

Roots

Botanic Gardens Conservation International Education Review

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Impact: Botanic gardens and the quest for evidencing change



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CONTRIBUTE TO THE NEXT ISSUE OF ROOTS

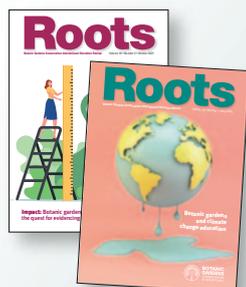
The next issue of Roots is about reducing waste. Now more than ever it is important that we reduce our impact to save the planet. We are currently looking for a variety of contributions including articles and education resources for the next issue.

Ideas include:

- Reducing water usage,
- Reducing food wastage,
- Reducing landfill
- Creating compost

Please include the positive change that has happened – particularly when it comes to your education and engagement programmes.

To contribute, please send a 100-word abstract to dominic.grantley-smith@bgci.org by 15th December 2021



BGCI FOOD WASTE CHALLENGE



An area larger than China is used to grow food that is never eaten and collectively we waste 1.3 billion tonnes of food annually. Just in the UK alone as an example, we throw away 1.4 million bananas a day, add this to all the other fruit and vegetables like uneaten cooked potato, leftover salad, half eaten bits of fruit and all those unnecessary peelings that end up in the bin – and the problem becomes very clear.

To help combat this, BGCI has launched a new one year pilot project called BGCI Food Waste Challenge, which tasks individuals to take on a 30 day challenge to reduce the amount of fruit and vegetables that they waste. Individuals can sign up to a new website (www.bgcifoodwaste.org/) take up the challenge and track their progress. There are a host of resources to support people as they undertake the challenge from hints and tips on reducing waste and notes on how to keep fruit and vegetables fresh, to recipes and ideas that will help them use up everything they have available.

We would love as many botanic gardens and environmental education sites as possible to join us by promoting the project. We have a communications package available with posters, social media links, digital information and other promotional material to engage your own visitors with and help us recruit individuals to the challenge. You will also get monthly updates about how much food we have reduced!

Sign up
www.bgcifoodwaste.org

BGCI'S ONLINE TRAINING PLATFORM

BGCI has launched an online training to provide online and blended learning training courses to BGCI members and other interested individuals. The platform, which is Moodle based, allows the creation of a range of interactive content with resources designed to complement BGCI's existing face-to-face training courses, projects and publications. Modules include:

- Defining a botanic garden
- Masterplanning
- Policy (linking to)
- Introduction to Interpretation
- Introduction to evaluation
- Scaling up biodiverse forests
- Air layering - added to existing veg prop module
- Scaling Up Biodiverse Forest Restoration

Find out more by visiting:
<https://training.bgci.org/>

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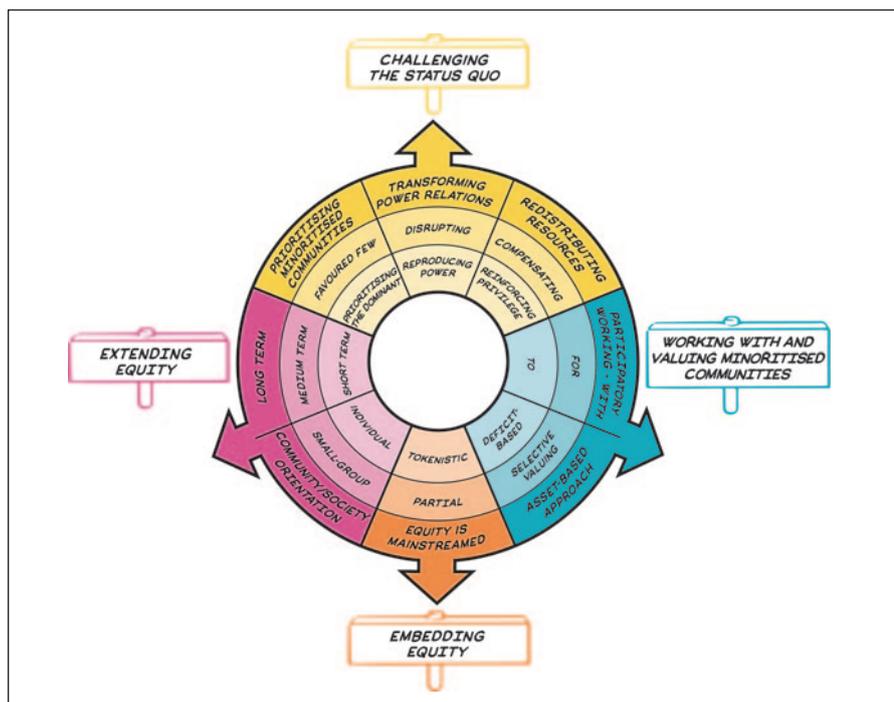
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BGCI is a worldwide membership organisation established in 1987. Its mission is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. BGCI is an independent organisation registered in the United Kingdom as a charity (Charity Reg No 1098834) and a company limited by guarantee, No 4673175. BGCI is a tax-exempt 501(c)(3) non-profit organisation in the USA and is a registered non-profit organisation in Russia.

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FIRST WORD

MEASURING IMPACT

In 2017, at the request of BGCI's International Advisory Council, BGCI produced a Technical Review on defining the botanic garden, and how to measure performance and success (Smith and Harvey-Brown, 2017). This study was based on the results of an online survey that BGCI carried out early in 2017 entitled 'Defining botanic gardens and key performance indicators'. In addition, a literature survey of botanic garden annual reports was undertaken to gather further data on how gardens measure success. In total, data was gathered from over 200 gardens in more than 50 countries.

In carrying out this survey and review, it became clear that too few botanic gardens measure the impacts of their work. Instead, there is a strong tendency to measure areas of activity. For example, the review found that nearly all the gardens that were assessed measured visitor numbers but only half of the gardens measured visitor attitudes (usually visitor satisfaction) or changes in visitor behaviour following a visit. Similarly, while monitoring and curation of collections was carried out by three quarters of the gardens surveyed, many fewer gardens recorded the use of their collections by third parties, and in most the kinds of uses were not recorded. In short, the 2017 Technical Review revealed a gap in best practice by botanic gardens – the need to measure impact rather than activity.

Impact is the focus of this edition of *Roots*. On page 6 Ben Littlefield and Dominic Grantley-Smith set the scene by defining what we mean by impact, and suggesting six steps necessary to develop a culture of practice which is more likely to capture, evidence and report on the impact of your work. One of the most fundamental steps is to set out the impact you want to make when first designing the project through the use of logical framework planning and using a Theory of Change approach. On page 14, Sarah Callan and Ari Novy examine the importance of impact statements as overarching goals for any project or institution. Another recommended step is planning evaluation into your project design to enable program development and maximise impact. An example of this approach is provided by the United States Botanic Garden on page 10.

Of course to measure impact you have to decide which kinds of impacts it is possible to deliver through your work. Changing visitor attitudes and behaviours is an aspiration for many botanic gardens, particularly when it comes to attitudes and behaviours related to the environment. On page 17, a case study from south west China looks at the impacts of green spaces on children's attitudes to the environment and their pro-environmental behaviour. One challenge with evaluating impacts such as behavioural change is that not all visitors are the same. The case study from Morton Arboretum on page 22 tailors the methodologies of various evaluative efforts to different audiences, including differentiating between children and adults, and new visitors compared to regular visitors. The case study from the Royal Botanic Gardens, Kew (page 26) looks at 'minoritised' audiences – a definition that includes people marginalised within a particular society depending on their race/ethnicity, gender, socioeconomic background, dis/ability, sexuality and other social axes. Such audiences may have very different attitudes to, and levels of engagement with science, which can impede impact.

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©Laura Kamedulski



Another case study on changing visitor behaviour comes from the Municipal Botanical Garden of Bauru in São Paulo, Brazil where visitor's interactions with marmosets were endangering the animals (page 32).

Impact is not just about attitudes and behaviours. The development and application of new skills is a critical impact for most botanic gardens, particularly through their schools education programmes. The case study from Vytautas Magnus University Botanical Garden in Kaunas, Lithuania (page 29) is an excellent example of the impacts of informal learning on children's knowledge and skills. Finally, the quality of interactions with visitors – and therefore the potential for impact - is very dependent on the frequency of their visits and how close their relationship is with the garden. The article on page 36 by the friends of Treborth Botanic Garden in North Wales is an excellent example of how botanic garden volunteers can work with staff on environmental issues – in this case switching from the use of peat-based compost and reducing dependence on plastic.

I hope you enjoy this edition of Roots as much as I have.

Paul Smith
BGCI Secretary General

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IMPACT AND THE QUEST FOR EVIDENCING CHANGE

The elusive quest for answering the question: 'what is the impact' often seems fraught at every turn. It is a question relevant to funders, strategy and the very roles our organisations play in society. It challenges us to prove the beneficial connections, behaviours and changes that result from our work. This article presents some suggested starting points to think about the impact of your work, it is not comprehensive nor will each point be relevant to every reader. Instead we recommend you reflect on the concepts shared and how they may fit into your work and your organisation's priorities.

What is/will be the impact? We all want to make a difference with our work, and measuring and reporting impact is one of those crucial ways we can prove that difference. Impact can be defined as long-term change or 'to have a strong effect on something or someone' but in the Museum or Higher Education context we often find a number of different definitions:

The Economic and Social Research Council defines impact as 'The demonstrable contribution that excellent research makes to society and the economy'¹ which is expanded beyond academia by the Research Excellence Framework exercise to be defined as '... an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life beyond academia.'²

Essentially impact is long term change that has resulted from our activities that we can evidence. It is different to 'outcomes' which are short term, specific changes resulting from an activity. A good example of this is thinking about sustainability – an outcome could be someone responding to a survey after taking part in a workshop that they now have a better understanding of how to be more sustainable in their actions compared to a baseline. An impact would be that person changing their behaviour and consistently making more sustainable choices over a long period of time. Impact can be planned for but just like anything in life, unexpected things (and impacts) can happen. What follows are six steps to start to foster a culture of practice which is more likely to capture, evidence and report on the impact of your work.

↑ SMART patrol team collecting data on trees in West Waigeo Nature Reserve, Raja Ampat, Indonesia. ©Yanuar Ishaq Dc, FFI



↑ Community and local authorities engagement meeting for *Magnolia pacifica* in Bosque de Arce, Talca de Allende, Guadalajara, Mexico.

1. GOOD PROJECT MANAGEMENT

Clear Aims and Objectives will not only help you create a plan for your activity, but it will also inform your evaluation plan and how you measure success. The Science, Technology and Facilities Council simplifies it to a 'Plan, Do, Review' cycle,³ with each step leading to the next. Consider your:

- Aims: What are the aims? What do you intend to achieve?
- Objectives: What are the objectives? What you will actually do to achieve those aims?
- Are these 'SMART' (Specific, Measurable, Achievable, Realistic and Time-bound) objectives?

2. FRAMEWORKS OF CHANGE

Many organisations have guiding principles or mission statements. A useful exercise to carry out early in your project is to start with these principles and work through a 'Theory of Change' framework to clearly identify what your needs, intentions, inputs, outputs (the things you create for the project, this could be relationships, training, physical resources etc.) and outcomes/impacts are/could be.

