©Botanical Garden of Tver State University*

How can we convince people who hold traditional knowledge that this is not just fairy tales and myths and hence important to conserve?

↑ *Grandma's Window: an exhibition of traditional regional house plants ©Botanical Garden of Tver State University*

↑ *Schoolchildren discover the secrets of the internal structure of plants at an ecology camp ©Botanical Garden of Tver State University*

Our projects always include research and scientific experiments but we develop them in a way that will appeal to people's different interests and prior knowledge.

↑ *This tour aims to immerse children in the wonder of regional flora ©Botanical Garden of Tver State University*

But how to expand the number of families who participate in the project? How to encourage families who already have ethnobotanical skills and knowledge to spread it among others? One of the ways we have addressed this is through family festivals. We organize the festivals in the garden during different seasons. They are open to all and are organized with the help of the local community consultants. During family festivals, we use a variety of methods to engage people and encourage them to interact. We use music, painting, cooking, poetry, creative application classes, and more.

Also as part of this project, we support families (especially city residents) who choose to live, either temporarily or permanently, in ecovillages. In these eco-settlements people build houses according to the regional tradition, use energy-efficient approaches and carry out organic farming for food. Our garden staff and volunteers organize scientific and experimental work in the ecovillages in order to help families explore the natural plant populations. We help to organize regular seed collecting trips, explain how to grow medicinal, edible and ornamental indigenous plants and teach them how to gather the plant parts for the production of organic products.

In this project we have seen great success. We have witnessed a vast increase in the numbers of participants from dozens to several thousand. To date, several young people who participated in the project have become students of the natural sciences faculties at our university. We have had buy-in from local businesses and regional media. This has resulted in getting patents for traditional herbal teas, rediscovered by the ecovillage residents, which are now on sale. Another example is the creation of a nursery of rare and endangered plants in one of the ecovillages, which will be used in a restoration program.

The *Back to the roots* project has become more like a living creature. It is always changing and developing, acquiring new aspects and activities. Therefore, it is not possible to explain all its intricacies in a short article, but we hope that the things mentioned above will be enough for you to understand that this project is no longer an experiment, and moreover – it is not a game. It has become a real part of people's lives. And that is what we consider as its most important result and the biggest success.

↑ *Local farmers present herbal teas prepared according to old regional recipes at a family festival in the garden ©Botanical Garden of Tver State University*

During ecological and ethnobotanical summer camps at the garden, families interact with scientists and get involved in experiments on bryology, mycology, horticulture and other fields.

↑ *Schoolchildren discover the secrets of the internal structure of plants at an ecology camp ©Botanical Garden of Tver State University*

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← *Garden staff head out on an Ethnobotanical expedition in the Tver region ©Botanical Garden of Tver State University*

Author: Kate Sackman

BABY I WAS BORN THIS WAY:
MAKING SCIENCE REAL FOR NON-SCIENTISTS

There is so much interesting science to share among our colleagues, but how do we make it interesting to the public? We want to engage and excite people about science but are swimming upstream in a flood of negative information and attitudes about science. Environmental news tends to be generous with blame and discouraging about our ability to make a difference. In order to inspire people to act, the message needs to positive, easy to understand and directly relevant.

A few years ago Lady Gaga emerged from a cocoon at the MuchMusic Video Awards, draped in an elaborate, winged costume. At the time, my first thought was that this would be a great opportunity for someone to do an article promoting the virtues of cool moths and butterflies.

HUMAN DIVERSITY MEETS BIODIVERSITY

Ok, so a butterfly lesson is not about plants exactly, but it is science. And it could become an article or a workshop or a story about the plants on which butterflies rely! The possibilities are endless. You could make your own video with wings strapped to your back making side-by-side comparisons between Lady Gaga, butterflies and their habitats.

The whole point of Lady Gaga's song, 'Baby I Was Born This Way' is that each of us is special in our own way. She was not referring to insects, but the diversity of the human race. What a great opportunity to talk about biodiversity!

SPEAK TO ME! UNDERSTAND YOUR AUDIENCE FIRST

To engage people you need to relate to who they are, not just promote what you think they should understand. People are willing to learn and even change their behavior if you respect them, intrigue them, and give them just what they can handle. Before you design or create any communications, research your audience. This means talking to them directly, asking them questions about what they know, what they care about, and what is exciting to them (e.g. their hobbies and heroes). Chances are they are not scientists. Keep it simple, appeal to what is meaningful to them, and you will hook their interest!

To engage people you need to relate to who they are, not just promote what you think they should understand.

THREE TASKS: ENTICE, ENLIGHTEN, AND EMPOWER

Accounting was terribly boring to me in college. I could barely stay awake, let alone understand what seemed like arbitrary accounting rules. But then a miracle occurred. A professor in my corporate training program, right after college, made accounting enthralling. He was Shakespearian in his delivery and Socratic in his methods. He would stride back and forth in the front of the classroom painting a verbal picture of the financial conundrum of a large multinational company. Management was trying to hide financial losses or an acquisition that had gone bad. How could we know for sure what was going on?

This professor turned every exercise into a grand mystery to solve. We were all so intrigued we could not wait to pull apart the financial statements to get to the bottom of the puzzle and understand the real picture. It was a magnificent whodunit every time! You can create this kind of excitement too. Just apply some creativity and borrow ideas from anywhere and everything to create a game, puzzle, or performance of your own.

TASK NUMBER ONE: ENTICE

If people are resistant to a message, the only way to engage them is to make your message irresistible. Entice the audience. Several methods work: create a mystery, set up a role play, or use humor. *A Review of Humor in Educational Settings: Four Decades of Research* (Banas and Dunbar, 2010) showed that the use of humor is very effective in attracting students and gaining their attention. Humor is best applied with a light touch because it can overwhelm the message if overdone. The benefit of humor is that it makes the message accessible, unintimidating, and memorable when used judiciously. Chose an aspect of your overall theme as a touch point to which your audience relates. Humor can be used to hook to such a starting point.

TASK NUMBER TWO: ENLIGHTEN

Now that you have their attention, speak to your audience for example about lizard habitats or native plants on their terms. What is their educational background, what are their constraints (e.g. time and money), what are they hoping to learn from you? Stick with the overall theme you have chosen.

Most importantly, before you create your message, know the one thing you want your audience to remember - one thing only. To ensure the message breaks through, it must be crafted to support that one thing.

FINAL TASK: EMPOWER

Congratulations! Your theme and execution have worked! Your newly engaged audience will easily retain the one key message you intended to communicate. They are now inspired to act, so do not miss the opportunity to give them One Green Thing to do, an action that easily fits within their daily living.

For instance, perhaps you have shown your audience the value of gardening with native plants. Offer a One Green Thing action: provide listings of local nursery sources of native trees to plant in their own gardens. Once you get your audience excited, harness that enthusiasm and convert it into the change you wish to see in them. Deliver knowledge in an inspiring way and you may motivate people to take action. One Green Thing leads to another. Ride that wave and you can convert disinterested audiences into partners in conservation!

The benefit of humor is that it makes your message accessible, unintimidating, and memorable

↑ *Engage the public with science by relating to things they know and love. ©Jim Hunt*

Once you get your audience excited, harness that enthusiasm and convert it into the change you wish to see in them

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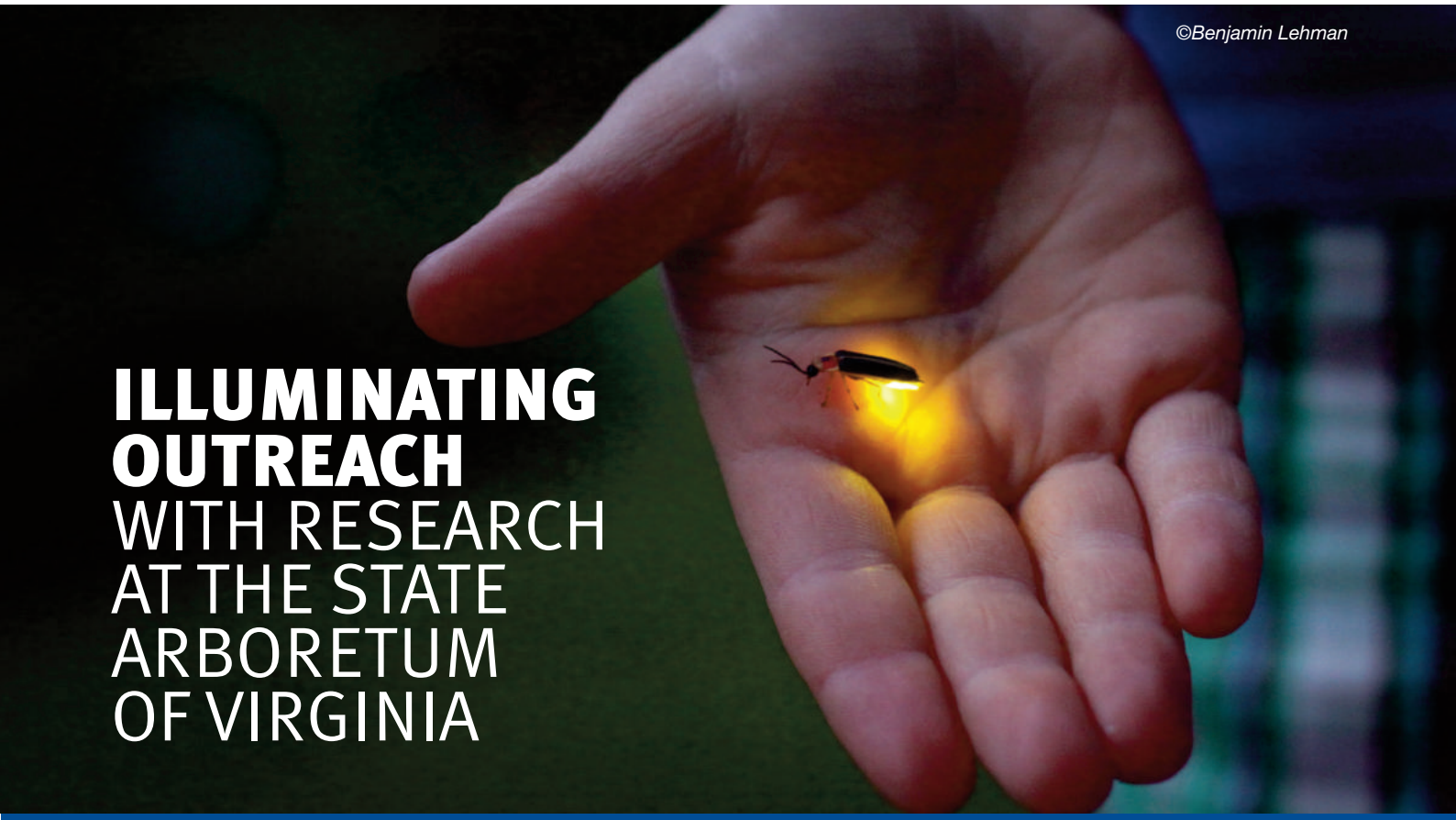


ILLUMINATING OUTREACH WITH RESEARCH AT THE STATE ARBORETUM OF VIRGINIA

Research conducted on site provides a rich source of inspiration for education and outreach at the State Arboretum of Virginia. One project in particular, Ariel Firebaugh's (AF) study of the effects of light pollution on fireflies, has captured visitors' imaginations. Working with arboretum staff and volunteers, we share her methods and results in an annual firefly festival as well as during summer full moon walks and in interpretive signs.

