greenminds

# greenminds
## case study

# Living Lab Nature Data Probe Toolkit

PLYMOUTH CITY COUNCIL · REAL IDEAS · National Trust · ARTS UNIVERSITY PLYMOUTH · Devon Wildlife Trust · THE DATA PLACE · UNIVERSITY OF PLYMOUTH · EUROPEAN UNION European Regional Development Fund · UIA

# Green Minds Model summary

**The Green Minds Model aims to summarise the structure of the GM approach, to aid its transfer and replication to other urban areas and authorities.**

Green Minds piloted new ways of implementing nature-based solutions within an urban environment. The project's central aim was to collaborate with stakeholders to recognise how humans, as part of nature, interact with nature in a complex system and to identify ways in which *systemic* change is brought about.

The model is presented as an integrated approach, where various nested elements are shown working together as a system. It reflects the particular challenges and scales of focus in urban areas - from individuals, to communities and neighbourhoods and at a citywide level. It focuses on particular leverage points for change (best practices) with regard to nature in cities, and is guided at its core by a set of underlying principles to inform practice.

At the centre of the model sits the system goal - *Urban Wilding. A set of guiding Principles have been created to inform the practice of Urban Wilding. These principles have emerged from our experiences designing and implementing Urban Wilding in Plymouth.

The eight Principles that have emerged from our programme of testing and development represent key leverage points to effect system change and to successfully integrate nature within urban place shaping. This includes exploring deeply held beliefs and values around our relationship to nature and to others, the creation of new organisational and digital infrastructures which empower citizens, and the development of new policy, planning and financial frameworks to support this.

Complex systems can behave differently at differing scales and so these are reflected too in the model to recognise the importance of understanding *who* needs to be engaged and *how*. This takes into account the need for multiple perspectives and the importance of equity (who participates), through an inclusive process of engagement from individuals to groups and organisations, and at neighbourhood and citywide scales.

Finally, the model acknowledges the importance of an ongoing and iterative co-design process. This process recognises that resilience requires the ability to adapt as solutions emerge within a complex and constantly changing environment. It is delivered through a cyclical, action learning approach in which lessons learned influence the next cycle of implementation to ensure a progressive approach.

The model is brought to life through our suite of Insight Papers, Guides and Case Studies which aim to illustrate how the model was implemented and what we learnt.

## Green Minds Urban Wilding Principles

The quality and quantity of nature has declined significantly in recent decades. Across the UK and Europe, nature recovery and restoration, rather than just preserving or conserving what remains, has become a high priority, as we have become more aware of society's dependence on nature[1].

We know that spaces that are more biodiverse can deliver multiple health and wellbeing benefits as well as other nature-based solutions such as improvements in water drainage, increased carbon sequestration, removal of air pollutants and increased pollination for food security[2]. 'Rewilding' has gained prominence as one approach to achieving such improvements in biodiversity, with a growing research body assessing its impact.

Urban (re)wilding, however, is still a new concept. We define Urban Wilding as 'any initiative, both human-aided and natural colonization, that aims to encourage biodiversity, ecosystem function and native species in urban settings'[3].

Urban Wilding is fundamentally different from wilding/rewilding/renaturing elsewhere. Cities and towns are dominated by human infrastructure and activity. Consequently, many natural ecosystem processes are significantly modified or constrained in urban areas. We rely upon ecosystem services for our health and wellbeing. Urban ecologies, which deliver these ecosystem services, are complex and poorly understood. However, we know that more biodiverse systems deliver more or better ecosystem services. We also know that we can mimic, or engineer, some specific ecosystem services such as storm water management. Whilst we don't know enough to design urban ecosystems to deliver all the services we need, we do know that more nature is good for people and urban living and that arranging it in certain ways can deliver certain specific benefits. We can't achieve this by doing nothing – positive interventions are required, which in turn demand enabling policy, community action and practical delivery mechanisms.

The Green Minds understanding of Urban Wilding recognises the need to shift from nature conservation to nature recovery - to focus on restoring much of what is rare or has gone and a recognition that we need to bring high quality Nature into places where people live.[4]

The Urban Wilding Principles below are designed as a set of prompts to help guide initiatives for nature to thrive in cities: to survive and reproduce, to expand, and to function as a system and so deliver more and better services to support urban environmental health, our economy, and human wellbeing.

*We have chosen to use the term 'wilding' instead of 'rewilding', as it better reflects the reality of nature in urban areas - to rewild implies a return to nature before urbanisation, which is not possible.