A 'Theory of Change' or 'Logic model' are essentially descriptions of why change is needed and how a project will achieve that change. The framework below is an example of this:

Research Excellence Framework: Impact statements from 2014, they found that projects that had vague beneficiaries, focused on dissemination or didn't have clear links to claimed benefits were generally considered low impact compared to 'long-term' or 'first time activities' which clearly 'resulted in' impact.

↓ Image 1: Example Logic Model Framework.
©Iomas, 2021

		Rationale	Evidence
AIM	What is the overall aim you want to achieve?	E.g. Evidence from research literature or a pilot/similar programme etc that the outcomes sought lead to achievements of the impacts/aims in similar contexts	Quantitative: Survey responses, feedback and/or statistical evidence. Qualitative: Case studies, testimonials etc. supported by evidence from the research literature that achievement of the outcomes leads to achievement of the impacts/aims Evaluation research
IMPACTS	What difference will/did it make beyond the immediate beneficiaries (e.g. their families, community, society at large)?		
OUTCOMES	What difference will/did it make to the immediate beneficiaries of your activities?	E.g. Evidence from research literature or a pilot/similar programme etc that the activities/interventions proposed will deliver the desired/intended outcomes	Quantitative: Survey responses, feedback and/or statistical evidence, including distance travelled assessments Qualitative: Case studies, testimonials etc. Evaluation research
OUTPUTS & QUALITY	How much beneficiaries, how much of the activities will you deliver/have you delivered etc	E.g. Evidence from research literature or a pilot/similar programme etc of the scale/duration/intensity of activity needed to realise the overall aims/impacts sought.	Attendance and activity records, records etc.
	How good are your activities (e.g. how satisfied are participants)?	E.g. Evidence from research literature or a pilot/similar programme etc of what makes for high quality activities/interventions	Satisfaction/feedback questionnaires/surveys.
ACTIVITIES	What will/did you actually do?	E.g. Evidence from research literature or a pilot/similar programme etc of what works in similar contexts to meet the identified needs.	Activity records
INPUTS	The resources and assets you invest in the project/service.	Evidence from similar interventions or your own plans of the resources required for delivery?	Records/accounts of the resources you use to deliver the project/service.
NEEDS & CONTEXT	The problem you have identified that needs to be addressed and any relevant contextual information that informs how you do it.	How do you know what your beneficiaries/community need?	Local strategies and plans, community feedback/consultation outcomes, research literature.

There are many different frameworks you can use to do this, from 'Moore's Strategic Triangle' through to the 'Museum Theory of Action'.⁵ The important thing is to find the tool that works for you and in your context. We recommend you bring together as many different stakeholders as possible to work through it with you as a group exercise.

3. PLANNING TO EVALUATE

Evaluation, at its core, is reflecting on, assessing or making a judgement about something, i.e. its quality or value. Good evaluation is critical for measuring impact. When planning your project, think about how you will evaluate it. A 'Common Standard for Evaluating Public Engagement'⁶ sets out a framework where you consider evaluating the **design** of your activity or project first: '*Does the design follow good practice underpinned by sound ethics?*' These are questions about risk, assumptions, ethics, involvement, trust, appropriate expertise, and resource.

The **delivery** comes next and asks questions about your outputs and outcomes: 'How will you know you delivered these outputs and outcomes? What tools will you use to track your progress?'

Finally, for **impact** the same questions are asked as for delivery, but it will be likely you will need to include evaluation activities for a period of time after the delivery. These will help you measure long-term changes and report against your impact goals. We (the UCL Engagement Team) usually recommend for each stage (design, delivery and impact) of your evaluation planning you consider the following questions:

- Why do you want to evaluate?
- What do you want to know?
- When are the best opportunities to find this out?
- Who needs to be involved?
- How are you going to find this out?
- What will you do with this information?

It can be tempting to try and capture as much data as possible, however remember that **evaluation should lead to action** and when thinking about your evaluation it should be proportionate to the amount of overall resource you are using, relevant to the project you are carrying out and its overall aims/objectives, appropriate for the people you are evaluating and realistic for the context you are working within.

4. TYPES OF IMPACT

Although as mentioned impact can be unexpected it can help to be aware of what forms impact might take, commonly reported impacts could be (but not limited to):⁶

- Instrumental impacts: Increased revenue and/or visitor numbers, public adoption of new technologies or policy change resulting from public pressure
- Capacity building impacts: The development and application of new skills for all stakeholders, including the public, your team, organisation and partners
- Attitudinal impacts: Long term changes in attitudes and associated behaviour
- Conceptual impacts: New understanding, knowledge, awareness and perspectives of issues related to research, perhaps entirely new research directions
- Connectivity impacts: New and lasting relationships, or the evolution of relationships as a result of the project



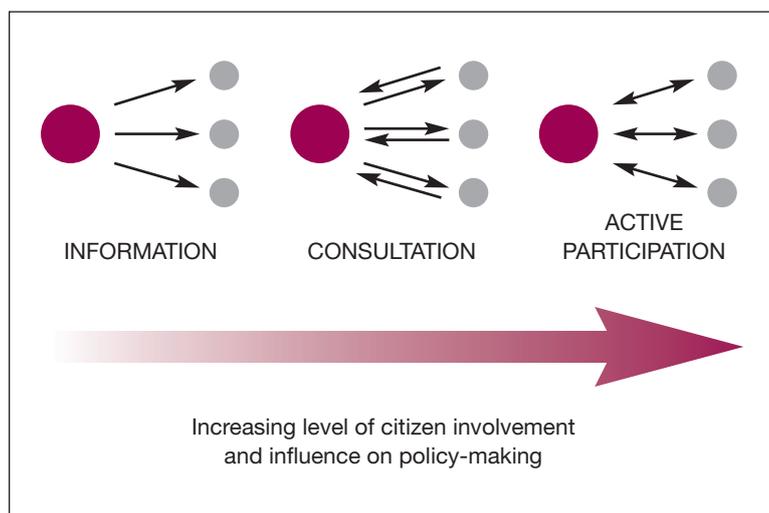
↑ Recovery demonstration plot.



↑ Training in Yachang Nature Reserve, China.
©Lin Wuying, FFI

5. MODELS OF ENGAGEMENT:

Fostering the right environment for impact to occur is key and your methods are defined by who you want to work with and what changes you are trying to make. For most projects more than one form of engagement is needed and as a general rule, two way interaction will provide the best environment for meaningful impact, both for your participants and for you/your organisation.⁷



↑ Image 2: OECD-Active Participation Framework. ©(Karsten, 2012)

6. IMPACT CULTURE:

What this article hopefully impresses is that for you to be able to effectively measure and report on impact, you need a culture of impact within your organisation. Evaluation needs to be considered as a core part of your practice, both the formative elements for improving your resources and the summative elements for reporting on those outcomes and eventual impacts. There needs to ideally be a systematic approach across your organisation where colleagues a) know what the impact goals are, b) are confident in embedding evaluation in their everyday practice and c) have an organisational-wide approach to reporting evidence that may form part of an impact narrative.

Final words:

Developing an impact culture takes time and is complicated, just like impact itself. Start small by defining the 'Why' and build in time and resource to gather and analyse the evidence you need. Planning for impact is strengthened by working in partnership with your stakeholders (team, visitors, funders etc.) so involve and share power with as many people and voices as possible – they can tell you what works for them.

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NEW BEGINNINGS WITH EVALUATION



↑ Urban Agriculture Resilience Program awardees work on an urban teaching farm ©EarthDance

Emerging needs of botanic garden audiences and new constraints for programming in a pandemic created unique circumstances for reimagining botanic garden education and engagement. Using two case examples: 1) the creation of a new Urban Agriculture Resilience Program and 2) the redesign of a well-established plant science youth program, we describe how initial insights into program impact, as well as challenges we faced, informed adjustments to both programming and evaluation. We suggest that by conceptualizing evaluation and program (re)development as interwoven strands, botanic gardens can measure impact and make data-informed decisions to better meet audience needs and programmatic goals.

EVALUATION IN DYNAMIC CONTEXTS

Evaluation is an invaluable tool to describe, understand, and expand the impact of botanic garden programming. Calls for more robust evaluation in the botanic garden and broader informal science education communities have underscored the need for measuring impact over activity (Smith and Harvey-Brown, 2018), for using evidence to guide decision-making at the institutional level (MacPherson, Hammerness and Gupta, 2019), and for contributing new knowledge to our field at large (Fu, *et al.*, 2016).

The impacts of education and engagement in informal learning settings such as botanic gardens can be uniquely challenging to measure.



← A Hands On Plant Science (HOPS) participant examines pollen under a microscope. ©Latin American Youth Center

Building capacity to address evaluation challenges and better understand how to maximize the impact of botanic gardens' work has become an increasingly critical pursuit.

By conceptualizing evaluation and program (re)development as interwoven strands, botanic gardens can make data-informed decisions about how to adjust our programs to better meet our audiences' changing needs.

Yet the impacts of education and engagement in informal learning settings such as botanic gardens can be uniquely challenging to measure (National Research Council, 2010; Smith and Harvey-Brown, 2018). The COVID-19 pandemic presented a new layer of complexity for discerning how to meet the changing needs of botanic garden audiences and evaluate program performance in the midst of new constraints. In this context, building capacity to address evaluation challenges and better understand how to maximize the impact of botanic gardens' work has become an increasingly critical pursuit.

We applied a utilization-focused (Patton, 2008) approach to the evaluation of two U.S. Botanic Garden (USBG) partnership programs impacted by the COVID-19 pandemic: a new national urban agriculture and food production program and an existing local youth plant science program. We sought to gain initial insight into program impact, using it to: 1) inform program adjustments to maximize potential to achieve intended results and 2) refine instrumentation to improve our ability to more robustly measure impact in future iterations. We were guided by questions such as: "What happens in the program(s) [and] what outcomes and impacts result?... What sense can we make of the findings?... [and] What actions flow from the findings and their interpretations?" (Russell, 2011, p. 13). We conceptualized evaluation and program (re)development as interwoven strands, working hand-in-hand to inform decision-making and action.

PROGRAM DEVELOPMENT SCENARIO: URBAN AGRICULTURE RESILIENCE PROGRAM

For several years, the USBG and the American Public Gardens Association have partnered to explore and grow urban agriculture across U.S. public gardens (see American Public Gardens Association, 2018). Given the urgent needs of public gardens and their audiences during the pandemic, in 2020 we collaborated to create a new Urban Agriculture Resilience Program that awarded funds to support public gardens' urban agriculture and food growing initiatives. Our intent was to enable gardens to continue or expand food growing and urban agriculture programming, while facilitating access to fresh produce in communities, increasing public knowledge in food production and urban agriculture, and demonstrating the potential of public gardens to play a valued role in urban agriculture.



↑ A youth organization staff member receives HOPS activity backpacks for on-site student use. ©United States Botanic Garden

We collected data through post-program surveys of awardee gardens, partner organizations, and program participants. We found that the awards supported nearly all participating gardens in fulfilling the program's intended results, but to varying degrees and in various ways. The broad range of project goals and activities among awardees challenged us in developing universally applicable instrumentation that could facilitate our ability to measure program impact as a whole. While we addressed this challenge by complementing quantitative data (e.g., pounds of produce distributed; participant engagement numbers) with qualitative data from multiple perspectives, we also recognized an opportunity to refine our instrumentation by developing more focused priorities. Additionally, we observed that collaborations played a central role in nearly all projects, and saw this as a dimension of the program to elevate.