Research, education, and public outreach are the cornerstones of nearly all we do at the State Arboretum of Virginia. By integrating research into education and outreach, we strengthen our message and engage visitors more deeply.

The State Arboretum of Virginia is part of Blandy Experimental Farm, a field research station affiliated with the University of Virginia's Department of Environmental Sciences. Research conducted here by students and faculty from universities across the country addresses topics in genetics, behavior, ecology and more.

Outreach benefits from on-site research in two main ways. Faculty and students contribute directly by presenting public programs, leading tours, participating in programs for kids and contributing to interpretation. Research results also reach the public through programme staff, environmental educators, and curators who share it with public and school groups. Communicating research by these means can be effective and efficient, since a majority of Americans visit informal science institutions such as museums and public gardens every year (National Science Board, 2012). Furthermore, most people learn science not through coursework or schooling, but through informal sources such as the media, museums and person-to-person conversations (Groffman et al., 2010; Varner, 2014).

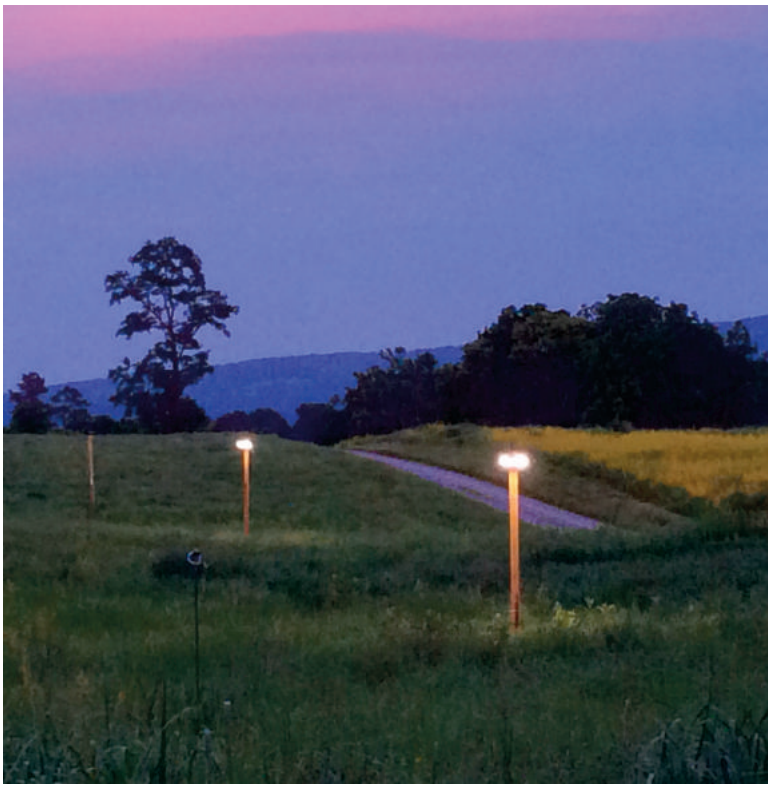
↑ *A high school volunteer catches fireflies in front of the Arboretum's main building ©Ariel Firebaugh*

LET THERE BE LIGHT

One research project in particular has captured visitors' interest—AF's doctoral research on fireflies. In this continuing project, she experimentally adds artificial lighting to previously dark firefly habitat to explore how light pollution affects firefly mating behavior and population densities. We share her methods and results in an annual firefly festival as well as through tours, full moon walks, and interpretation.

Who doesn't love fireflies? Children are naturally drawn to their flashes and inevitably try to catch them. Adults fondly recall the seemingly larger populations of their childhood, ponder the beauty and meaning of their flashing patterns, and appreciate this magic through their children's eyes. When AF began her firefly research here, we quickly agreed to offer a firefly program. In 2013-2015 we attracted 38, 85, and 66 participants, respectively, the last on a day with heavy rain until twenty minutes before the start of the event. These are excellent numbers for us given our rural location. Offering a firefly program essentially guarantees interest, but it also poses challenges. The arboretum's largest indoor space holds 50, fewer than we attracted the past two years. To manage this, we have participants select one of two options to begin their evening. In the library, we offer a short, illustrated talk aimed at adults and older kids. Scattered around the room are live fireflies in jars, microscopes for examining dead, collected fireflies, lights simulating firefly flash patterns, and information about fireflies and other insects. Outside, we offer activities, crafts, games and information for families with younger children. Parents at our 2014 festival asked for more content for their young children. Therefore, in 2015, after the games and crafts, we read aloud Emily Morgan's *Next Time You See a Firefly*, combining this with information about fireflies' use of light.

We try to end these two strands at about the same time so we can walk together to a 35-acre, warm-season grass meadow. This meadow, AF's main study site, supports large populations of two firefly species, ensuring a spectacular light display in good weather.



↑ *The evening light show begins! Female fireflies flash from the vegetation while males flash their reply in flight ©IdlHandz*

"the common denominator of public outreach activities is communication"
Pace et al., 2010, p. 294

↑ *A research student investigates light-pollution effects on insect communities ©Ariel Firebaugh*

"most people learn about science not through formal schooling, but through informal sources, such as the media, science centers or museums, and interpersonal contacts"
Groffman et al., 2010, p. 286

← *LED lamps add artificial light at dusk in a warm-season grass meadow ©Ariel Firebaugh*

The highlight of these evenings—not surprisingly—is the light show. Nets and jars are handed out, instructions are provided for capturing fireflies without harming them, and the fun begins. Of course, we ask children to release their fireflies at evening's end!

Last summer, after a half hour of observation, capture and release, and with darkness upon us, AF was asked about the light posts she had erected in the meadow. We weren't surprised to get questions about her lights and research, but we were pleased that even young kids gathered around to listen. In addition to questions about these remarkable beetles and their flashing, parents asked what they might do on their property to encourage fireflies. This Q&A at the meadow's edge will definitely be part of our 2016 festival.

CHALLENGES

Our Firefly Festival is a successful, annual event, yet it does present challenges. One is our limited indoor space, discussed above. Another is managing a relatively large group at dusk and after dark—particularly since we encourage children to run about in search of flying insects! Of course, we rely on parents to watch their children, but we also ask our volunteers to watch for wandering kids. Last year we had 13 volunteers and staff, most of them undergraduate research students.

We continue working on an assessment tool to evaluate how much children learn. In 2015, we asked children (ages 3-10) to draw a firefly after listening to a short talk about firefly biology. Many of these drawings showed a strong understanding of firefly morphology (six legs, antennae, wings, light organ, etc.). This year we will make these assessments more informative by including a pre-assessment.

SHARING YOUR RESEARCH: PAIN OR PLEASURE?

The public appreciates and has much to gain from programs such as this, but the rewards and advantages go both ways. Researchers benefit through increased interest in, understanding of, and support for their work. Ahn (2015) found that requiring undergraduate research students to communicate their work to K-12 students caused them to consider

← *Who doesn't love catching (and releasing) fireflies? ©L-ines*

↑ *Nature's night lights! Captured fireflies flash simultaneously, creating an impressive display ©Benjamin Lehman*

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their research from the perspective of non-scientists and enhanced their research experience. Outreach also typically improves communication skills (Illingworth and Roop, 2015). Funding agencies such as the U.S. National Science Foundation now require evidence of 'broader impacts' of proposed projects, impacts that reach beyond college campuses, professional conferences and journal articles. In a 2013 policy memorandum (Executive Office of the President), U.S. President Obama advocated for greater ease of public access to scientific research. Varner (2014, p. 333) goes so far as to argue that *"scientific outreach must be practiced with the same rigor as the science that is to be shared with the public."*

LIONS AND TIGERS AND BEARS

Perhaps it's not surprising that visitors are interested in charismatic species such as monarch butterflies, fireflies and raptors (lions and tigers being hard to come by in Virginia). It's true that our job is easier when offering programmes on charismatic species - those the public is inherently drawn to. However, we should not limit outreach to such species. In a study of the Eastern hellbender, reasonably interpreted as uncharismatic, attitudes of local residents toward these salamanders improved when provided with additional information (Reimer *et al*., 2014).

The arboretum's mission is to advance understanding of the natural world through research, education and public outreach. These three pillars, important in their own right, gain impact through mutual reinforcement. Incorporating research increases the effectiveness of our education and outreach and encourages our audience to stay involved in environmental issues. Although it isn't difficult to 'sell' our firefly program, especially by involving families, it is our goal to help visitors 'see the light' even on environmental topics that are less familiar or less inherently fascinating.

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"effective interaction between life scientists and the public could not be more timely" *Varner, 2014, p. 333*

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THE NOMADIC BOTANIC GARDEN OF CÓRDOBA

Since 1987, the Royal Botanic Garden of Córdoba (RBGC) has had a strong commitment to education and science communication. Within this working framework, we have initiated a project called the 'Jardín Take Away'. This innovative project intends to take RBGC beyond its garden walls. It is based on a bus with a green roof that travels around the city to promote the garden's facilities and its work. See you at the next stop!

TAKING THE GARDEN OUT INTO THE CITY

Going from one place to another, not remaining in the same place is what defines the nomadic nature of a living being. Could this concept really apply to a garden? RBGC has set up a project of a garden on the go, a travelling garden which presents plants from around the world to the people and showcases their relevance to society.

RBGC is located in Andalucia, Spain. It was opened to the public in 1987 and its main aim is the dissemination of scientific knowledge and engagement with society. RBGC has always been fully committed to its educational and social roles.

With this focus, the Education Department runs various educational and dissemination activities to bring the world of plants and the garden's facilities closer to society. Botany, gardening, ethnobotany, agriculture, palaeobotany and the environment are some of the topics we deliver through formal and informal education.

Our latest project, which started in March, 2015, is the 'Jardín Take Away'.

↑ *Students from Araceli Bujalance Arcos School were invited onto the bus ©Francisco Ramón Merino*

A NOMADIC GARDEN

What does this project consist of? It is literally a travelling garden, a part of the RBGC touring around the city. The garden is growing on the roof of a bus which visits educational centres bringing RBGC to citizens. The combination of the roof garden outside the bus with an interpretation centre inside the bus communicates the botanical activities carried out by RBGC.

The key factors for getting 'Jardín Take Away' on the road were:

Idea. After a detailed analysis of our visitors, we found that some sectors of our city's population are reluctant to visit our garden and other museums or heritage sites. To mitigate this issue, we developed a project to bring the garden to the streets, in different neighborhoods and education centres.

New partnerships. To realise our idea we needed a transport method and this is why we chose an urban bus. We then approached the local transport company (AUCORSA) and an agreement was signed. AUCORSA gave us a vehicle recently retired from service, so that we could transform it into our interpretation centre. Importantly, this project needed funding and specialized designers' expertise that the garden did not have. The financial aspect was partly covered thanks to support from the Fundación Descubre, and the design aspect was covered by involving final year students of the Graphic Design and Ephemeral Architecture course of the School of Arts and Crafts 'Mateo Inurria'. The students worked on brand design, exterior decoration and interior decoration.

Thus the process of transforming the bus internally and externally began. The renovation process has been integral and multidisciplinary including:

- Design and installation of a green roof on top of the bus.
- Removing of all the original bus furniture (seats, steps etc.) and creation of a new open space.
- Development of the brand and image of the 'Jardín Take Away' and redecoration of the vehicle.