[1] Nature Recovery for Our Survival, Prosperity and Wellbeing: A Joint Statement by the Statutory Nature Conservation Bodies of the UK. jncc.gov.uk/our-role/the-uk/nature-recovery-joint-statement

[2] Dasgupta, P. (2021). The Economics of Biodiversity: the Dasgupta Review. London (HM Treasury); Maller, C. (2018) Healthy Urban Environments. Routledge

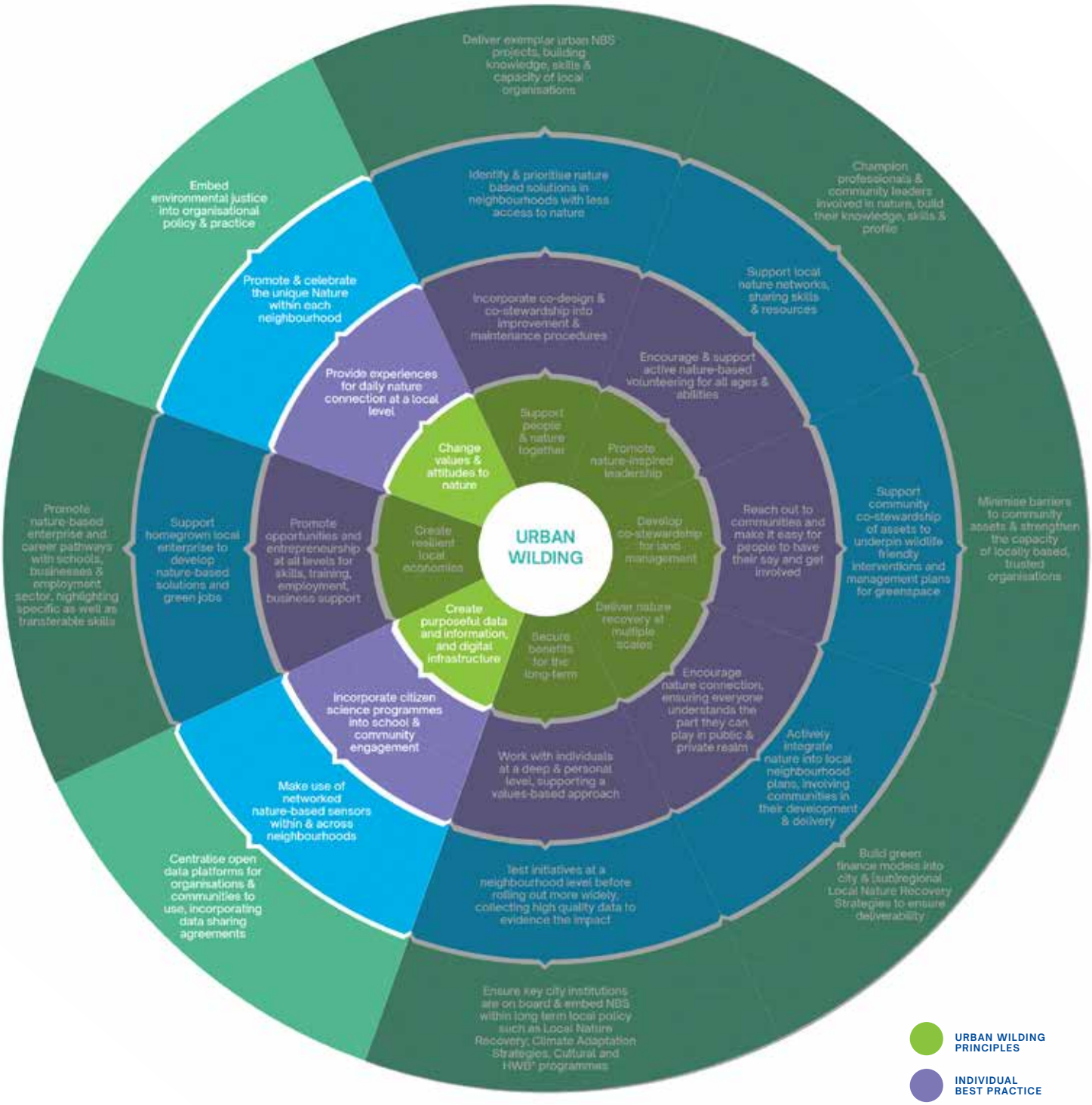
[3] Maller, C., Mumaw, L., & Cooke, B. (2019). Health and social benefits of living with 'wild' nature. Ch 9 in Rewilding. Pettorelli, N., Durant, S., and du Toit, J. (eds). Cambridge University Press

[4] Juniper, T. (2022) Tony Juniper: Green Paper – an opportunity for an integrated approach to Nature recovery - Natural England

# greenminds model

**The model illustrates the three system levels at which the Urban Wilding principles are applied to drive action: the individual, with neighbourhoods, and within organisations.**

Permeability, both within and between segments, reflects the need for adaptability through local learning gained through an action learning approach, in which lessons learned influence the next cycle of implementation.