We decided to continue our collaboration on the Urban Agriculture Resilience Program for a second year, using evaluation results to articulate more specific priorities and gather consistent data across all programs. A key change was a requirement that awarded projects include collaborations between public gardens and outside partners. This allowed us to celebrate the collaborative successes we saw in the first year and encourage further public garden collaborations. We developed a new rubric articulating updated program priorities, using it as a tool to evaluate projects' potential to: utilize the assets of public gardens and partners; combine food growing and education; facilitate public engagement in urban food growing; benefit audiences experiencing food insecurity; and build sustained capacity in urban agriculture. In addition, we added an external sharing component to enable gardens and partners to learn from one another. We will continue gathering data for evaluation and program improvement.

PROGRAM REDEVELOPMENT SCENARIO: HANDS-ON PLANT SCIENCE

For 15 years, the USBG has offered Hands On Plant Science (HOPS), a summer program engaging youth in plant science learning activities on-site at the USBG, in collaboration with local youth organizations. We had already selected a collaborating organization when the pandemic began and all programming moved online. Together, we made a decision to adapt HOPS activities for students' at-home use. We assembled backpacks with all activity materials to be delivered to students. Students completed the activities independently at home and then joined online discussion sessions with peers, USBG educators, and partner organization staff. Our intent was to engage youth in a positive science learning experience, build their confidence in doing science, and increase their interest and knowledge related to plants.

We collected data through post-program student surveys, field notes, and an interview with partner organization staff. We found that the opportunity to engage in hands-on learning activities supported our goals for students, but that the online environment presented challenges to engagement and data collection. A key challenge to measuring impact was regular access to students to support their engagement with HOPS activities, including creating and sharing work in their HOPS journals – one of our planned data sources. Partner organization staff played a key role in alleviating the challenges of the distance learning environment, liaising with students and suggesting adjustments to improve student experience. At the end of the program, our data suggested that students had a positive experience with the program – particularly the opportunity to engage in hands-on activities during a time when most instruction was happening on screens, with little or no access to scientific tools.



↑ *Urban Agriculture Resilience Program awardees operate a youth-led urban farmstand.*
©Grumblethorpe Historic House and Gardens

The need for botanic gardens to adjust our work during the pandemic created a unique opportunity for learning.



↑ *Harvesting greens for an Urban Agriculture Resilience Program project on a campus farm.*
©Matthaei Botanical Gardens and Nichols Arboretum, University of Michigan

Based on our evaluation results, we decided to continue offering HOPS in partnership with local youth organizations, with a revised program format and organizational roles. We eliminated the student online component, but continued the approach of offering the program off-site. Rather than an at-home experience, we redesigned HOPS to take place at partner organizations' community-based locations. To better utilize the assets of partner organization staff, we created a new online facilitator training to prepare them to work in-person with students on HOPS activities. In addition, we cooperated closely with organization staff on collecting student data, facilitating our ability to measure and describe program impact in the future. We piloted this revised version of HOPS with one partner organization and later scaled-up to three simultaneous partner organizations.

LOOKING BACK AND LOOKING AHEAD

The need for botanic gardens to adjust our work during the pandemic created a unique opportunity for learning. By conceptualizing evaluation and program (re)development as interwoven strands, botanic gardens can make data-informed decisions about how to adjust programs to better meet audiences' changing needs. Our experience illustrated the ways in which challenges we faced in measuring impact, including instrument development and data collection, could help inform adjustments to our evaluation and programmatic approaches. We recognized great potential for expanding collaboration in the evaluation process, and found that opportunities to engage partners more actively in gathering and sharing information expanded our potential to learn. We look forward to continued conversation across the botanic garden community about ways to build capacity to measure the impact of our work.

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↑ Distributing produce as part of an Urban Agriculture Resilience Program project.
©Pennsylvania Horticultural Society

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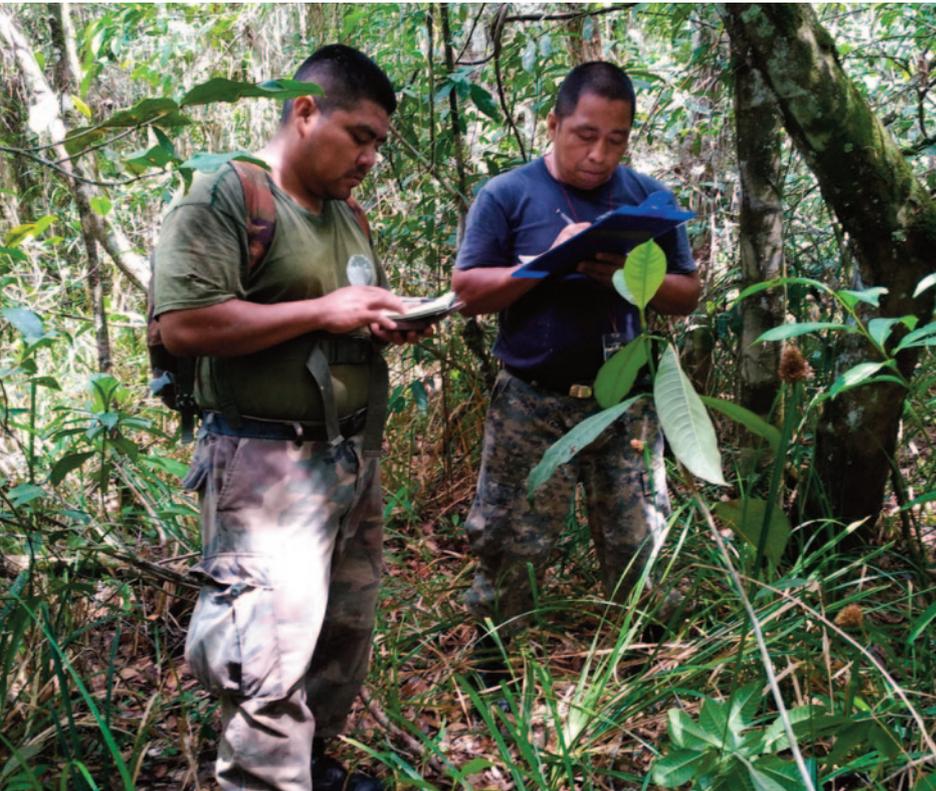
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United States Botanic Garden

IMPACT STATEMENTS: CRITICAL TOOLS FOR BOTANIC GARDEN PLANNING AND EVALUATION



Impact statements are concise descriptions of the impacts a botanic garden hopes to achieve in a specific audience. Like mission statements and other foundational documents, the impact statement can serve as a critical tool for garden-wide planning and evaluation. The exercise of creating an impact statement and its subsequent utilization allows for more intentional and verifiable impacts on target audiences.

← Ya'axché rangers recording tree data in the Maya Mountain North Forest Reserve, Belize. ©Ya'axché Conservation Trust

Botanic gardens are institutions that hold documented living plant collections for the purpose of education, research, conservation and display. This concise definition tells us what botanic gardens are (collections of living plants) and what gardens do (educate, research, conserve and display). But the definition does not specify the impact gardens hope to have on their visitors and society at large. Botanic gardens are old institutions, some dating back over 500 years. While the basic definition of a botanic garden has remained relatively constant through history, the impact of each garden has changed over time. The earliest botanic gardens were often medicinal gardens advancing treatments to alleviate human suffering from disease. In the age of exploration, botanic gardens were often agents of colonial expansion, seeking to collect and transfer plants for the benefit of colonial powers. In the 20th century, many botanic gardens embraced conservation, aiming to conserve plant life for future generations. In the 21st century, many gardens focus not only on the preservation of plants for conservation and scientific goals, but also on leveraging plants to improve the human condition. Gardens can promote healthy lifestyles, aesthetic beauty, sustainable utilization of plant resources, arts, social interaction, indigenous knowledge, ecological repair, and so much more. The opportunities to create impact as a botanic garden are staggering and require concerted efforts in thoughtful planning to achieve.

*Impact statement -
One sentence that describes the overall effect of a museum on target audiences. It balances aspiration with realism, and by design, reflects the staff members' passion for their work, the museum's distinct qualities, and what is relevant to audiences.
Randi Korn, Intentional Practice for Museums*

Most gardens are familiar with and have crafted mission statements that articulate what the garden does. Impact statements, however, express goals from the visitor's perspective. Instead of stating the garden's purpose, the impact statement describes the effect the garden has on its target audiences. Impact statements do not replace mission statements, but complement them.

The mission and impact statements from The Wild Center in Tupper Lake, New York, illustrate the difference in intent and focus of the two statements and show how they enhance each other.

Mission statement: Our mission is to ignite an enduring passion for nature, the Adirondacks, and its story—where people are working to thrive with nature and offer an example for the world.

Impact statement: People deepen their connection to nature and consider their role in sustaining their natural world for future generations.

Impact statements can be used in many ways. Foremost, an impact statement is the foundation of intentional practice that informs resource allocation and programmatic goals. When creating impact statements, organizations are challenged to plan and reflect on how they want to affect their audiences. Beyond establishing a philosophy of intentionality at the core of the garden, an impact statement can also be a powerful tool for refining outputs. A garden can decide to implement—or not implement—exhibits, programs, or activities based on their ability to achieve the impact outlined in the impact statement. Additionally, impact statements and the process of writing them can help align staff toward a common goal and create space for collaboration. Often, impact and evaluation of impact are seen as the responsibility of the education department alone. However, the impact statement creation process requires the input of all staff, creating a sense of shared responsibility. The impact statement is better thought of as a foundational strategic statement for the whole institution, rather than a tool primarily in the education department. Finally, impact statements are critical to the ability to evaluate impact on a garden's intended audience. They serve as a pre-established benchmark that allows a garden to evaluate their successes and avenues for improvement.

Much in the same way gardens develop mission statements and strategic plans, an institution initiates a multi-step and inclusive process to develop an impact statement. Typically, the garden would begin working internally with staff and expand outward into various stakeholder groups and audiences. The garden should begin by asking three critical questions:

1. What are we deeply passionate about?
2. What are our garden's distinguishing qualities and strengths?
3. What does our audience care about?

The first two questions are highly internal and should be addressed by a wide and inclusive group of staff. The goals of answering these two questions are to find what motivates the team and identify institutional strengths. The third question is external. Before reaching out to an audience to determine what they care about, the garden must first identify which audience segments to focus upon. While gardens often define the visiting public broadly, it is critical when developing an impact statement to clearly identify 3 to 4 specific audience segments on whom to focus impact. This is challenging as it can feel like deprioritizing part of the audience. But the benefits of focus when trying to achieve impact will propel the process forward. A garden can always focus on new audience segments as it reexamines impact over time. It takes time and much discussion to answer these three questions with sufficient detail, clarity, consensus and action orientation. But once they are answered, a garden



↑ Fagaceae training at Pha Tad Ke Botanic Garden in Laos. ©BGCI



↑ Seed collecting in Uganda. ©BGCI

has all the ingredients needed to draft the impact statement. As the statement forms, the audience is centered as the target for impact. Furthermore, it should be clear in the statement that the impact will be achieved by leveraging the garden's unique qualities and the staff's passions. Impact statements are necessarily externally focused, and so should always be presented with the mission statement. Additionally, many institutions like to keep the impact statement in a perpetual draft form, which encourages a continuous re-evaluation of audience segments, the garden's strength and staff passion.