Trend. The idea of a public transport with a green roof already existed in some American and European cities, but our innovation lies on combining a travelling exhibition with a vehicle that is covered in vegetation. In this way the bus acts as a real life example of the function and benefits of green roofs and vertical gardens.

Creation. There are two exhibition spaces in the bus, which despite the fact that they are designed by different working teams have a coherent aesthetic and conceptual unity, which clearly identifies the bus as an element of the RBGC.

↑ *Jardín Take Away: under construction ©Royal Botanic Garden of Córdoba*

↑ *Science Fair in Sevilla ©Royal Botanic Garden of Córdoba*

'Jardín Take Away' is based on the concept of the nomadic way of living, moving from one place to another

Interior: the bus has been equipped with roll-up banner stands that act as information panels, tables for workshops, audiovisual devices, plant material and museum specimens, so visitors can learn what they can expect when they visit RBGC and understand better the world of plants. This experience is not a substitute for a visit to the botanic garden, but it is a way to arouse curiosity and interest in the garden and botany in general.

The bus also functions as a space where children can play and learn about plants and their importance in our daily life. In particular, children get access to a mini library, the garden's game 'Plant Guinness World Records' and they can participate in workshops or activities. In short, it is a place designed for the children to learn while having fun.

Exterior: the bus roof has become a small but dynamic garden with plants that are seasonally changed, and make reference to those species found at the same period in the botanic garden. This roof is not only decorative, but helps us to create awareness concerning nomadic urban gardening and agriculture; to connect urban communities with nature using underused spaces of the city in a recreational way; to improve the image of the city; to reduce CO2; to use green covers as thermal and acoustic insulators; and to promote and foster environmental education. Two different crops have been planted on the green roof over a waterproofing membrane: an ornamental garden of Hispanic-Muslim design and a winter vegetable garden.

Bus stops, our garden on the go. Bus trips have been planned annually. During the 2014-15 school year, the bus toured in the city 11 times and stopped in various places including: university campuses, schools, suburban neighborhoods, tourist hot spots, city centre etc. Each trip requires planning in advance, since we need to apply for a special permit from the local authority, as well as rent and install a special platform which allows people to see the green roof from above.

In 2016 around 20 trips to several places within the city are planned, as well as some additional trips to schools.

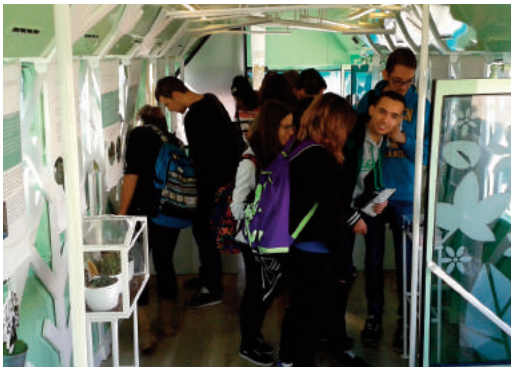
EVALUATION

One year since the 'Jardín Take Away' started touring it has been visited by approximately 2500 people, a large number of whom did not know RBGC at all or had only visited the garden a long time ago. In the future, we are planning to monitor the visits to the bus, to find out whether the people visit the botanic garden following their experience at the 'Jardín Take Away'.

Around 2500 people have visited the 'Jardín Take Away' during its first year in operation, despite being on tour only a dozen times.

↑ *Students at Rabanales University Campus explore the green roof of the bus ©Royal Botanic Garden of Córdoba*

The innovation lies on combining a travelling exhibition with a vehicle that is covered in vegetation



↑ *Students explore the exhibits inside the bus to learn about plant science ©Royal Botanic Garden of Córdoba*

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GETTING THE PUBLIC EXCITED ABOUT YOUR SCIENCE

How can plant scientists engage with the public? Where should they begin exploring this world of communication with non-specialists? Which 'publics' might be interested in plant science research? At the University of Oxford Botanic Garden we have been pondering these questions for a number of years. In 2010 we developed a training course for plant science PhD students called '*Getting the public excited about your science*'.

A DEEPER INVOLVEMENT

Over the years, we have collaborated on research projects and invited scientists to contribute to our newsletters and lecture series. More recently, we looked for ways for them to be involved at a deeper level. In 2010, the Garden's education team was approached to work with the PhD students of the University's Department of Plant Sciences. Science communication and public engagement were to become embedded in their training from the beginning of their postgraduate research. The aim was to equip the students with these essential skills, which they would continue to develop and use as their careers progressed. So, as an organisation with extensive public engagement experience, we could help build capacity amongst new scientists, enabling them to share their future research with the public.

The course was entitled Getting the public excited about your science (GPE), and the first iteration comprised four sessions:

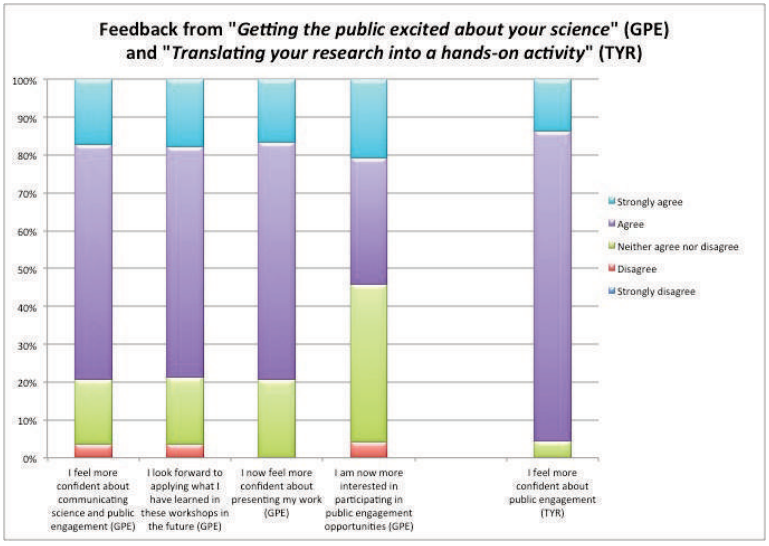
- Meet and greet introductory session, including a communication challenge: can you describe your research in three sentences?
- Science communication masterclass, to explore a range of public audiences and activities, and provide the opportunity to have a go at developing and delivering mini-sessions
- Departmental seminar for the non-scientific staff members of plant sciences rather than the research scientists
- Participation in 'Discover Plants' primary school session at the botanic garden during British Science Week (for pupils aged 7–11 years)

Feedback from some of the first participants:

"Great inspiring workshop to improve your communication skills."
"Extremely helpful for engagement with the general public."

↑ *As part of the Research Excellence Framework, UK universities are now required to demonstrate the impact of their research on wider society, so public engagement training is a vital pre-requisite. ©OBGHA*

Getting your public excited about your science is now a compulsory training module for all first year PhD students in the Department of Plant Sciences at the University of Oxford.



← *Figure 1. Feedback from public engagement training at the University of Oxford Botanic Garden.. ©Kate Castleden*

"The course has inspired me to think more seriously about getting involved in public engagement activities."

The course was deemed a success and became a valuable addition and complement to the students' other training. It is now a compulsory module for all the incoming postgraduate research students in the Department of Plant Sciences. Each year it has been carefully evaluated, reviewed and developed, and today's version comprises seven sessions:

- Meet and greet introductory session
- Public engagement masterclass – part 1, including time for presentation practice, feedback and reflection throughout
- Cells study day for 16–18 year olds at the Oxford University Museum of Natural History: PhD students present their research to 200 school pupils
- Public engagement masterclass – part 2
- 'Discover Plants' primary school session
- Departmental seminar for non-scientific staff
- Development and delivery of a hands-on activity at the Fascination of Plants family-friendly event at the Harcourt Arboretum

The additional sessions provide the students with a greater breadth of experience with different audiences and the opportunity to practise delivering their own talks and activities in a range of venues. Feedback from the audiences included:

"I found the talks really interesting and it made me consider pursuing the field of plant science as a career." (School pupil after the Cells study day)
"Hearing the science explained in an accessible manner by enthusiastic researchers was very stimulating." (Audience member after the departmental seminar)
"The matching vegetables game was my favourite!" (8-year old child after family-friendly event)

Since the course started, 36 students from 12 countries have completed the module and some of their feedback can be found in Figure 1. The GPE training course has built confidence and enthusiasm in its participants, for both public engagement and presenting their own work.

THE SELF-SELECTING OPTION

Also included in Figure 1 is feedback from another public engagement training course entitled *Translating your research into a hands-on activity* (TYR). This session is a half-day workshop (delivered by the University of Oxford Botanic Garden in collaboration with the University's Museum of Natural History and the Museum of the History of Science)

It can be a challenge to deliver compulsory science communication and public engagement training to students who are reluctant to participate.

↑ *Taking a closer look at legume root nodules during the 'Discover Plants' primary school session ©OUMNH*

The botanic garden has benefited from providing practical opportunities for PhD students to get involved with our work, and the students have become an integral part of some of our programmes, such as 'Discover Plants' during British Science Week.

↑ *Describing tobacco infiltration during the Cells study day. ©OBGHA*

and is available to research students and staff across all academic disciplines at the University of Oxford. There is some overlap in the content of the two courses. The biggest difference between them is that those who attend the TYR training are self-selecting.

Figure 1 illustrates the difference in perspective between course participants. Comparing the last column with the first, it is interesting to note that almost all the self-selected participants feel more confident about public engagement after the course (around 95% agreeing or strongly agreeing), compared with around 80% of those for whom the training was compulsory. This is despite the fact that the self-selected participants only received a half-day workshop (TYR), compared with the more detailed and extensive training of GPE, which also included several opportunities for participants to put their learning into practice.

This demonstrates one of the biggest challenges with GPE. As a compulsory course, the students came with a range of attitudes towards public engagement. Motivating those not committed to the training was a significant challenge; we did have some reluctant converts, who began the training quite skeptical but who enjoyed and valued the course by the end. Comments included:

"Really valuable for helping you learn to explain science to non-scientists."
"It has helped me to feel more confident in presenting and talking about my work to non-specialists."
"I have never worked with children before and was pleasantly surprised that I quite enjoyed it."
"In the primary school session one girl told me she would like to be a scientist too when she grows up which really made my day!"

Since 2010, public engagement and impact have risen up the UK higher education agenda, and they are now an integral part of the assessment of the quality of university research (REF, 2014; HEFCE, 2015). Our GPE students are getting the grounding they need for future UK research careers. Many have come to Oxford from abroad and as their careers progress it is likely they will go on to work all over the world. Thus the legacy of this course will be international, as the students continue to use their public engagement skills in their future research groups.

BENEFITS AND OPPORTUNITIES

New public engagement training opportunities have also arisen over the last six years, such as the collaborative TYR training. In addition, our education team has developed science communication and public engagement training for education trainees and horticultural trainees. All of these courses have enabled us to work more closely with research scientists to share their work with the public.

In conclusion, developing and delivering this science communication and public engagement training module for new plant science PhD students has been a great opportunity. The botanic garden has benefited from forging closer links with another university department and the students' contributions have enriched our various events and activities. Providing these scientists of the future with the understanding, experience and confidence to continue their public engagement work throughout their careers has been a privilege. And of course, we hope that their plant science research will also contribute to our wider goals of plant conservation and education.

↑ *Discussing ash dieback with 16–18 year olds during the Cells study day ©OUMNH*

As part of the Research Excellence Framework, UK universities are now required to demonstrate the impact of their research on wider society, so public engagement training is a vital pre-requisite.