Armed with paired impact and mission statements, new avenues of evaluation open up. Regular evaluation is one of the fundamental principles of intentional practice, and impact statements set the benchmark. Evaluation not only provides information and insight internally to the garden, but also helps communicate impact in concrete terms to external audiences and stakeholders. Evaluating and communicating impact helps gardens set their own standards for success before other impact-distracting metrics are put upon them from external sources. Regular evaluation also creates and maintains a culture of continuous learning. Implementing an organization-wide evaluation of impact can be daunting, so impact evaluation can first be tested on smaller projects, like a program or exhibit.

To measure impact, the garden needs to identify the intended audience and specific visitor-experience outcomes that demonstrate the achievement of the intended impact. These outcomes differ from outputs like the number of visitors served or programs implemented. Outcomes are explicit, measurable results that support the impact statement. In order to measure these outcomes, associated indicators need to be identified. Once these have been established, impact can be evaluated by measuring those indicators in the intended audience. For example, if the desired outcome is that visitors are able to observe a plant more accurately, an indicator might be that the visitor is able to provide more descriptive details about that plant. These indicators can be measured throughout the project-development process to benchmark the project against impact in front-end, formative, or summative evaluations.

Botanic gardens have a long history of transformational impact. However, at this point in history, gardens have more options than ever to achieve impact. Gardens are attempting to serve ever more diverse audiences while expanding programming well beyond basic plant and horticulture education. Furthermore, audiences are changing rapidly, creating new opportunities to reach people with programs and exhibits. Drafting an impact statement as a part of foundational and strategic documents is a powerful tool to harness the power of a garden and its staff to achieve meaningful impact for visitors. An impact statement will help bring focus, intentionality and metricability to the dizzying array of programming options, and open up new avenues for planning and evaluating the transformational programs only botanic gardens can offer.

Note: Much of what is presented in this article is a summary of sections of the book *Intentional Practice for Museums*, by Randi Korn (2018). This book is a must read for those interested in a deeper dive into impact statements and intentional practice.



↑ Planting seedlings of *Paubrasilia echinata* in Brazil.
©Noelia Alvarez de Román

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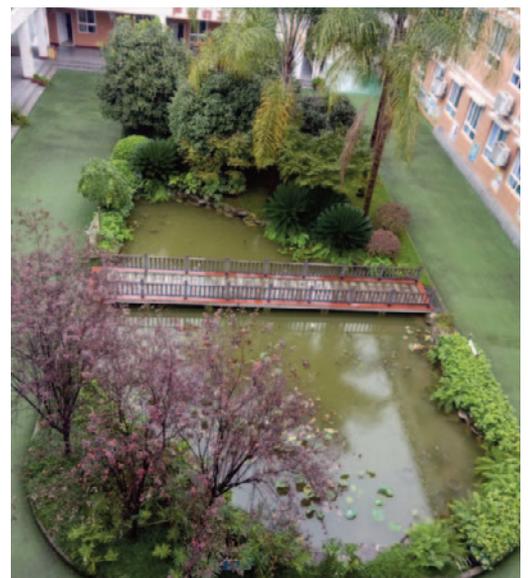
School green spaces are very important places to connect children with nature. Our empirical study in a city in Southwest China found that student's perceived school environment is significantly correlated to the physical green space quality, and the perceived school environment has a positive relationship with the student's preservation attitude and pro-environmental behavior. Our study suggested that, when supplemented by outdoor pedagogical activities, school green spaces could significantly contribute to equipping children with environmental literacy. Our study also showed that some modules in schools could support the educational function, such as, vegetation gardens, flower gardens, 'secret gardens', big trees, a reading gallery, and green corridors, etc. How botanical gardens can help local schools to create green spaces is discussed at the end.

GREENER SCHOOLS, GREENER CHILDREN

SCHOOL GREEN SPACE IMPROVES CHILDREN'S ENVIRONMENTAL ATTITUDE AND BEHAVIOR

With the rapid development of urbanization, the importance of nature to children has become more evident, to improve physical abilities, cognitive function, social interaction, mental health, and attitudes and conservation willingness towards nature (Markevych *et al.*, 2017). Nature has healing properties, however pure forms of nature such as primary forests and wilderness, are not accessible to everyone, particularly children whose time is often heavily occupied by school, and safety in such areas needs to be considered. In this case, green space in cities may provide a substitute to pure nature, and be beneficial to health. Previous studies have also found that schools with green spaces have a positive relationship with a student's creative play, social interaction, cognitive development and academic performance (Chawla, 2015). However, whether school green spaces have any effect on a student's environmental attitude and behavior is still unclear, thus we conducted an investigation to address this.

↙ ↘ Flower gardens in schools. ©Liu & Chen, 2021



QUESTIONNAIRE DEVELOPMENT

Environmental attitudes (EA) refer to a person's psychological tendencies when evaluating an environmental object (e.g., environmental protection, appreciation of nature, or the human-environment relationship) (Kaiser *et al.*, 2013; Milfont & Duckitt, 2010). Dating back four decades, there are hundreds of EA measurements that have been developed (Larson *et al.*, 2015). Among them, the revised New Ecological Paradigm (NEP) Scale and the Two Major Environmental Values (2-MEV) scales are two widely used tools. The NEP scale measures adults' general beliefs about the relationship between human beings and the environment (Dunlap *et al.*, 2000) and is often used as a one-dimensional measure (Hawcroft & Milfont, 2010). The 2-MEV scale measures adolescents' environmental attitudes and values and is designed to distinguish two higher-order environmental-value factors: preservation (PRE) and utilization (UTL), which are based on several primary factors (Wiseman & Bogner, 2003). In an earlier study, we compared these two scales in terms of predictability of pro-environmental behavior (PEB) and found that the 2-MEV scale showed a higher predictive power of PEB than the NEP scale (Liu & Chen, 2020). So the 16-items 2-MEV scale (Liu & Chen, 2020) was used as the measurement of EA in this study. In the 2-MEV scale, the PRE factor refers to 'a biocentric dimension that reflects conservation and protection of the environment', the UTL factor refers to 'an anthropocentric dimension that reflects the utilization of natural resources' (Wiseman & Bogner, 2003, p.787).

Pro-environmental behavior (PEB) refers to 'actions that contribute towards the environmental preservation and/or conservation' (Axelrod and Lehman, 1993). In this study, we used a study-specific PEB scale, which was developed based on Several PEB scales (Evans *et al.*, 2007; Tucker & Izadpanahi, 2017; see also: Kaiser, Oerke, & Bogner, 2007; Larson *et al.*, 2015; Whitmarsh & O'Neill, 2010). This PEB scale consists of ten items which focus on two aspects of PEBs: personal sphere PEBs (sustainable lifestyle behaviors in children's daily lives, such as resource and energy saving, and recycling); social sphere PEBs (interpersonal actions, such as persuasion and talking about environmental issues) (Liu & Chen, 2020).

We also looked at student perceptions about the school environment (PSE), their frequency of interaction with natural elements in schools (INE), and the frequency of participating in other environmental education activities outside schools. For all the aforementioned variables, we used several declarative items to represent, and a 5-point Likert-type scoring system with responses ranging from 1 (strongly disagree) to 5 (strongly agree) to quantify (Liu & Chen, 2021).



Green space in cities has comparatively the same benefits to a resident's health as pure nature does. School green space has a positive relationship with a student's creative play, social interaction, cognitive development and academic performance (Chawla, 2015).



↑↓ Reading gallery in schools. ©Liu & Chen, 2021

The 2-MEV scale measures adolescents' environmental attitudes and values, and is designed to distinguish two higher order environmental-value factors: preservation (PRE) and utilization (UTL), which are based on several primary factors.

DATA COLLECTION

Twenty primary schools in Chongqing, China were randomly selected based on the school list from the local education department website. In those twenty schools, 1,597 valid samples (97.8% were aged 10–11) were collected. Among them, 829 were boys and 861 were girls, 89.9% of them had been at their current school for at least four years.

We also quantified the school's physical environment with eight variables: green space area, green space area per student, plant species diversity, vegetation structure diversity, landscape possibility, recreation facilities, green area of corridors, and indoor plants. Through a principal component analysis, these eight variables were grouped into two principal factors – 'Green Environment' and 'Indoor Green' (representing green space quality in the outdoor and indoor environment of the school, respectively) (Liu & Chen, 2021).

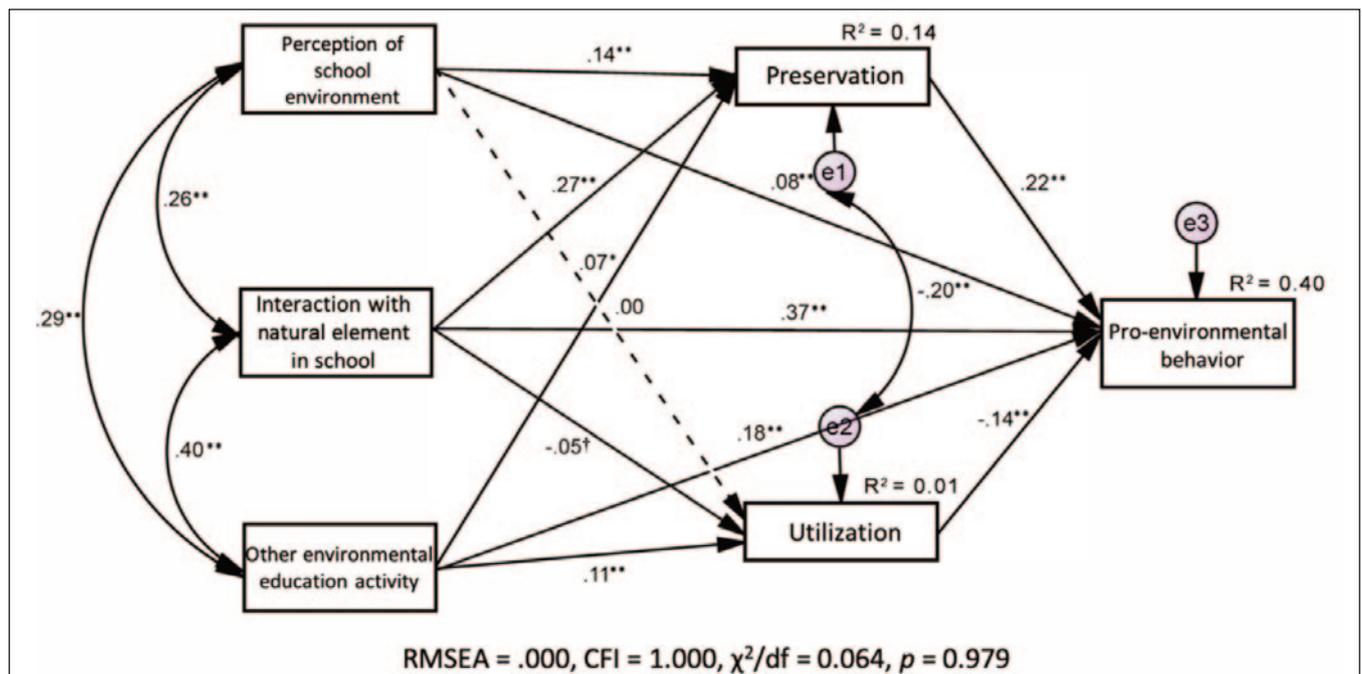
WHAT WE FOUND?