↑ *Planting peas and beans at a family-friendly event ©OBGHA*

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SCIENCE FOR ALL AT VMU KAUNAS BOTANICAL GARDEN

As a picturesque green area with rich botanical displays and collections, innovative programmes for education and cultural and community events, Kaunas Botanical Garden attracts more than 60 thousand visitors per year. Education projects are for visitors of all ages: children, families, teachers, students and adults. Recently, numerous new initiatives and unique exhibitions have been developed for students and school communities to increase the public's environmental awareness.

↑ *A group of scientifically-minded youngsters investigate different issues in a biweekly workshop conducted by two teachers ©The Carl Zeiss Microscopy Center*

Kaunas Botanical Garden (KBG) of Vytautas Magnus University is a multifunctional university botanical garden located close to the centre of Kaunas city. KBG is a partner in the Lithuanian Academy of Science's project for the 'Development of a National Science Communication System in Lithuania'. This project provides funding for the *NSO laboratory*, which began in 2009. The *NSO laboratory* provides an informal education programme for young explorers who join the project individually or through their school, when carrying out specific experiments as part of the curriculum. Our students learn how to use microscopes,

test tubes, automatic pipettes etc. and become accustomed with the main rules of the laboratory: using chemicals, making solutions, growing crystals and studying specimens taken from nature (e.g. plant pigment thin layer chromatography). Scientists from the Kaunas universities are invited to give classes for children in the NSO laboratory. The childrens' creativity and learning is encouraged by getting them to teach each other. You can see examples of the experiments carried out in this video http://www.youtube.com/channel/UCzQeA8BjDObFNoDXbpOlzEQ.

In summer, the NSO laboratory organises summer field expedition camps for schoolchildren. The team of children, guided by two teachers, explore nature in the garden. They investigate and learn about the many ponds, trees and flowers and take part in the Biodiversity Rally. This involves learning how to identify plants, birds and insects, following plant pollinators, searching for evidence of wild animals, collecting specimens for examination under the microscope and much more. For example, our young explorer, Deividas (aged 17), wanted to ascertain whether densely growing populations of the invasive *Heracleum sosnovskyi* can be efficiently eradicated by covering its habitat with black plastic. We accepted his proposal and supported him to carry out the investigation. He discovered that the seed bank of *H. sosnovskyi* is entirely eliminated after covering for four months and that 15 species of local plants start to colonise the area within 4 months of removal. Moreover, he performed in vitro experiments and showed that, contrary to the accepted belief, the germination of *H. sosnovskyi* seeds is not dependent on light, yet light is required for the further seedling development. The presentation of his results was awarded by the 3rd prize in the European Contest of Young Explorers.

Particularly popular with university students are night expeditions, organised in collaboration with the zoology experts from Kaunas T. Ivanauskas Museum of Zoology. During two such nights, entomology fans were lucky enough to catch four unregistered species and two insects from the Red Data Book of Lithuania. They also observed bats and night birds.

To spread our way of working further, in collaboration with the Lithuanian Centre of Non-formal Youth Education, we delivered a seminar on informal education in NSO Laboratory for school teachers in 2015.

↑ *NSO laboratory outdoors: getting ready for the 'insect rally' ©TGertruda Stuopyte*

Our students learn how to use microscopes, test tubes, pipettes. They become accustomed to the standard processes of a laboratory: using chemicals, making solutions, growing crystals and studying specimens collected in the field

↑ *After a theoretical explanation our visitors enthusiastically help to remove leaves with larvae of horse-chestnut leave miner ©Vida Mildaziene*

We also have a range of environmental activities for a variety of audiences.

In 2015, KBG started the *Green Gardening* project in partnership with the neighbouring school – St. Francis gymnasium. We helped them realise their dream of being able to design and grow their own vegetable, herb and ornamental garden. The site, at KBG, is considered a special new display for our visitors.

Environmental education for adults and the development of exhibitions has been funded by a programme from the Ministry for the Environment that aims to disseminate information on environmental issues to society. The project entitled Zaliasis aleksotas involved a variety of activities for the local community, including: 12 distance learning seminars, 50 online TV programmes and 200 online radio broadcasts. We also organized 12 public events; for example community volunteers were invited to the garden to help in the eradication of *Heracleum sosnovskyi* and *Cameraria ohridella*, and support other environmental management activities.

In 2011-2013, the unique B. Galdikas oak grove was planted at KBG. This was at the behest of the famous anthropologist Professor B. Galdikas, who wanted to plant an oak grove in Lithuania to raise awareness of deforestation. The B. Galdikas oak grove comprises 100 genetic clones of Lithuania's 50 most famous oaks. Amongst them - 40 are from natural heritage monuments. Their seedlings were prepared by a Kedainiai forestry officer, Juozas Girinas, who grafted the branches (scion) taken from famous trees to pedunculated oak rootstocks. Each seedling has a patron (indicated on its label) who is the person or the group who planted the oak and has the responsibility to care for it in future. The grove attracts many visitors because it represents the idea of world-wide biodiversity protection. Even members of the Indonesian parliament planted oaks in the grove during their visit to Kaunas in 2014.

The unique exhibition Plants for Bioenergy (2013-2014) was also under the umbrella of the Zaliasis aleksotas project. It involved displaying 50 plant species used for biofuel with descriptions of their properties and with interpretation about the need to switch to renewable energy sources.

In summary, we have presented the very diverse range of educational activities in KBG. Those which come under science communication are directed towards all groups of society. The hope is that this will give the public, of all ages, an understanding and appreciation of the work of a botanic garden, environmental science and the importance of plants and plant conservation.

Teams of children and teachers take part in the 'Biodiversity rally' – learning how to identify plants, birds and insects, following plant pollinators, searching the traces of wild animals, and collecting specimens for examination under the microscope.

↑ *After a theoretical explanation our visitors enthusiastically help to remove leaves with larvae of horse-chestnut leave miner ©Vida Mildaziene*

Our night expeditions are particularly popular with university students. During these we share stories about the relationship between plants and insects

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← *Planting oaks with prof. Birute Galdikas ©Vida Mildaziene*

Author: Emily Feehling


©Bill Blevins

BUILDING TOMORROW'S FARMS: SEEKING SOLUTIONS FOR AN INCREASINGLY URBAN WORLD

From the tight urban confines of Washington, D.C., a university is growing food on rooftops, using fish to make fertilizer and trying to improve the economics of urban farming. To engage surrounding neighborhoods and communicate its work to a broader online community, researchers use a new online tool called Plants Map, which combines online profiles with interactive, QR-code-labelled plant signs in the gardens.

For many people, the words, 'college of agriculture' conjures up images of livestock, large-scale farm equipment and pastoral settings.

But at the University of the District of Columbia's College of Agriculture, Urban Sustainability and Environmental Sciences (CAUSES), testing grounds are more likely to be rooftop gardens, small raised beds and other creative means of growing sustenance amid a big city.

Land-grant universities have served the American farming community since the mid-nineteenth century, but as the only land-grant institution in the United States with an exclusively urban focus, the University of the District of Columbia (UDC) takes a different approach to the problem of growing food.

Compelling reasons to pay attention to that approach reach much farther than the school's campus in Washington, D.C.

According to a 2014 United Nations report, 81 percent of the U.S. population lives in urban areas, up from 64 percent in 1950. Worldwide, 54 percent of people live in urban areas, a number that is projected to grow to 66 percent by 2050 (UN, 2014).

"If we're serious about sustainability, then we have to get back to producing food closer to where we live."
Sabine O'Hara, Director of land-grant programs at the University of the District of Columbia

81% of the U.S. population lives in urban areas, up from 64% in 1950.
United Nations

To sustainably feed a world where fewer and fewer people live near traditional centres of farming, something has to change.

"For the first time in human history, the vast majority of us live in places where we historically have not grown our food," said Sabine O'Hara, director of land-grant programs at UDC and dean of CAUSES. *"That really requires a completely new look at the food system."*

CAUSES approaches this challenge holistically. The school has developed an intricate system of food hubs that try to anticipate every need an urban community could have related to feeding itself, e.g. remediating bad soil, reusing waste products and re-introducing populations that have long been deprived of fresh produce to basic preparation methods.

"If we're serious about sustainability, then we have to get back to producing food closer to where we live," O'Hara said.

From researching the best methods for growing in urban settings, to teaching people how to prepare the foods, to running farmers markets and compost facilities, these food hubs seek to address the complete cycle of food production and consumption (O'Hara, 2015).

Through its various food hubs, CAUSES experiments with different means of urban food production.

In summer 2015, O'Hara helped cut the ribbon on the largest food-producing green roof on the East Coast. The 20,000-square-foot garden, the centerpiece of a food hub on UDC's Van Ness campus, grew a variety of herbs, flowers and vegetables, including cucumbers, tomatoes and sunflowers, in its inaugural season.

Green roofs have become a popular tool for storm-water management and energy efficiency in all kinds of buildings. What makes this green roof different is that it is specifically made to produce food.

This is complicated by the fact that water, fertilizer and fruiting plants all affect the weight load on a roof; therefore, careful documentation is necessary.

At another location in the District, directly across from the Capitol Heights Metro station, UDC made an innovative arrangement with the city's housing authority to transform a 3-acre lot it owns, but wasn't using, into the East Capitol Urban Farm.

Volunteers from the District of Columbia Building Industry Association and various grants and partnerships helped jump-start the project. About 1,000 people showed up on a September Saturday and completed 70 percent of the work to establish the farm. A few weeks later, 200 more volunteers from the local neighborhood, schools and other institutions came to move the project further toward completion. The new farm is expected to be up and running in spring 2016.

Through its work in the food hubs, CAUSES researchers have learned how even challenging urban settings can be transformed into food production sites without too much difficulty.

Box gardens, for example, can be installed on existing surfaces. In areas where soil contamination may be an issue, they can provide a solution. CAUSES has pioneered the use of aquaponics as a way to grow large amounts of produce in small urban settings. Aquaponics combines growing fish with growing vegetables without soil.

↑ *Tomatoes and bush basil grow in containers along one side of the food-producing green roof at the University of the District of Columbia ©Bill Blevins*

"This is hugely important not just for our own city but for the country and for cities around the world."
Sabine O'Hara, Director of land-grant programs at the University of the District of Columbia

↑ *Signs that include a scannable QR code linked to each plant's profile on the website PlantsMap.com mean anyone can learn what is growing ©Bill Blevins*

Community viability is built into how the school sets up its programs.

By-products from the fish eliminate the vegetables' need for fertilizer. This method grows large amounts of vegetables faster, using 90 percent less water and no commercial fertilizer, compared to growing in soil.

"That's really what our work is about," O'Hara said, *"adopting sustainable practices in a way that is applicable to densely populated urban environments."*

All of this work requires buy-in from the surrounding community to really take root, and O'Hara is encouraged by the reception the school's food hubs have received.

Community viability is built into how the school sets up its programs. Training programs in aquaponics are run with a view toward hiring neighborhood residents to eventually run the facilities.

Three of the five land-grant centers in CAUSES--Urban Agriculture, Sustainable Development and Nutrition, Diet and Health--are collaborating on an ethnic crops program, researching the production, preparation and marketability of crops that aren't native to the U.S., but are part of specific ethnic food traditions.