Using the 'Green Environment' variable as an independent variable, and PSE as a dependent variable, building a regression model, we found students' perceived their school environment was consistent with objective measures of green space quality. Meanwhile, we found students who perceived their school environment as a better environment to have a better environmental attitude and self-reported pro-environmental behaviors. Also, students who interacted with natural elements in school (INE) more frequently have a better environmental attitude and self-reported PEB.

Using the pathway model (Figure 1) we can see the triple-folded relationship between PSE, INE, EA, and PEB (this model is established on the basis of controlling demographic differences among students). From the figure, we know that INE has a Significantly positive relationship with preservation attitude, and also a positive relationship with PEB. Noticing that all the relationships in the pathway model are correlations, not cautions, the direction of those lines were decided by psychological theories or previous empirical studies.



↑↓ Green corridor in schools. ©Liu & Chen, 2021



↑ Figure 1. Pathway model showing the influence of students' perceptions of school green space, natural activity within school, and EE activity out of school on environmental attitudes and pro-environmental behavior ($n = 1,597$; number on the pathway represents path coefficient). ©Liu & Chen, 2021



↑ Secret gardens in schools. ©Liu & Chen, 2021

THE COMPONENTS OF A GOOD SCHOOL GREEN SPACE

From this study, we can see that a good school environment does affect a student's interaction with it, and has a positive relationship with a student's preservation attitude and pro-environmental behavior. In our school visit, we found a good school green space needs to be composed of many modules. Different modules provide children with different interaction possibilities, and thus can meet different needs and shape Student's behavior. Here we introduce some modules we observed that were very popular and used frequently by students and we hope this will be useful for our readers.

1. Vegetation garden

In the vegetation garden, children can learn the origin of food, practice hands-on activities, learn teamwork, and think about the relationship between plants and human beings. The vegetation garden can be grown on a small patch of land anywhere that has enough sunlight in the school, including on the roofs of teaching buildings.

2. Flower garden

This refers to those gardens that mainly consist of ornamental plants, where the function is to serve recreations for students. A good small garden landscape should be complex, and will allow student's play to be more diverse.

3. Secret garden

The 'secret garden' is much smaller than the small garden, often locates somewhere in the corner of the school or a 10 m² space behind the teaching building. In many of our interviews, students expressed that their favorite place on the campus was the 'secret garden' (this name is also given by students). The biggest advantage of the secret garden for students is its freedom (out of sight of the teacher's eyes), this allowed the students to play more freely, and stimulated more creative play. Thus, leaving a place that is just for students, may provide them with free space to grow.

4. Big trees

We often found, especially in small school campuses, that there was usually a big tree on the school grounds that students were familiar with and knew a lot about. The shade of a big tree can give students a sense of safety, the space under the big tree can be seen as having magic powers that attract both children who love calmness, and provide space for multiple users.

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5. Reading gallery

An outdoor reading gallery is also very attractive, and many children like reading and/or doing homework there, some also like playing the game there. A strip-shaped gallery also provides a division of space, which makes the place for more accessibility and provide more affordance.

6. Corridor greening

Apart from green spaces in the school grounds, the corridor is also a very important place to create a green environment in schools. Students may not have enough time to go downstairs during the class break, however plants (greening space) can significantly enhance a student's attention and release their stress (Ulrich *et al.*, 1991). Vine plants are very suitable to grow on the wall of the corridor, also some schools use the corridor space as plant growing space for students and let them decorate it themselves.

BOTANICAL GARDEN'S ROLE

To cultivate students with high environmental literacy, we need to provide students with good school green spaces and encourage them to use these spaces freely, thus the school green space can be an invisible classroom that provides a daily benefit to students. In the process of building a better school green space, schools may need the help of professionals such as botanical gardens. A popular trend is to help schools build their school garden (Burt, Koch, & Contento, 2017), not a simple vegetable garden but a green space that has richer environmental structure, and stronger affordances (Liu & Chen, 2021). That means a good green space is not necessarily a place with many plants, rather we should consider carefully about in which way to plant those plants, how to use them to create an environment that can be liked by different children (based on age groups, gender, personality, and so on). By observing children's behavior in green spaces and inviting them into the process of environmental design we can achieve these aims (Wake & Eames, 2013). Botanical gardens, with their knowledge of plants, horticulture, and creativity, can help schools to create a better green space.



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← Big trees in schools. ©Liu & Chen, 2021



This article illustrates how The Morton Arboretum works to understand the mission-impact of public programs and interpretation projects that serve an array of different audiences. These evaluation efforts are part of a rigorous process of program and exhibit design, and constitute a fraction of assessment projects across the Arboretum. Evaluation outcomes provide program and exhibit planners key data for decision making, particularly for how projects should evolve to better serve the ever-changing needs of specific audiences. Outcomes also provide a foundation for determining longer-term evaluation objectives.

← An N-ACT participant clears out cuttings on a conservation work day. ©The Morton Arboretum

THE MISSION-ALIGNED IMPACT OF AUDIENCE ENGAGEMENT

Public gardens face many challenges when endeavoring to understand the impact of exhibits and programs on audiences. Each visitor comes to a garden at a different level of readiness to learn or be transformed, or to act to advance the garden's mission. Indeed, each visitor may have different expectations from a visit; the same exhibit or program may mean different things to different guests. We want to think that visitors read interpretation or attend programs and come away with a deepened commitment to our mission or to advocacy—a lofty goal and one that is difficult to measure. Evaluation and visitor research show us that the connection is not quite so straightforward.

Fields like social and environmental psychology offer ideas on how to reliably assess programs or experiences. However, it seems that the more rigorously we attempt to examine impact, the more daunting it is to reach any kind of actionable conclusion. How then do gardens capture mission-aligned impacts that result? This article covers two areas where The Morton Arboretum has made strides toward understanding impact: public programs and interpretation.



↑ Youth Volunteers Amara and Andrew help Children's Garden visitors paint sunflowers. ©Laura Kamedulski



PROGRAMMING'S IMPACT

The Arboretum works on capturing mission-aligned impacts by tailoring the methodologies of various evaluative efforts to different audiences. A spectrum of programming for a range of ages needs an array of tools to assess impact, and the Arboretum has been able to diversify its evaluation approach appropriately. Methodologies like pre/post test comparisons, focus groups, and even multivariate analysis allow the Arboretum to collect both quantitative and qualitative data. This combination helps to paint a rich picture of how thoughts and behaviors change when different programs are engaged.

Assessing a Youth Volunteer Program

The Arboretum's Youth Volunteer Program (YVP) offers different roles for middle and high school-aged students in the Childrens' Garden and in Summer Science Camps. Focus groups have highlighted that most participants are simply looking for volunteer experience to bolster college applications. Participants don't come to the program highly affinitive, but when responding to the Arboretum's pre/post survey about participant perspective on intended outcomes, we see improvement on items such as "I like to be in nature," "my actions can help make the natural world different," and "people should help the environment." These changes demonstrate the program's ability to positively impact perspectives about the importance of nature and the power of STEM learning (science, technology, engineering and maths) – an incredibly important mission-aligned outcome, particularly for an adolescent audience that's still forming an identity.

Adult programming as "dosage"

Each guest that engages with a garden does so as a unique product of their experiences and environment. The right evaluative approach can take some of those differences into account by controlling for variances in demographic data to identify differences that result from engagement. The Arboretum recently assessed the ability of its Natural Areas Conservation Training (N-ACT) program to elicit action in participants, using the number of courses participants had taken as a "dosage" for a multivariate analysis of data on a survey asking how participants think, feel and act toward nature. Participants in the "high" dosage (3+ courses) consistently scored more positively on items like "I feel more connected to all living things on earth,"

↑ The Arboretum's Library is open to the public, but new visitors may not know it exists.

©The Morton Arboretum

We want to think that visitors read interpretation or attend programs and come away with a deepened commitment to our mission or to advocacy—a lofty goal, but one that is difficult to measure. Evaluation and visitor research show us that the connection is not quite so straightforward.



↑ The Plant Clinic offers free, individually tailored advice on plant care. ©The Morton Arboretum



“My N-ACT courses strengthened my belief that my actions can have a positive impact,” and “Have you used what you learned in your N-ACT course(s) in your own yard or local natural area?” This study also used focus group discussions to gain insights into the dosage effect, revealing that frequent participants often share course content with others, creating a ripple effect beyond N-ACT’s impact on an individual participant. The mixed-methods design of this evaluation provided both quantitative and qualitative evidence of the N-ACT program’s capacity for impact.

INTERPRETATION AND A PATH TO ENGAGEMENT

If we define engagement as interest and enjoyment sustained over time, and if we use interpretation to spark that interest and enjoyment, what role then does interpretation play in a visitor’s long-term commitment to an institution? At the Morton Arboretum, we used summative evaluation of interpretation associated with two installations to establish how long visitors spent in each area and what messages they took away from the interpretation. In both cases, we saw visitors recognizing the Arboretum as an authority and resource for information on tree care and conservation. These are good results, but can they lead to deeper engagement?

One of the ways we hope to build on and sustain a visitor’s interest over time is to link that visitor to the network of resources and programs that the Arboretum offers, including the Library, the Plant Clinic, guided tours, classes, programs, and volunteer opportunities. In the past, interpretation panels mentioned other resources on site or online. But tracking a decision to take advantage of these offerings back to the text on the panel is difficult and assumes a single point of influence in the decision. We also hesitate to describe engagement as a straightforward path from low-level (repeat visits, reading interpretation) to high-level (membership and volunteering), with high-level engagement leading to mission-impact. Instead, interpretation is one point in a network of opportunities. We needed a method of evaluation that acknowledges the complexity of a visitor’s interactions with these opportunities.

↑ *The Arboretum's Visitor Center at the core of the Arboretum is the first stop for new visitors.*
©The Morton Arboretum

One of the ways we hope to build on a visitor’s interest and sustain that interest over time is to link that visitor to the network of resources and programs that the Arboretum offers.

The dosage effect reveals that frequent participants often share course content with others, creating a ripple effect beyond one program’s impact on an individual participant.

Measuring engagement through interpretation

Focus groups have given us a more nuanced picture of visitors at various levels of engagement, from new visitors to long-time members and volunteers. To reimagine interpretation at our Visitor Center we reviewed results, which suggested that newer guests were more likely to seek out information here than long-time members. Similarly, they were less aware of opportunities for learning such as classes, tours, and amenities such as the library and the free Plant Clinic, than long-time members. We are therefore looking at interpretation in this space and targeted tours as a chance to help these visitors shape their experience at the Arboretum.

The focus group suggested that deep engagement and commitment to the Arboretum's mission happens over time. A longitudinal study following a group of new visitors and looking at the points where they engage—or disengage—will offer more insights into the value and purpose of interpretation.