Interest in these foods is high among both immigrant populations and urban dwellers interested in ethnic cuisine, giving them high marketability. *"When it comes to making it viable in small urban environments, the question has to be which produce fetches the highest revenue, and which contributes the highest nutrient value?"* O'Hara said. *"You want to focus there first."*

To help spread the word about its projects, UDC established an online profile on a mobile-friendly website called Plants Map.

The website allows individuals, organizations, schools and other entities to establish profiles where they can upload their plant collections and organize them with photos and notes. Mobile-friendly technology allows users to map the actual location of their plants and order plant tags and signs that contain a QR code allowing anyone with a smartphone to scan the tag and access the information stored in that plant's online profile.

O'Hara first learned about Plants Map when she was on an advisory panel for a District-based investment fund.

She likes it both for its ability to communicate the school's work and for the internal features that make it easy to track and record data about crop management and outcomes. Around the country, botanical gardens, universities, landscaping companies and avid gardeners have begun using the site as a way to reach a broader audience.

Over the winter, UDC students and faculty have been working to fill out the plant profiles on the site.

O'Hara wants teachers, students and the general public to be able to use the online descriptions and Plants Map interactive garden tags installed in the Garden of the Senses, a community garden project filled with plants that stimulate the five senses, to conduct self-directed tours and tie the garden into STEM-focused lessons.

All of this work on producing food in small, populated spaces will have increasing relevance as the world's population continues to urbanize, O'Hara said: *"This is hugely important not just for our own city but for the country and for cities around the world. Urban agriculture has come of age. We really need focus on that, and to share what we've learned has to be an important focus of what we do."*

↑ UDC has pioneered the use of aquaponics, which uses 90 percent less water than growing in soil ©Bill Blevins

↑ Plants in the Garden of the Senses, another UDC initiative, are labelled with QR codes and tags that display which senses each plant stimulates ©Bill Blevins

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AN ECO-SCHOOL TO LINK SCIENCE RESEARCHES AND THE PUBLIC


©Cuiyu LAN

There is a widely recognized gap between the public and scientists. To improve public understanding of science and its significance, we developed the Eco-School at Shenzhen Fairylake Botanical Garden, in 2014. The Eco-school courses aim to bring the scientific research happening at the garden to primary school students.

There is a perceived lack of public understanding about science and the scientific role of botanic gardens. Furthermore,it is widely accepted that the public struggle to understand scientific research results (Treise and Weigold, 2002). People without a scientific background face a problem when confronted by the scientific language and scientific framework found in an academic paper. This is a spanner in the works when trying to gain public understanding of and support for research projects. A vivid and accurate, yet simple, description of the scientific results is often required. This cannot always be achieved when only scientists are involved in relating science to the public. A lack of interaction between laypersons and scientists can easily result in failure in the effective communication expected (Fischhoff and Scheufele, 2013). Given the above, when it comes to science communication, defining the key audience; their skills, experience and requirements, and identifying crucial messages and means to communicate them is key to successfully engaging the public (Ford, 2010).

People without a scientific background can find it difficult to understand scientific papers. This can be problematic when trying to gain public support for scientific research.

Shenzhen Fairylake Eco-school, which was established in 2014, aims to deliver a course that brings knowledge from our plant scientists to the public, especially young people. We focus on the younger generation because we believe they will become the strength that will conserve the environment in years to come. We have named our approach 'a classroom, a textbook and a team of volunteer teachers'.

We set up one indoor classroom decorated with plant drawings but most of the courses are held in the 'outdoor classroom': our garden.

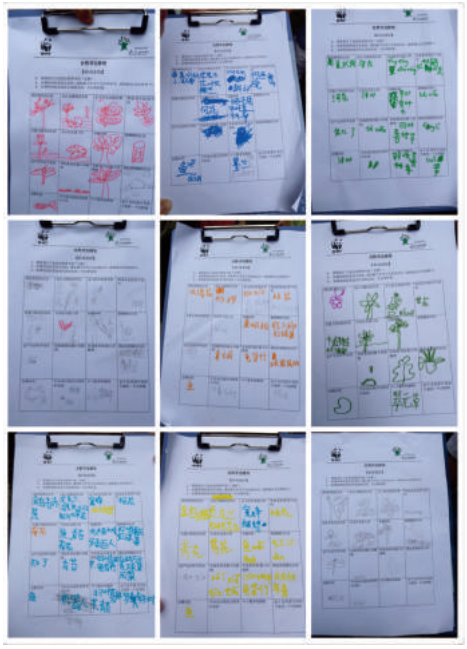
The first two textbooks we have produced are about mosses and cycads. The development of these was supported by senior researchers in our Species Conservation Centre and Cycad Conversation Centre. These are aimed at people with limited scientific knowledge. The books were written in simple terms, using an engaging narrative style, with plenty of pictures to illustrate different species, habitats and uses for plants.

The group of volunteer teachers is our major resource for bringing plant science and current research happening at the garden to the public. Before leading education activities independently, the volunteer teachers complete training courses and internships. Our volunteer training course closely reflects the textbooks and includes a variety of exercises related to education theories and tools. Our scientific researchers act as the trainers. After training, volunteer teachers contemplate what they have learnt and combine it with their own expertise and interpretation styles.

↑ *The text book about mosses and cycads ©Fairylake Botanical Garden*

← *Dr. Qin ZUO teaches volunteers about his research ©Cuiyu LAN*

Defining the key audiences, their skills, experience and expectations, and identifying key messages and methods to communicate them is key to successfully engaging the public. *Ford, 2010*



↑ *Students' drawings as part of a game that encourages them to explore ©Cuiyu LAN*

Shenzhen Fairylake Eco-school, which was established in 2014, aims to deliver a course that brings knowledge from our plant scientists to the public, especially young people.

← *A public tour of the garden ©Cuiyu LAN*

← *The jigsaw puzzle game about elephant's-ear in the environmental education course ©Cuiyu LAN*

So far, we have focused our attention on primary school pupils, and will look at other groups later. For young people, e.g. students in primary schools, due to their instinct to play and inability to concentrate for a long time, games and other outdoor activities can help to deliver knowledge more effectively. Pupils attend the Pupils attend the course and non-specialist non-specialist volunteer teachers act as knowledge transmitters facilitating an active learning style (through playing games and storytelling). One particularly effective activity is a game that encourages exploring. Nine plant descriptions are given to participants, they then have to find the plants in the garden and draw them. By completing this game, students make close observations of plants and learn about their biology in a fun way.

The Eco-school course has been well received. It has been run 23 times and more than 600 students have taken part and given positive feedback. There are various benefits of this approach: the garden engages new and larger audiences; the pupils learn about current science in an engaging setting; the volunteer teachers learn about current scientific research and public engagement which can lead them towards career development.

Definitely, this model is not perfect. A major challenge is the time it takes to transform new scientific results into applicable activities, which currently takes several weeks or even months. To solve this problem, we intend to create a standardised teaching plan so that we can include new research immediately. Another problem is the unstable situation of the number of volunteers. As the work is voluntary, we sometimes face a lack of teachers. This will be alleviated by ensuring a durable and sustainable volunteer structure, through good management and policy and an efficient training process to train new volunteers each year.

The Eco-school course has been well attended. Last year, it ran 17 times and 400 students participated and gave positive feedback.

↑ *The environmental education course led by a volunteer teacher ©Shan LI*

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← *An outdoor training course led by Hui WAN ©Cuiyu LAN*

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SLICE, DICE AND DELIVER: MASSAGING SCIENCE MESSAGING FOR DIVERSE AUDIENCES

The education team at Canada's Royal Botanical Gardens are like a kitchen mandoline, always ready to creatively slice and dice scientific content to match communication and education needs with the needs, interests and characteristics of many audiences. This article focuses on two successful initiatives for communicating science content.

Royal Botanical Gardens (RBG) is Canada's biodiversity hotspot. Our 100 hectares of plant collections and display gardens are surrounded by a 1000-hectare nature sanctuary within the Niagara Escarpment World Biosphere Reserve and accessed via a 27-kilometre trail system.

RBG's Horticulture, Natural Lands, Science and Education Departments form a Biodiversity Programs Division that collaborates to share research with a wide range of audiences, from children and the general public, to naturalists, landscape designers and "avant-gardeners". Content varies from ecological restoration and invasive species to archaeology, species at risk or trends in plant breeding. We use diverse channels including publications, events, interactive videoconferences, exhibits, workshops, courses and school programs.

↑ *Students document the variety of plants found in the buffer zone between garden and nature sanctuary ©Royal Botanical Gardens*

← *A short biodiversity survey is one of 15 activity stations at the student symposium ©Royal Botanical Gardens*

THE SENIOR SCIENCE STUDENT SYMPOSIUM

Like gardens and museums everywhere, we find that reaching senior high school students is always a challenge. During the UN International Year for Biodiversity 2010, we set up a special enrichment day for students in their final two years of secondary school, designed to meet curriculum needs from senior biology, environmental science and geography courses. This was efficient programming; we could accommodate up to 300 students at once, and our scientists could also teach (they can't help deliver every high school program but can commit to one symposium day in fall and spring). We included lectures by leading researchers (onsite and via videoconference) and hands-on workshops. The day was a success for a first effort but teachers suggested more hands-on learning outdoors. We adjusted accordingly and changed the theme to align with the International Year of the Forest in 2011. It was again a success, though registration numbers (and revenues) did not climb as much as we hoped.

For three years we annually refreshed the event, thinking that a fresh, timely program would make the symposium more attractive. It turned out what teachers really wanted was reliability and repetition, to include the program in their annual curriculum cycle. We also found that many teachers were struggling to deliver an engaging plant science unit in grade 11 biology. We put our efforts into that unit and started offering a consistent symposium theme each semester – a cost-effective decision for us and a better match for teacher needs.

The Power of Plants day is divided into a plenary session, plant challenge stations and a culminating activity. To set the tone, we invite well-known (preferably young and hip!) researchers to provide an inspirational opening presentation. Whether it's the sex life of plants or how genetic barcodes can uncover fraudulently labelled herbal remedies, this introduces students to the relevance of botany in daily life and possible career opportunities. Students then pick up a map/guide and head out in teams to find 15 inquiry-based stations spread around our gardens and adjacent natural lands. Staff and volunteers at each station provide a demonstration or facilitate a discussion that encourages hands-on, minds-on learning in the field. At the end of the day, the students regroup to collaboratively solve a challenge and share what they have learned. Topics at the stations include biodiversity, plant structure/function, plant growth and survival, sustainability of ecosystems, habitat restoration, interrelationships with the animal world, ethnobotany, species at risk and invasive species research.

COOTES PARADISE FISHWAY: SOMETHING FOR EVERYONE

Since the 1950s, RBG has been helping to restore the marsh ecosystem in Cootes Paradise Marsh, our 300+ hectare freshwater coastal wetland at the westernmost tip of Lake Ontario. Once known as the most spectacular wildlife area in Canada, the marsh suffered a number of pressures, especially a huge (literally, up to 20kg/35lbs each) breeding population of the invasive common carp. Studies showed these fish were preventing regeneration of native vegetation and that reducing their number was essential to returning any balance to the ecosystem.

We explore new ideas and find new ways to make real-world plant science and ecological content engaging and relevant to senior level students.

↑ *Young sapling planted with a few centimeters of a mature tree bordering the vista ©Andrew Vovides*

It turned out what teachers really wanted was reliability and repetition, to include the program in their annual curriculum cycle.

Whether it's the sex life of plants or how genetic barcodes can uncover fraudulently labelled herbal remedies, we introduce students to the relevance of botany in daily life, and possible career options.

In 1997, under the auspices of the Remedial Action Plan for Hamilton Harbour (part of the International Joint Commission's Great Lakes Water Quality Agreement), we opened a unique structure to help us manage this invasive species. Built at the mouth of a nineteenth-century shipping canal, the Cootes Paradise Fishway keeps common carp out of the marsh while allowing native fish to move between the wetland, Hamilton Harbour and Lake Ontario. A series of underwater baskets in the barrier trap all fish greater than 2.5cm wide. When fish are migrating, a gantry crane lifts the baskets twice daily and RBG ecologists hand sort the fish, moving native species in or out of the marsh, excluding carp. Species of interest or concern are tagged and monitored.

To celebrate the millennium, Hamilton opened a Waterfront Trail that brought thousands of people past the Fishway each month. Many stopped to watch our aquatic ecologists at work transferring, measuring and tagging fish and this soon became a local 'must see' experience. Staff were answering so many questions, that they proactively began to narrate their way through each lift, identifying fish species and helping the public understand the connection between the carp, the murky marsh water, and the lack of wetland plants. Simple interpretive signage explained the structure to walkers who arrived when no staff were present. We posted a list of demonstration times, resulting in a queue of people waiting whenever staff arrived to conduct a lift.

To build on the Fishway project, our ecologists communicate findings at public open houses, scientific conferences, stakeholder meetings, and through reports and fact sheets, while our interpreters engage with casual visitors and the many school groups who take part in curriculum-based programs and use our fish population data in the classroom. Newest to the program mix is an interactive discovery cart, open through the summer and staffed by a student interpreter and volunteers who engage visitors with information and activities about how the Fishway operates and how this has benefited the marsh. Our creative education team update the cart with new programs, props, and materials, designed to engage the broadest audience possible with this fantastic example of technology and an inspiring story of environmental stewardship, research, and action.

← *Fishway lifts delight visitors with many sizes of many species of fish – being splashed is a bonus!. ©Royal Botanical Gardens*

↑ *Ecologists hand sort the fish, ensuring that native species are able to move into and out of the wetland and invasive carp remain in Hamilton Harbour ©Royal Botanical Gardens*

All aimed at engaging the broadest audience possible with this fantastic example of technology that helps us tell an inspiring story of environmental stewardship, research, and action.

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← *Small groups of students gather together to collaboratively solve the Power of Plants Challenge. ©Royal Botanical Gardens*

Author: Max Coleman

NEW SURVIVALISTS

Max Coleman, Science Communicator at the Royal Botanic Garden Edinburgh, explains the thinking behind the new children's trail around the glasshouses, and explores how our innate survival instinct can be turned into a useful hook for engagement.

Growing up with an interest in plants, I was drawn to The New Naturalist Library books. In Britain this series was truly ground breaking, bringing the science of natural history and ecology to the layman for the first time. Their unique selling point was a combination of authoritative natural history writing and quality colour photography – in drab post-war Britain, the series turned out to be a roaring success. The distinctive dust jacket artwork and the fact that the books are part of a series turned them into collector's items and publisher Harper Collins suggests the New Naturalist back catalogue of over 100 titles is "arguably the most influential natural history series in the world". If we exclude the natural history film output of the BBC, I'd not be inclined to disagree.

↑ *Cover artwork for the Survival of the Smartest trail ©Liv Wan*

We all have basic survival instincts and the utility of nature seems to be endlessly popular.

However, along with the things that made it great, the series had a weakness. Many of the authors were academics and did not necessarily have a gift for engaging or stimulating writing. Some of the titles are heavy going and not particularly well organised. Today, it is fair to say the series is no longer the publishing phenomenon it once was.

Thinking about how to inspire a modern audience about plants, and taking a leaf out of the New Naturalist book, led me to the idea of the 'new survivalist'. Working on the premise that we all have basic survival instincts and, as the utility of nature is endlessly popular, it should be possible to engage a broad spectrum of people by focusing on how nature, plants in particular, might help us survive. For a botanist, the survivalist angle is particularly relevant as plants help us in so many ways – even more than animals. Plants can become building material, fibre, fuel and medicine, as well as food. The great interest in foraging is one of the more obvious expressions of plant usefulness viewed from the perspective of survival. It does have to be said that in Britain, at least, foraging today is more likely to be about commercial supply of the high-end restaurant trade, but nevertheless the interest is there. All the popular books and television shows have created the celebrity forager ready to entertain and inform us on the uses of plants as food.

From a child's perspective, utility is also an effective vehicle for engagement. Most children pick up sticks that have various uses in their imaginative play. Even computer games designers have homed in on the utility and crafting approach. Many games have a survival element to them and collecting useful things, including natural materials, is a common theme.

Clearly the survivalist mind-set is deeply ingrained. A quick internet search will bring up a vast array of wacky, some verging on paranoid, blogs about survival and preparedness. There seems to be an internet sub-culture aimed at getting people ready for the anticipated apocalypse.

TWO ASPECTS OF SURVIVAL

So, taking advantage of the survivalist bandwagon, the *Survival of the Smartest* trail was born. The basis of this self-led glasshouse trail for children is that the young explorer will visit a series of plants capable of assisting in some aspect of survival during the journey. This is good as far as it goes, but it does limit participants to thinking about plants solely in terms of how they might be useful to people. To take the engagement

For a botanist the survivalist angle is particularly useful as plants help us in so many ways.

↑ *Bamboo shoots are a familiar food in Asian cooking ©Liv Wan*

Even computer games designers have homed in on the utility and crafting approach.

↑ *Cross-section of bamboo showing its use for steaming rice ©Liv Wan*

← *The Survival of the Smartest trail is a great way to get children to think and learn about what they encounter at the garden ©RBGE*

a stage further, the narrative in the trail booklet prompts participants to consider some of the special adaptations that help the plants themselves to survive – for example, the stilt roots of screw pine (*Pandanus* sp.) are all about stability on potentially unstable river banks. The answers to questions about plant adaptation posed during the trail are provided on small interpretation panels beside each plant. Thus even visitors who don't do the whole trail get some bite-sized facts about a selection of interesting plants.

Along the way a series of stamps are collected in a pocket-sized trail booklet, which is illustrated in a playful and fun style. A special stamp is the prize for completion of the trail. The booklet is of good quality, to encourage participants to keep it as a memento of their journey. Along with the set of stamps (which neither children nor adults can seem to resist), participants personalise their booklet with an invented explorer name, their own ideas about adaptation and a drawing of a fantastical plant, complete with survival adaptations.

The trail was devised by a small team of staff at the Royal Botanic Garden Edinburgh, working with a graphic designer, an illustrator and a writer, to a modest budget. This multi-disciplinary team has developed a high quality, engaging and, most importantly, fun trail suited to a wide audience of children and their carers. The most challenging aspect was finding robust, low-maintenance stamps for the booklet and more durable stamps that emboss designs on the pages have now replaced the original self-inking stamps.

RESEARCH IN THE SPOTLIGHT

The *Survival of the Smartest* trail is also being used as a showcase for the Garden's research. This is achieved during special events by having a manned station at the start of the trail displaying a wide array of plant adaptations and props relating to survival and plant collecting. Facilitators involved in botanical research use this as a resource for exploring the topic of survival and adaptation both in terms of plants and people. Participants then set off on the self-led trail, which can be augmented with additional props if desired.

So, for example, the Royal Botanic Garden Edinburgh probably has the finest living collection of Cape primroses (*Streptocarpus*) in the world, thanks to a research programme exploring their evolution and genetics. This collection, and others like it, provide an ideal resource for bringing plant adaptations to life for visitors.

One Cape primrose species stands out, as it is adapted for bird pollination and features robust red tubular flowers. Comparing this species with insect-pollinated relatives immediately highlights the adaptations. Other species in the genus have flowers adapted for self-pollination, presumably as a response to a scarcity of pollinators. Cape primroses take one of three radically different forms: a shrubby form, a rosette of leaves that looks very primrose-like and a bizarre single leaf form called unifoliate. In this last, the single leaf develops from a seed leaf (cotyledon) and grows continuously from the base. Such an adaptation is thought to assist survival in the heavily shaded environments where these species grow, because energy can be entirely devoted to producing leaf area. This way of maximising photosynthesis is an unusual solution to a common problem faced by plants of the forest floor.

Almost any group of plants could illustrate a wealth of adaptations for survival, so this approach by no means relies on having extensive collections of unusual plants. The aim is to get people looking closely at plants from two very different perspectives united by a common need: to survive. If, in the process, a sense of wonder about plants is generated, the new survivalist approach will have worked its magic.

↑ *Giant bamboo activities ©Liv Wan*

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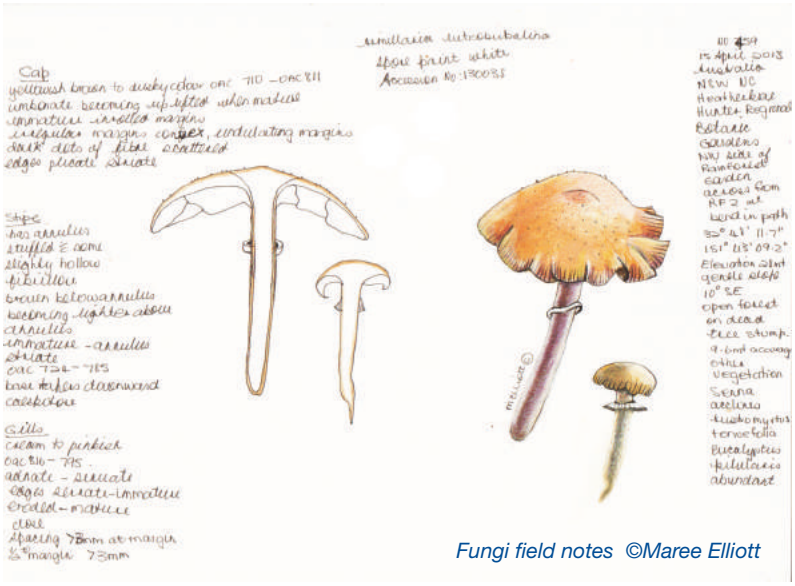
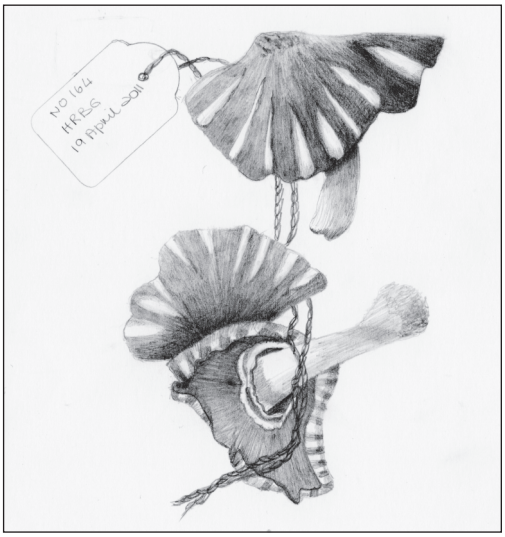
Author: Maree Elliott

FUNGI:
PROMOTION OF A NATURAL ASSET

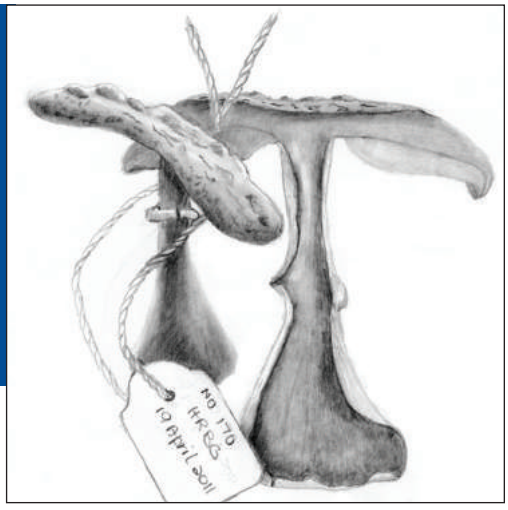


Fungi field notes ©Maree Elliott



↑ *Illustration of Agaricus rotalis ©Maree Elliott*

The inspiration for my art practice comes from the extraordinary forms and colours of fungi and their relationship with other organisms within the environment. Workshops, night walks, presentations, exhibitions and artist's talks are the unexpected outcomes of my research as a PhD candidate at the University of Newcastle NSW.