NEXT STEPS

The evaluation projects mentioned here are the beginning of assessing impact but not a complete picture. To complement current efforts, the Arboretum is participating as a host site for the Measurement of Museum Social Impact (MOMSI) study through the Institute of Museum and Library Services. We are also planning a longitudinal study of our early childhood programs to measure STEM outcomes on a protracted timeline. We hope to develop an evaluation tool to measure impact across audiences that is vetted for reliability and validity, adding more social science research rigor to our programming practitioner approach. We also plan to look at interpretation as one part of a network of formal and informal learning opportunities which collectively draw visitors into a deeper and more sustained connection to the Arboretum.

Demonstratively capturing impact is possible, but resources are necessary to refocus existing evaluation projects or design new ones. However, while similarities do exist between institutions, missions and desired outcomes may differ so that a one-size-fits-all approach won't necessarily apply. Communities of practice can be helpful in connecting to peer institutions to learn what ideas around measuring impact may be appropriate for an organization's specific needs. The methods and case studies described here are only a sliver of what is possible to quantify a garden's mission-impact.



↑ A group of Youth Volunteers stops to hear about the Human+Nature sculptures during the summer of 2021. ©Laura Kamedulski

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The Morton Arboretum

Science Capital is a combination of four main areas: what you know about science, how you think about science, science-related activities you do (outside of formal science education) and who you know (do you know a lot of science-y people).

Science Capital is important because it helps us understand why some people engage with science and other less so, highlighting that engagement is rarely reflective of interest alone, but shaped by a range of someone's resources and dispositions.

Research shows that those already participating in informal science learning (including botanical gardens) are more likely to have a high science capital. In order to diversify participation and better support minoritised* people's engagement with science, it is beneficial to develop longer-term initiatives while also levelling the playing field to ensure these initiatives have equity at the core of their design.

The Equity Compass was co-produced with informal science learning practitioners as part of the Youth Equity and STEM project (a 4-year, US-UK collaborative research project with a team at UCL Institute of Education) to help practitioners reflect on, develop and evaluate strategy and programmes from an equity perspective. While the project focused on young people aged 11 to 14, the resources developed in the project have been usefully applied to other ages and settings.

The Equity Compass tool asks the user to identify and critically question practices that are reinforcing positive outcomes for privileged young people versus those that are supporting equitable outcomes for more privileged people from minoritised communities. Enacting equitable practice is not about what you do, but how and why you do it – it is the equitable stance that matters and the Equity Compass can help you reflect on the perspective that underpins your practice.

The Equity Compass has eight equity dimensions, grouped in four overarching areas. Below, are some examples of how these dimensions could be used to help practitioners and organisations identify equitable outcomes and impact:

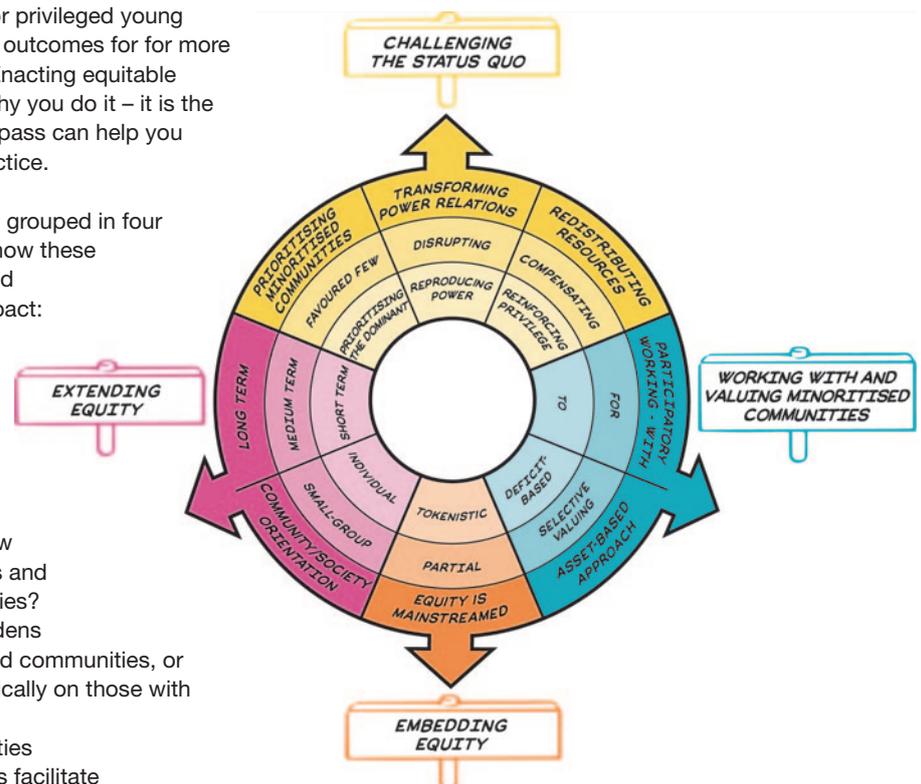
- Challenging the status quo
 - **Transforming power relations** – how do botanic gardens think about power and privilege? e.g. what 'counts' as science, biology and botany, or who can pursue a career in this sector?
 - **Prioritising minoritised communities** – how do botanic gardens support interests, needs and values of people from minoritised communities?
 - **Redistributing resources** – do botanic gardens predominantly engage people from privileged communities, or are efforts being made to focus more specifically on those with fewer resources and opportunities?
- Working with and valuing minoritised communities
 - **Participatory working** – do botanic gardens facilitate opportunities for working with minoritised communities (e.g. co-designing activities and projects), recognising them as producers of knowledge and not merely consumers?
 - **Asset-based approach** – do botanic gardens recognise and value diverse people's interests, knowledge and resources – or focus on what people are 'lacking' (which would signify a deficit-based approach)?

“Examining their audiences and contributing to debates on social inclusion is vital if botanic gardens are to reach the widest possible audiences with their message and be socially responsible.”

Dodd & Jones (2010, pg. 37)

“We know science impacts everyone's lives which is why we want to open our doors and contribute to diversifying participation.”

Julia Willison, Head of Learning and Participation, Royal Botanic Gardens, Kew



↑ The Equity Compass uses four areas of evaluation: challenging the status quo, working with and valuing minoritised communities, embedding equity and extending equity.

©UCL Institute of Education, Youth Equity and STEM project

- Embedding equity
 - **Equity is mainstreamed** – how mainstreamed, intentional and foregrounded are equity issues in botanic gardens – are they everyone’s core responsibility or are they a peripheral concern?
- Extending equity
 - **Long-term** – are equity initiatives one-off, short term, or longer-term?
 - **Community/ society orientation** – to what extent do botanic gardens’ activities benefit wider community/society?

We give one illustrative example of how the Equity Compass could be used to guide evaluation and foreground issues of equity when planning to work with minoritised communities. Let’s take an example where a botanic garden develops a programme for local young people involving a cooking activity to teach participants about edible plants. Reflecting ‘**redistributing resources**’ dimension of equity, the programme could consider how and where the programme is being advertised, to include young people who might typically not attend such programmes. Thinking about ‘**prioritising minoritised communities**’, it would be useful to consider what the participants themselves would like and need from such an activity (rather than focusing predominantly on what knowledge the botanic garden team plans to teach). One way to better understand and engage with minoritised communities is through ‘**participatory working**’, such as inviting people to take part in co-designing the activity (YESTEM Project Team, 2021).

A good metric to evaluate the equity of the outcomes would be to find out whether participating young people report an attitude change in terms of seeing gardening and cooking as science when before they didn’t (‘**transforming power relations**’ and what ‘counts’ as science). Another would be to find out whether participants (especially those from minoritised backgrounds) felt that their existing knowledge, skills and experience were being heard, valued and recognised (reflecting an ‘**asset-based approach**’). For instance, the cooking activity could include asking participants to share family recipes, or experience using lesser-known plant-based ingredients, then ensure that their contributions were valued.

Thinking what impact a programme might have – and how it might affect people on a broader scale, it would be important to consider how equitable practice can be extended towards more **longer-term** benefits, not only for participating individuals, but also their families and their community (‘**community/ society orientation**’). It must be recognised that sustained, long-term engagement is key to increasing science capital, and for more minoritised young people to consider science as something that is ‘for me’.

To maximise equitable outcomes and impact, practices must be **embedded** over the entire organisation rather than rely on the outreach and education programme/s team – or a handful or passionate individuals. By making equity everyone’s core responsibility, botanic gardens can better support all people, young and old, to engage with and benefit from their resources, and taken an active part in the conversations about sustainability and conservation.

For more information, tools and resources, please get in touch on ioe.sciencecapital@ucl.ac.uk.

We will be publishing an insight on Equitable Youth Outcomes soon (see yestem.org or follow @YESTEM_UK on twitter).

*Using ‘minoritised’ rather than ‘minority’ puts the emphasis on the systemic issues and structures that are failing to sufficiently recognise, support and value some people. People can be minoritised within a particular society depending on their race/ ethnicity, gender, socioeconomic background, dis/ability, sexuality and other social axes.

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VMU BOTANICAL GARDEN EDUCATION: THE POSITIVE IMPACT ON CHILDREN'S SKILLS



Botanical gardens (BGs) offer non-formal educational programmes, which are usually considered fun and pleasant activities but not as useful practice for improvement of scientific knowledge and skills. Vytautas Magnus University Botanical Garden in Kaunas (Lithuania) aims to address this misconception and to prove that valuable learning processes can take place in BGs too. A pilot study was planned, in which three tools – children's drawings, a free-form letter and a survey consisting of two-tier type questions - were used to determine the impact of BG educational programmes on students' understanding of natural sciences and their attitude to them.

← Herbs workshop in progress. ©Ieva Baškevičiūtė



↑ Excursion in the greenhouse. ©Ieva Baškevičiūtė

Vytautas Magnus University Botanical Garden in Kaunas (Lithuania) offers a wide spectrum of educational activities – learning inside and outside the classroom, excursions, after school activities, day camps, distance-education and events (Jurkonis and Aleknavičiūtė, 2020). This is in keeping with the vital role of botanical gardens (BGs) in scientific research, conservation and citizen science (Chen and Sun, 2018). Many schools and parents have discovered our educational programmes and return repeatedly after their first visit (Aleknavičiūtė and Mulevičienė, 2018). The BG educators get positive comments and congratulations for a fun and enjoyable time in the BG, however not many visitors think about the impact which our teaching has on the younger generation. Usually people do not see the BG as a place for learning, but only for fun. However, a belief that students can learn only in a classroom is false.



← Education about DNA extraction.
©Ieva Baškevičiūtė

BG educators are trying to have a positive impact on children's knowledge but also on their skills, understanding and attitude to the natural sciences.

Learning in non-traditional spaces and outdoor education are widely accepted and effective (Slade, Lowery and Bland, 2013). The BG is a perfect place for teaching and learning (Noralizawati and Noriah, 2018) especially if we are talking about natural sciences. Botany, zoology, ecology, genetics – all can be learned using the BG spaces and materials.

BG educators are seeking to change the misconception that BG learning is suitable only for fun. Social sciences research methods have been applied to this end, with four scientific papers in train. The research has already started and the first pilot test took place in summer 2021. Standard activities, which the BG educators organize every year, were chosen to assess their impact on children. These activities were run as a summer camp, “A talented summer camp in the VMU Botanical Garden”, over 5 full days. The programme of the camp included various activities: from exploration of native, rare, endangered and exotic plants to investigation of the intracellular and genetic mechanisms of plants. Fifteen children from 9 to 15 years attended the camp daily.