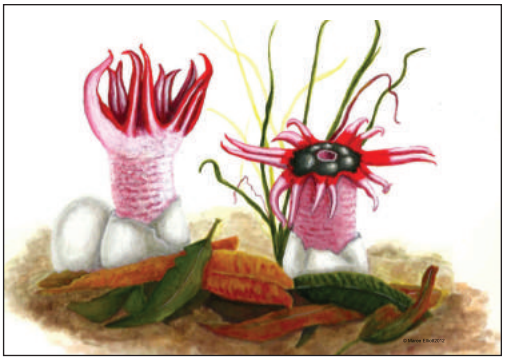


↑ *Illustration of Amanita ananiceps ©Maree Elliott*

The Fungi Collection at the Hunter Region Botanic Gardens (HRBG), Heatherbrae, NSW Australia was established in 2010. Its launch was marked, in 2011, with a solo exhibition of my artwork featuring the fungi.

I am passionate about fungi and amazed at the extraordinary forms and colours, so much so that I decided to produce scientific illustrations of the fungi I had collected. There were copious amounts of information about botanical scientific illustration but little about illustrating fungi. I was unable to use the information about plants to illustrate fungi because fungi have a different set of identification features. So I decided to make it a research project.

I attended many workshops and conferences to gather the information I needed. I developed a benchmark of processes involved in information gathering in the field, laboratory, studio and herbarium. These constitute methods for illustrators. The field processes involve finding, collecting and documenting fungi and then dissecting, observing and documenting the macroscopic features for identification purposes and these processes have been used as the foundation for public workshops.



↑ *Painting of Aseroe rubra ©Maree Elliott*

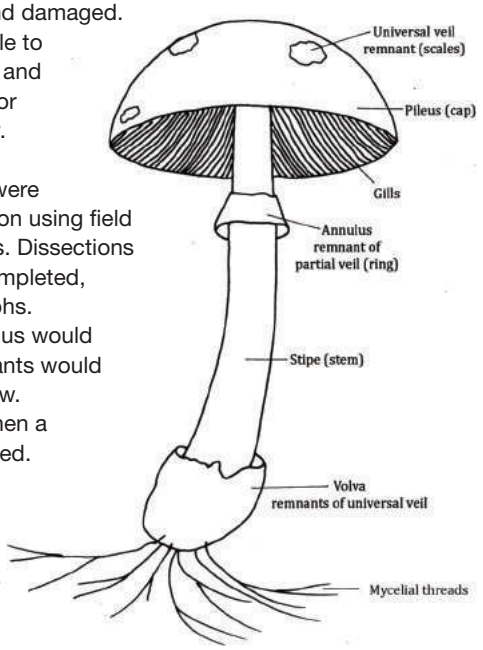
← *Omphalotus nidiformis by day ©Maree Elliott*

It gave people an opportunity to experience the field note taking and photography processes associated with collecting fungi.

The workshops were organised over one day on a weekend. Although it did not attract large numbers, it did attract a young audience. The workshops began with a presentation about fungi and a walk around the gardens, photographing and gathering fungi. It gave people an opportunity to experience the field note taking and photography associated with fungi collecting. Also, they were shown how to store fungi so that they were in still in a good condition when taken back to the workshop. Fungi cannot be pressed like plants and so are carried in a basket after being placed in paper bags or wrapped in foil to prevent them from being crushed and damaged. The walks also helped people to begin to make observations and question any oddly shaped or coloured organism they saw.

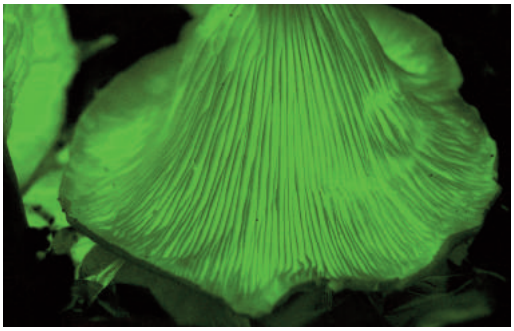
↑ *Collecting in the field ©Maree Elliott*

I developed a benchmark of four processes for information gathering and studio work for illustrators.



← *Anatomy of a mushroom ©Maree Elliott*

After the walk, all the fungi were laid out ready for identification using field guides and specialised apps. Dissections and measurements were completed, followed by more photographs. Knowledge about each fungus would gradually build and participants would discuss the features they saw. Excitement often ensued when a fungus was correctly identified.



↑ *Glowing Omphalotus nidiformis at night time ©Maree Elliott*

Charts and guidelines with macroscopic features were used so participants could go through steps logically, ensuring no feature was missed. A glossary was provided to explain features: the cap, gills and stipe (stem). Spore prints were also taken to be used for microscopy at a later date. Observing important macroscopic features, and reading the descriptions in the field guides and apps, helped participants became more familiar with the new vocabulary they had learned. Sorting fungi into their taxonomic groups provided a starting point for the less familiar. The microscopic features were not explored in these workshops because we only had a few hand lenses and one dissecting microscope, which was not suitable for microscopy.

Fungi are truly extraordinary organisms that need recognition for their essential contribution to our ever changing environment.

← *The fungi poster displays species that are frequently enquired about ©Maree Elliott*

Keeping it simple and using visual aids, in the field and the workshop, generated awareness and interest and increased the participants' skill base and confidence.

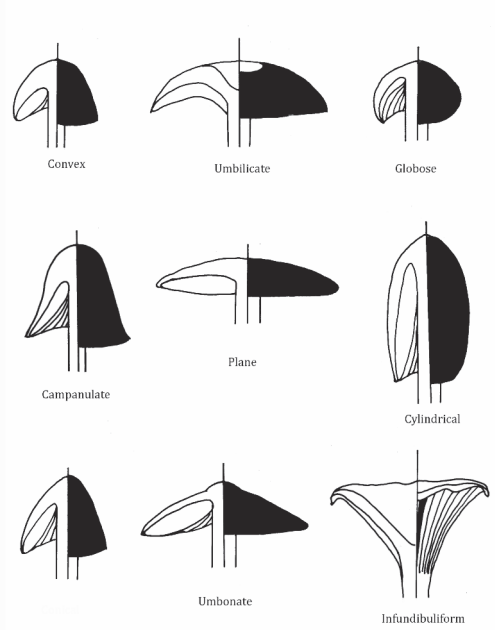
In 2011, a glow in the dark fungus, *Omphalotus nidiformis*, was collected. This prompted a decision to offer the community night walks. People of all ages come on these walks, which commence around 6pm and finish around 8pm. The night walks have been very popular and well attended. Fungi do not always appear in the same place or at the same time each year and it is usually a tense moment trying to choose a date when we think the fungi will appear and be at their best.

Another activity involving fungi at the HRBG is the annual photography exhibition which has a section dedicated to fungi. This involves community participation and awards for outstanding photographs taken within the gardens. This can alert us to what types of fungi can be found around and within the gardens at a given time.

Since the launch of the Fungi Collection, I have had several exhibitions at different venues where I have given artists talks about fungi and the benchmarks for illustration. These have been well received with people in the audience often suggesting their organisations as sites for future field trips.

Fungi are truly extraordinary organisms that need recognition for their essential contribution to our ever-changing environment. My research has raised fungi awareness, encouraged garden tourism and has brought in some small amounts of funding.

Keeping it simple and using visual aids in the field and the workshop generated awareness, interest and increased the participants' skill base.



↑ *This diagram illustrates the variety of cap shapes ©Maree Elliott*

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PIONEERS IN PUBLIC ENGAGEMENT

KRISTINA BJUREKE'S STORY

"Plants are my job and my hobby. My friends are botanists and I talk plants with them, and I read about plants and they give me joy!"

Kristina Bjureke has trodden a winding career path: from limnologist to nature tour guide, to guide for school groups at the botanic garden in Oslo, to lecturer in botany and researcher dedicated to Arnica montana.

It was two decades ago when Kristina Bjureke, of Swedish nationality, started working for the botanic garden of University of Oslo after settling in Norway and raising her family. Education, until then, was delivered to school groups by PhD students as part of their degree requirements. Kristina, with no additional training or advice, began guiding school groups and families part-time. Her role grew as she became a permanent botany lecturer for children, adults and university students. While teaching at the garden Kristina embarked on a research journey studying Arnica montana (Mountain arnica) for her postgraduate studies. Still now she continues to work on it –it's her favourite plant! A special display in the garden showcases the great diversity of semi natural grassland, Arnica montana habitat.

Kristina is a rare blend of educator and scientist and her day to day life varies accordingly. In the morning she educates school children coming through the garden gate, while in the afternoon she may be busy with her science. She finishes the day with an evening tour for general visitors. Kristina sits on the expert committee selecting which plants should be considered invasive alien species in Norway. An exemplar of science communication is Kristina's citizen science project involving adults and school children in eradicating invasive alien species. After an introduction to the difference between invasive and native species and activities exploring the impact of invasive species on ecosystems, participants contribute to combating the issue by identifying and eradicating invasives in the field.

Not satisfied with transferring plant knowledge to people, Kristina seeks to engage people with plants, and so she was involved in the European INQUIRE project which focused on reinvigorating Inquiry-Based Science Education through teacher training across Europe. Kristina applies her collaborative ethos within her organisation as we all externally. Being part of a small team, two educators working alongside other scientists, gardeners and curators, makes it easy for collaboration across departments. What she enjoys the most is when she works alongside her colleagues. Her regular collaboration and dialogue with the horticulture team in particular may be attributed to her very first job when she was a gardener at 18. This has given her an understanding of their roles.

"We meet each day, sit and chat together about a new sign, a new display, everything. And I think this is very useful, because I don't like those big walls between people working for education and outreach and curators. Also, I think when we do something together people look at the fruits of our collaboration with different eyes and give each other critical comments so that the results will be better. I am quite proud we have this good cooperation."

BRIGHT THINGS - GREAT RESOURCES

THE 3 "R" PROJECT: CONSERVATION OF THREATENED CACTI WITH THE PARTICIPATION OF LOCAL COMMUNITIES

http://www.concyteq.edu.mx/PDF/Tres%20erres%20que%20tu%20eres.pdf

The three Rs in the title of this project relate to the steps required to ensure conservation of local species under threat:

- Recognize biodiversity's local and universal value
- Reproduce plants through horticultural and conservation projects
- Recuperate the number of species and individuals in the area

The project was developed in an area identified as a biodiversity hotspot at the southern end of the Chihuahuan Desert in Mexico. This was due to its wide variety of endemic, threatened species of flora.

The Cadereyta Regional Botanic Garden developed a method, which aimed to preserve wild species in their natural habitat. To ensure a good reception on the part of the locals, the project was introduced to the community and local authorities, through a presentation and a brief summary document delivered at public sessions at local schools. The approval from a local committee was obtained prior to the beginning the activities.

Young people from the community were recruited and a five-member team was selected from candidates using a criteria based on their academic ability, attitudes towards nature and tendency to relate to it in a positive way. Then, a meeting was held with students' parents to inform them about the project's objectives, and to request their permission to allow their children to take part in the activities.

Our approach consisted of basic field training to provide basic knowledge about plants and the environment and to help them identify the target species *in situ*. This was complemented by extensive horticultural training with sessions held at the botanic garden. These offered theoretical background and the practical skills needed to operate the greenhouse in which they would reproduce five local species at risk of extinction. Team members also devised their own protocol to help them continue propagation activities in the community, assuming full responsibility and working independently as horticulturalists.

The final products included an informational leaflet designed by the botanic garden staff and the students, and two greenhouses – one in the community and the other in the botanic garden, with more than 500 seedlings growing therein.

The "3 R" project is an example of interaction with local communities, engaging their young representatives in the conservation of threatened flora, and raising their awareness of its presence and importance. Key points to remember when carrying out work of this nature are: prior local approval, careful selection of participants, and practical training. Maintaining contact with the community over a long period of time is also desirable to ensure long-term commitment and sustainability of the work.

Sponsored by the "Investing in Nature" Program, BGCI.

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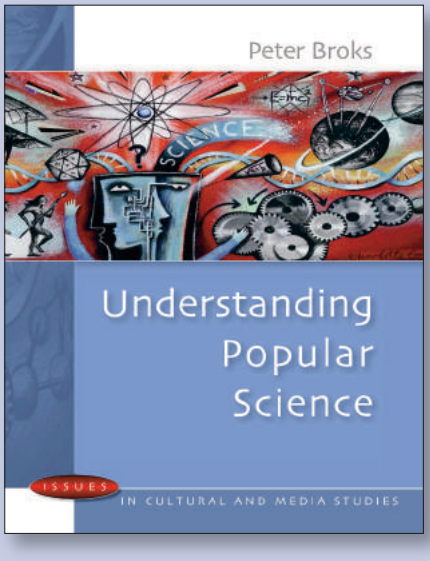
RESOURCES

THE CLASSICS

1. A Short History of Nearly Everything (book)

"Taxonomy is described sometimes as a science and sometimes as an art, but really it's a battleground." Using language that is humorous, energetic and quirky, Bill Bryson's bestselling book communicates the wonders of scientific inquiry. This is a resource that shows you how to communicate science in a very effective way.

Bill Bryson
2004, Black Swan, London, UK



2. Understanding Popular Science (book)

If you are new to science communication this book, written in a friendly and accessible style, presents the history and main theories behind the field. As a science communicator you will find out how people think of and behave towards science and scientists in order to plan effective and relevant engagement activities.

Peter Broks
2006, Open University Press, London UK

THE NEW IDEAS

1. The Wellcome Trust (website)

Being the world's second-largest private funder after the Gates Foundation, The Wellcome Trust is an independent global charitable foundation dedicated to the improvement of health. Funding scientific research and science communication is part of the core activities of the Wellcome Trust. Visit the Trust's website to find education resources, information about their funding and inspiration from their projects such as 'The Crunch' and 'Naked Scientists' that are innovative, spark curiosity and invite creativity.

http://www.wellcome.ac.uk/Funding/Public-engagement/Funded-projects/Awards-made/WTDV030223.htm

2. Science Communication: A practical guide for scientists (book)

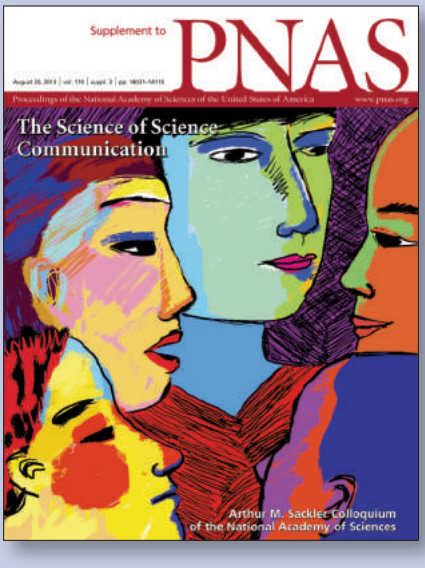
With up-to-date information on science communication developments this is a manual combining theory and practice. A brief history of science communication is followed by case studies from well-known scientists and experts that offer inspiration for public engagement activities.

Laura Bowater and Kay Yeoman,
2012, Wiley-Blackwell, Oxford UK

3. King's College London's definition of science communication (pdf)

This short document succinctly describes science communication and why it is important. Although the document has a UK focus the information is still relevant to the field internationally.

https://www.kcl.ac.uk/sspp/departments/education/study/undergraduate/Science-EngCom/What-is-Science-Communication-Catalyst-24-1-556-1.pdf



4. Assessing what to address in science communication (pdf)

'Rather than relying on experts' intuitions about what people need to know, communication materials should be based on evidence about the relevant beliefs that audience members already have and what they are still missing'. Bruin and Bostrom explain the mental models approach that can be used to create easy to understand and effective science communication materials.

Wändi Bruine de Bruin and Anne Bostrom
http://www.pnas.org/content/110/Supplement_3/14062.full

5. The Collective Memory website

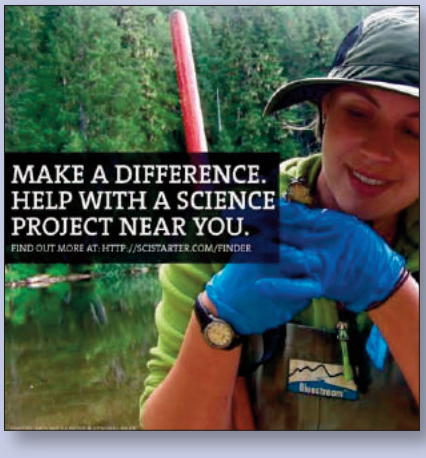
Are you looking for methods to evaluate your public engagement activities? Visit Collective Memory, a database of evaluations of a diverse range of science communication initiatives. You can also upload your project information and evaluation results and contribute to this online community.

British Science Association
http://collectivememory.britishscienceassociation.org/

6. SciStarter (website)

SciStarter is a large database of citizen science activities form different parts of the world covering a wide range of topics. This online space offers the opportunity to find a citizen science project that matches your interest and contribute to it, or get inspiration to start your own.

http://scistarter.com/topic/20-Ecology%20%26%20Environment



7. Communicating Plant Science in the Digital Age (blog)

Ian Street's blog post explains that scientists are underutilising social media and the internet to communicate their work to non-scientists. Through analysing examples of general science and plant science communication, Street shows there is an appetite for science out there and provides suggestions on how to utilise it.

Ian Street
http://blog.aspb.org/2014/06/17/communicating-plant-science-in-the-digital-age/

READY FOR PRACTICE

1. Citizen Science (website)

Are you looking for a guide on how to set up a Bioblitz (an intense biological survey conducted with the public), or a more long term citizen science project? Visit the Natural History Museum, London Citizen Science portal to explore their projects and comprehensive resources.

http://www.nhm.ac.uk/take-part/citizen-science.html

2. Pilots Resource Pack for Training Explainers (website)

Use these online resources to learn how to organise debates to engage adults with science, run a science show, learn the fundamentals of inquiry-based learning and reflect on your practice as an educator. These 'Tools for thought' were developed to support science centres' educators in Europe to establish their work as professionals.

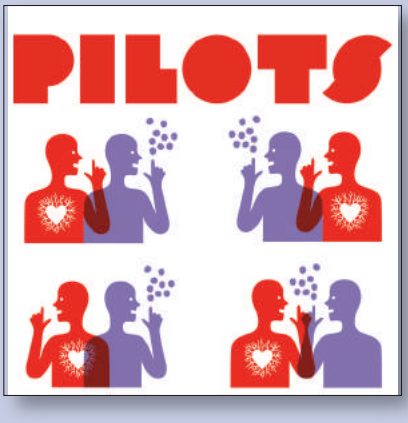
ECSITE
http://www.ecsite.eu/activities-and-services/resources/pilots-resource-pack-training-explainers

THE ODD ONE OUT BUT REALLY USEFUL

1. The secrets of good science writing (website)

Although botanic garden professionals are not journalists as part of their work they often need to produce journalism to communicate plant science. The Guardian media provide a series of articles on how to write about science ranging from how to avoid common mistakes in science writing to how to create a successful science blog.

The Guardian
http://www.theguardian.com/science/series/secrets-science-writing



CONTRIBUTE TO THE NEXT ISSUE OF ROOTS

HAVE YOU GOT A FANTASTIC VOLUNTEER YOU WANT TO TELL THE WORLD ABOUT? IS YOUR GARDEN WORKING WITH VOLUNTEERS IN A NEW AND EXCITING WAY? DO YOU MANAGE AN EXCEPTIONAL VOLUNTEER PROGRAMME?

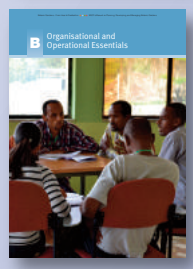
Volunteers are essential to the running of many botanic gardens, representing guides, gardeners, educators, admin staff and much more. In the next issue of Roots we want to create a stage for these often unsung heroes.

Think you've got a story the world needs to here?
Get in touch by 4th July!

We are currently looking for a variety of contributions for the next issue including articles, education resources and profile of an inspirational garden staff or volunteer.

Find out more about how you can get involved on our website **(www.bgci.org/public-engagement/roots/)** or email **Liliana.derewnicka@bgci.org**

FROM IDEA TO REALISATION – BGCI'S MANUAL ON PLANNING, DEVELOPING AND MANAGING BOTANIC GARDENS



This new publication from BGCI, is intended to support botanic gardens and arboreta as ever-evolving institutions that respond to environmental and societal needs, changes and challenges.

Covering planning, governance, collections, education, the social role, interpretation, sustainability and much more the manual offers guidance and best practice examples to support all areas of botanic gardens' work.

Consisting of four main parts, the eight chapters of the manual are being published in stages over the coming year, with Chapters 1 and 2 now available online.

- Chapter 1: Planning and Implementing Botanic Garden Design Projects
- Chapter 2: Governance Models, Human and Financial Resources Development

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www.bgci.org/resources/2016-BGCI-botanic-garden-manual

BGCI
Plants for the Planet

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CELEBRATING LANDSCAPES AT THE ANNUAL BOTANIC GARDENS EDUCATION NETWORK CONFERENCE

Join the UK Botanic Gardens Education Network annual conference to get inspiration on working with communities, engaging with landscapes, and health and wellbeing.

This year's annual gathering will take place between 2-4th November at Alnwick Garden, the world's most extraordinary contemporary garden.

The conference will welcome educators from botanic gardens, and related organisations, across the UK and abroad to share practical advice, best practice and new ideas about botanic garden education related to this year's theme of local landscapes

Look out for updates on the BGEN website
bgen.org.uk/training-events/