The BG educators aim for a positive impact not only on the children's knowledge, but also on their skills, their understanding of and attitude to natural sciences. It is important not only to make an impact but to check if the methods and activities are really working. The BG educators chose three main methods to assess the impact: drawings, free form letters, and survey questions. At the end of the camp participants were asked to draw what they had learned during these five days. White A4 format paper, coloured pencils and markers were provided. They had up to an hour for this task. Children could choose freely what to draw and were advised that the professionalism of the drawings was not important.



↑ Children's drawings. ©Vesta Aleknavičiūtė

Even simple methods can be used to measure the impact and to prove that the BG can be a suitable environment for teaching and learning, and not just for leisure activities.



↑ Floral workshop preparation. ©Ieva Baškevičiūtė
← Workshop in the educational garden.
©Ieva Baškevičiūtė

This task was given to participants from 9 to 11 years old. The second method to measure the impact was a free form letter. At the end of the fifth day, camp participants were asked to write a letter about their experience in the BG camp. White A4 format paper and pencils were provided for this task. Children could choose the recipient of the letter and the length of it. The time available for this task was 40 minutes. This task was given to all participants. The third method to measure the impact was a survey on photosynthesis. The survey consisted of 13 two-tier type questions and was a modified version of a survey created by Haslam and Treagust (Haslam and Treagust, 1987). This paper survey was given to the participants twice – once at the beginning of the camp (to evaluate existing conceptual understanding) and at the end of the camp (to assess the extent of changes, if any). The time available was 45 minutes. This task was given to participants from 12 to 15 years old. On completion all tasks were collected and evaluated by the BG educators. All tasks were anonymous; children used their own created nicknames. The children's parents were informed about the pilot test and gave their written permission.

The BG educators analyzed all the children's work. The evaluation of the children's drawings showed that mostly participants learned how to use a microscope and gained knowledge about amphibians, insects and birds. The analysis of the children's free form letters provided the following insights: participants gained new knowledge about natural sciences ("I have expanded my knowledge and I am insanely happy about it"); children changed their attitude to the natural sciences ("This camp changed my approach to biology. It showed that biology can be interesting, fun, crazy and changing the world"); students liked to learn in non-formal learning environment ("I have a desire to visit the botanical garden and its plants more often"). Finally, all surveys were assessed, comparing the same person's first and last day's answers. All students improved their results: the smallest difference was from 11 to 13 right answers (2 right answers more), the biggest difference was from 2 to 8 right answers (6 right answers more).

To sum up, BG educational activities have a positive impact on children's attitude, knowledge and conceptual understanding about natural sciences. Even simple methods can be used to measure the impact and to prove that the BG can be a suitable environment for teaching and learning, not just for leisure activities. However, more data is needed to support this initial finding. This pilot study is a first step in our research. Subsequent stages will involve more students and more activities, in order to evaluate their impact on conceptual understanding and attitude to the natural sciences.



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← *On the way to the summer camp.*
©Ieva Baškevičiūtė

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IMPACT OF INTERACTION BETWEEN VISITORS AND FAUNA IN BOTANICAL GARDENS



The Municipal Botanical Garden of Bauru (MBGB) has been receiving an increasing number of visitors, creating several negative consequences for the native fauna, such as food supply by visitors and disease transmission. In 2017, we observed the death of several marmosets (*Callithrix* sp.) by human herpes, generating a need to create an educational campaign to guide the public to not feed or have physical contact with these animals. After the beginning of the campaign, several surveys were carried out with visitors to assess the impact of this educational activity on the visiting public.

Botanical gardens differ from public parks, historic gardens and other horticultural attractions. Many are created and managed for a variety of purposes, including visitor attraction, environmental education, science, and their main objective, plant conservation (Smith & Harvey-Brown, 2017). Today, botanical gardens are key players in both plant conservation and education. Every year c.500 million people visit botanic gardens around the world (BGCI, 2021). Raising awareness in society through these institutions is vital for the establishment of a harmonious relationship between humanity and plants and their natural environments.

THE REALITY OF THE MUNICIPAL BOTANICAL GARDEN OF BAURU

The Municipal Botanical Garden of Bauru (MBGB), located in the city of Bauru (São Paulo-Brazil), has an area of 321 hectares with a vast area for public visitation and an important reserve of native vegetation, representing one of the largest conservation areas of cerrado in the state of São Paulo, considered a priority area for conservation. Therefore it is extremely important that public engagement includes information on the negative and positive impacts on local biodiversity.



↑ Marmosets collecting food left by visitors. ©Silvio Serrano - Archives of the Botanical Garden of Bauru
↖ Picnic area. Place chosen to observe the behaviour of visitors and marmosets. ©Fátima Sandrin - Archives of the Botanical Garden of Bauru



← Aerial view of the Municipal Botanical Garden of Bauru showing the reserve of native vegetation.
©Archives of the Botanical Garden of Bauru

In recent years, due to the annual increase in visitor footfall, we have noticed increased negative impact, especially in the interaction of the public with the local fauna. One of the consequences was caused by the offer of food to a species of primate (*Callithrix* sp), popularly known as marmosets. In 2017, marmosets were found dead, infected with human herpes. According to Casagrande (2007), the virus is lethal to marmosets and contamination occurs through the consumption of contaminated food.

This issue incentivised MBGB to create an educational campaign to reverse this situation, engaging the public and seeking a change in behaviour. According to Smith and Harvey-Brown (2017), information on visitor satisfaction, attitudes, and behavioral changes is important for organisations to measure. The data provides information for the development of management tools that can maintain a balance between the leisure, conservation and education roles of the organisation. With this in mind, MBGB hoped to answer the following questions: 'Can we measure the impact of the actions of the Botanical Garden on the community where it is located?' And 'How best to collect data for these measurements?' This article presents the findings and reflects on the MBGB experience with its educational campaign to encourage behaviour change in the visiting public.

To measure the impact of MBGB on the public, interviews were initially conducted with visitors, with the sample number determined according to Mourão Júnior (2009), for a known population (Table 1). For this work, we used the known number of MBGB annual visitors (c.70,000), which meant the requirement for 382 questionnaires.

$$n = Z^2 \cdot P \cdot Q \cdot N / E^2 \cdot (N-1) + Z^2 \cdot P \cdot Q$$

Subtitle:

Z = Confidence Level: 95% (For 95% Confidence Level use Z=1.96)

P = Expected Hit Amount (%): 50%

Q = Expected Error Quantity (%): 50%

N = Total Population: ≤ 100,000

E = Accuracy Level (%): 5%

n = sample size

Table 1 - Formula for calculating sampling for a finite population.



↑ Sick marmoset, infected with human herpes.
©Bruna Mendonça Santos - Archives of the Botanical Garden of Bauru

Although the conservation of the flora is the main activity of the Botanical Gardens, gardens that have natural areas, open to the public, should be concerned about the impact that visitation causes on the local fauna. Therefore, proposing educational campaigns is of great importance.



↑ Campaign advertising material delivered to visitors.
©Archives of the Botanical Garden of Bauru



← Educator of Botanic Garden of Bauru presenting the educational campaign for students. ©Archives of the Botanical Garden of Bauru

VISITOR SATISFACTION SURVEY

Gomes and Cardoso (2015) conducted a survey to determine the profile of visitors and their satisfaction with the MBGB. The results showed that the visiting public is made up of adults between 25 to 50 years old (59%), who seek a place for rest and leisure (63%), accompanied by their family (49%). The place they most liked to visit was the ecological trail (32%). The public was satisfied with the MBGB (64%), however 36% suggested various improvements in structure and service. For visitors, the MBGB is regarded as a place of leisure and well-being (23%), promoting contact with the natural environment (18%), as well as being a place of conservation and preservation (18%) and a source of information about plants (13%). For MBGB, it is important visitors develop positive feelings about the institution and recognize the importance of environmental protection and therefore educational programmes are key to disseminating this message. Data showed that the ecological trail was the preferred place by visitors to learn this message and reinforced the need for it. It also demonstrated the importance of botanical gardens as sites where people can engage with natural environments.

PUBLIC KNOWLEDGE ABOUT THE MARMOSET

Santos and Cardoso (2017) surveyed public knowledge about marmosets. The participants surveyed were adults over 25 years (77%), with higher education training (72%), who understand that marmosets are monkeys and primates (79%), feed on fruits (84%), live in the region's forests (15%) and whose behaviour is altered by human action (12%). Of those interviewed, 10% considered it an invasive species. Around 13% considered marmosets an attractive docile animal and only 4% considered them a dangerous animal.

Regarding human behavior, 23% reported that they had already fed the marmoset and 72% reported that they had observed other people feeding the animal. With reference to contact, 11% reported that they had already touched the animal and 51% reported that they had observed another person having contact with the animal. With respect to the transmission of diseases, 54% believed that marmosets can transmit diseases to people. The data revealed that the public has reasonable general knowledge about the animal, but is unaware of important issues such as feeding habits. The marmosets basically feed on resins and exudate from trees, the feeding of fruits and insects is secondary (David, 2005).



↑ Information banner placed in the picnic area to inform visitors. ©Archives of the Botanical Garden of Bauru

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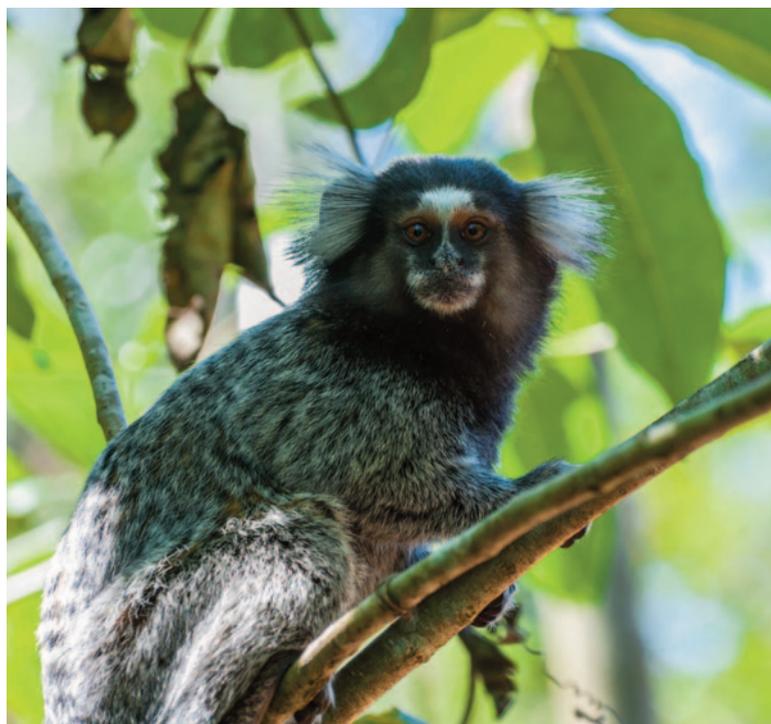
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THE EDUCATIONAL CAMPAIGN

Following on from the previous findings, MBGB proposed an educational campaign in 2017. This was called "EU CURTO SAGUI - ELE LÁ, EU AQUI" ("I like marmosets - when they are over there and I'm here"), with the objective of getting the population to behave appropriately when engaging with free-living animals, using the marmoset as an example. The campaign was developed at MBGB and included the production of printed material, banners and signposts, in addition to training employees and monitoring and advising during visits. The campaign also involved lectures in schools, hospitals, universities, environmental events in the city and dissemination through various media, including the institution's social networks.

ANALYSIS OF THE IMPACT OF THE EDUCATIONAL CAMPAIGN ON THE VISITING PUBLIC

Santos (2018) conducted a survey to verify the interaction between visitors and marmosets. The research took place in 2018, after the launch of the educational campaign, and involved direct observation and recording of the behavior of the public towards marmosets (705 records). According to Santos (2018) visitors approach the marmoset more often (30%) than the other way around (20%), initially approaching (30%) and taking pictures (18%), followed by feeding (17.5%) and physical contact (3%). So the process of changing the habits of these animals begins with human action. Animals, recognizing humans as an easy source of food, end up getting increasingly closer to visitors (20%). Adults display greater risk behaviours than children such as touching (2%), picking up (0.15%) and offering food (9%). Children, observing the behavior of adults, are in turn encouraged to develop risk behaviours in relation to marmosets. The results demonstrate the need to create other strategies to increase the effectiveness of the campaign. We should also recognise that for effective results, educational campaigns, or any process of environmental education, must be continuous and not just one off events (Brasil, 1999).



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← *Callithrix* sp - Marmoset found in the native vegetation of the Botanical Garden of Bauru. ©Silvio Serrano - Archives of the Botanical Garden of Bauru

SPOTLIGHT FRIENDS OF TREBORTH BOTANIC GARDEN



Plant sale volunteers and staff. ©Friends of Treborth Botanic Garden

The Friends and staff of Treborth Botanic Garden have, over the last few years, been pursuing two initiatives to improve our sustainability in growing plants for our plant sales and for use within the Garden. Firstly, we have moved over to peat-free compost, and, secondly, we are exploring ways to reduce our use of plastic pots.

We are well aware of the environmental issues associated with the depletion of peat bogs to provide peat based growing media, so we have been exploring various alternatives. There are numerous peat free composts available now, but many of these are of poor quality – lumpy, sandy, or filled with twigs and other bits of uncomposted wood. One of the Friends of Treborth Botanic Garden is a professional horticulturalist and had recommendations from his contacts about a particular brand of peat free compost, made by a British manufacturer. He and the Curator then trialed it at the Garden and had discussions with the manufacturer, and now we have a growing medium mix especially prepared for us. This is mainly hot-composted wood waste, which has a good crumbly texture, with the addition of sterilised loam. The loam helps to ensure that moisture is retained in the compost and will help the plant not to dry out when planted in the garden. This mix has proved to be very satisfactory, and the Friends buy this in big bulk bags for use in the Garden, and in 50 litre bags for members of the Friends to use for the plants that we propagate at home for plant sales. The only problem that we had was in 2020 when there was a shortage of this compost; the manufacturer explained that, as a result of the pandemic, there was a surge in demand as people were taking up gardening in lockdown, and many were asking for peat free compost. While it is good that the message about avoiding peat products is getting through to the public, the demand for peat-free growing media caused a shortage world wide in the basic ingredients such as wood waste and coir.

We use a lot of plastic: module trays for sowing seed, then larger pots for pricking out and growing on plants to be sale-ready. Members who are growing plants at home from their cuttings and divisions will often re-use plastic pots so at least these are getting used more than once. The flimsier modules and cell trays that we use for vegetable seeds are more difficult to re-use though, so we have been looking at other options, in particular compostable pots. Ideally we want material that will not degrade while the plants are being grown for sale, but can then be planted straight into the garden, and will break down in the soil allowing the roots to grow without restriction. Some pots claim to be degradable, but may in fact just break down into micro-plastics, and we want to avoid introducing these into our gardens. Others use a lot of plant material that has to be imported, possibly from tropical areas, which raises questions about the environmental costs of transport, possible habitat destruction, and poor working conditions. Treborth Botanic Garden is part of Bangor University, and one of the Friends heard about work being done by the University's BioComposites Centre to develop biodegradable packaging, including grass fibre trays for fruit. Garden staff and members of the Friends visited the BioComposites Centre to discuss the possibility of making pots and modules made of grass, hopefully our own Treborth grass. Funding will be needed however to progress this further. In the meantime we are using small cell pots that are made of cellulose in an open mesh structure. The mesh allows the roots to grow through without hindrance and the material slowly composts in the ground.

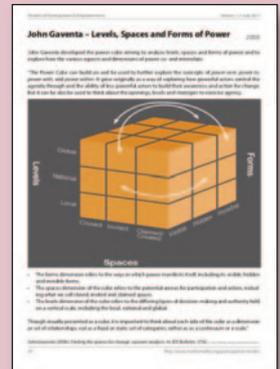
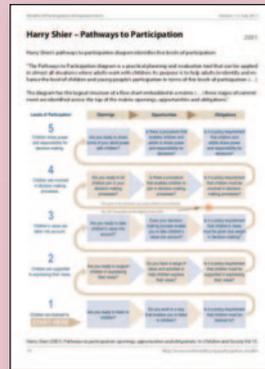
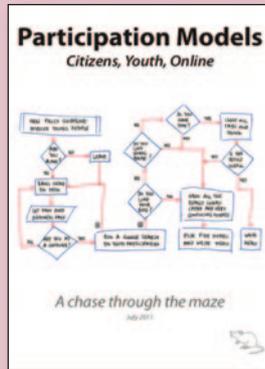
By trialing these alternatives, and publicising these to our members and the public who come to our plant sales, we hope to spread the message about sustainability in gardening.

RESOURCES

Participation Models: Citizen, youth, Online

Understanding different participation models can be complicated. Creative commons have broken down each model to explain which model you should use in your project.

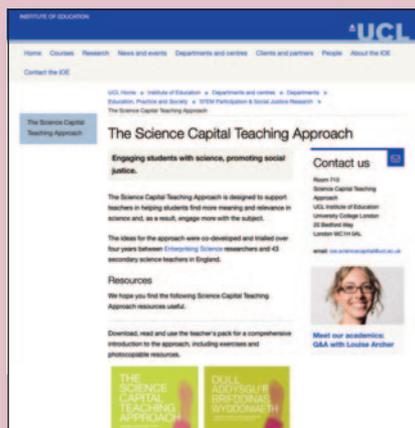
<https://www.nonformality.org/wp-content/uploads/2011/07/Participation-Models-20110703.pdf>



Science Capital model

The Science Capital Teaching Approach is designed to support teachers in helping students find more meaning and relevance in science and, as a result, engage more with the subject. Many museums support this method, which aid the relationship between schools and them.

<https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/stem-participation-social-justice-research/science-capital-teaching-approach>



RE resources – there is a lot out there – I'd always recommend the Reed *et al* paper I referenced and its associated toolkit:

Paper:
<https://www.scienceopen.com/document?vid=a7ffe736-af4b-42e0-b504-925c3a7defba>



Toolkit:
<https://www.qmul.ac.uk/publicengagement/goodpractice/evaluation-toolkit/>



UCL has created some online training, which is free and available to all. These documents were co-created by BGCI and UCL. You need to sign up to UCL eXtend before you can access the following links:

Introduction to public engagement:
<https://extend.ucl.ac.uk/course/view.php?id=615>

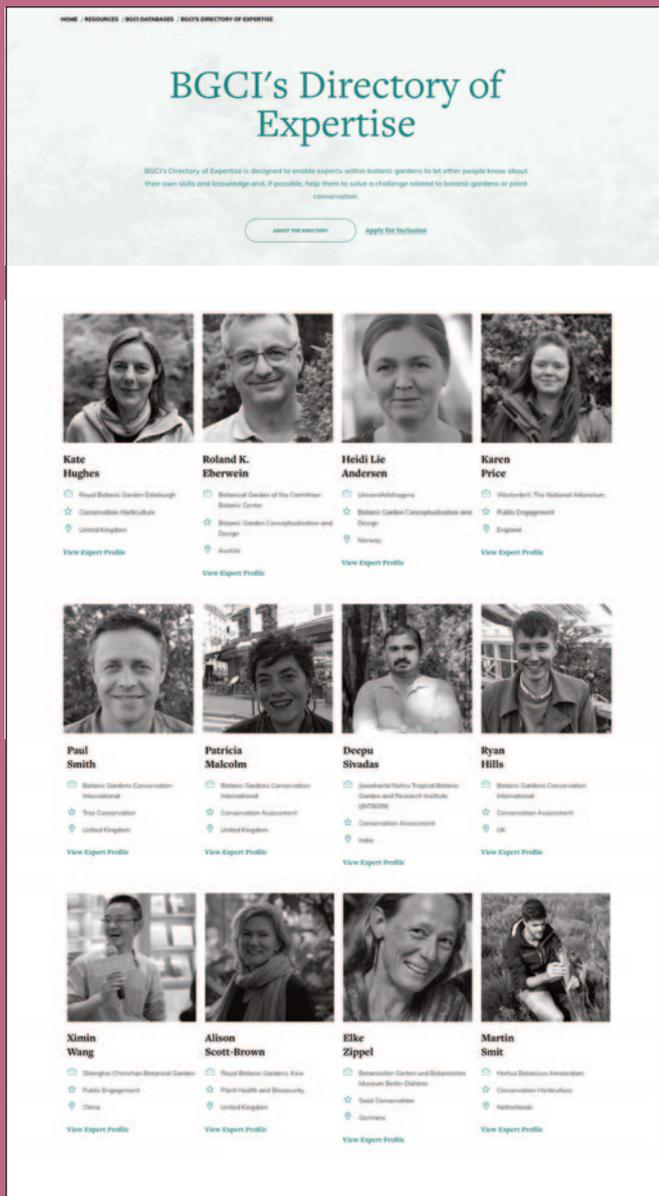
Public Engagement as part of your research grant:
<https://extend.ucl.ac.uk/course/view.php?id=677>

Practical Skills for Public Engagement:
<https://extend.ucl.ac.uk/course/view.php?id=675>

Evaluating the Impact of Engagement:
<https://extend.ucl.ac.uk/course/view.php?id=676>

For a deeper insight in to impact, BGCI would recommend:

<https://rowman.com/ISBN/9781442263291/Measuring-Museum-Impact-and-Performance-Theory-and-Practice>



BGCI'S DIRECTORY OF EXPERTISE

BGCI's new Directory of Expertise is designed to enable experts within botanic gardens to let other people know about their own skills and knowledge and, if possible, help them to solve a problem or challenge related to botanic gardens or plant conservation. As a membership benefit exclusively for BGCI Institutional Members, staff associated with these institutions can apply to be listed in the Directory.

The Directory currently includes 11 areas of expertise including Public Engagement. BGCI's purpose in creating this Directory is twofold: firstly, to share the knowledge and skills in the botanic garden community with broader society to solve problems or save plant species, and secondly to give staff of BGCI Institutional Members opportunities to broaden their experience and make a contribution that might not come their way in day to day work.

For more information or to be listed as an expert visit:
<https://www.bgci.org/resources/bgci-databases/directory-of-expertise/>