URBAN WILDING PRINCIPLES

INDIVIDUAL BEST PRACTICE

NEIGHBOURHOOD BEST PRACTICE

ORGANISATIONAL BEST PRACTICE

EUROPEAN UNION
European Regional Development Fund

UIA URBAN INNOVATIVE ACTIONS

*Health and wellbeing

# Urban Wilding Principles

### Support people and nature together

Promote a just transition to wilder cities through equitable access to nature, socially just policy and involvement in the co-creation and co-stewardship of nature-based solutions that are adapted to climate change, biodiverse and support nature connection.

### Promote nature-inspired leadership

At all levels of management (individual, community/neighbourhood, city administration, business, etc) enable nature positive actions to enhance urban liveability through education, training, and policy.

### Develop co-stewardship for land management

Democratise land management and ownership through the development of co-stewardship solutions with user communities, introducing inclusive and empowering processes for engagement, creating community assets, and utilising diverse governance structures.

### Deliver nature recovery at multiple scales

Make the most of the local built environment and its scale, acknowledging that no space is too small to be valuable whilst at the same time recognizing that larger green spaces and high degrees of connectivity are key for nature recovery.

### Secure benefits for the long-term

Develop integrated policy instruments that embed urban wilding in development practice, led by communities and advised and supported by public administrations to create resilient cities and a population connected to nature.

### Create purposeful data and information supported by digital infrastructure

Develop new digital infrastructures to generate community-owned and insightful knowledge of urban nature to support nature connection, and nature-positive policy and practice.

### Create resilient local economies

Promote and empower nature-related careers, cooperatives and social enterprise across all sectors, to create new jobs and new value in green and blue infrastructure.

### Change values and attitudes to nature

Promote nature connection amongst citizens, to enhance individual and community wellbeing and to foster nature-positive choices.

# Introduction

**The Green Minds Living Lab aims to redefine the future of green space in Plymouth by developing a series of site-specific digital experiments across the city that create a better model of civic engagement and governance within the urban green space.**

**In the Green Minds project, we used scientific and creative digital tools to make nature in the city much more visible and exciting to people and foster engagement with green space.**

## Technology in the wild

Data can be an important tool to help us understand what is happening in our natural environment and the impact of human activity.

**Citizen science**, as a participatory approach to gathering and understanding nature data, has the potential to deepen connections between people and nature, and increase local participation in greenspace governance. But there are many challenges with accessing and installing technology in the wild, such as lack of internet connection and lack of ways for non-experts to meaningfully interpret data.

In this Case Study we describe how we tested and implemented a series of digital infrastructure and practical tools in a specific park, which we used as a pilot to test out the best way to engage people and stakeholders.

**Place-based citizen science** in Living Labs* can support co-creation of nature-based solutions and foster environmentally responsible behaviours, resulting in more informed and engaged participation in urban governance. The benefits include strong engagement and empowerment of end-users by creating scientific literacy around the usage of digital tools, accessing data and in turn, creating environmental awareness which can lead to more informed decision making in implementing change.

BELOW: sensor in Central Park


**By bringing the data alive to people in creative ways the project aims to understand and adapt the way we care for, use, and manage our urban natural spaces in ways that benefit people and wildlife while also engaging the community to help share the data in meaningful and accessible ways.**
**– KATHARINE WILLIS, UNIVERSITY OF PLYMOUTH**

*'A 'Living Lab' can refer to a diverse range of local experimental projects, given such a project is participatory in nature and aims to trial and test innovative solutions in a real-life setting.' Gupta, A., Willis, K. (2023 in press). Place-Keeping in the Park: Testing a Living Lab Approach to Facilitate Nature Connectedness in Urban Greenspaces. Sustainability, 15

# Overview

**Digital technologies and place-based data can provide new ways of interacting with nature by enabling us to see how wildlife uses our green spaces, and so help us to value and manage those spaces differently.**

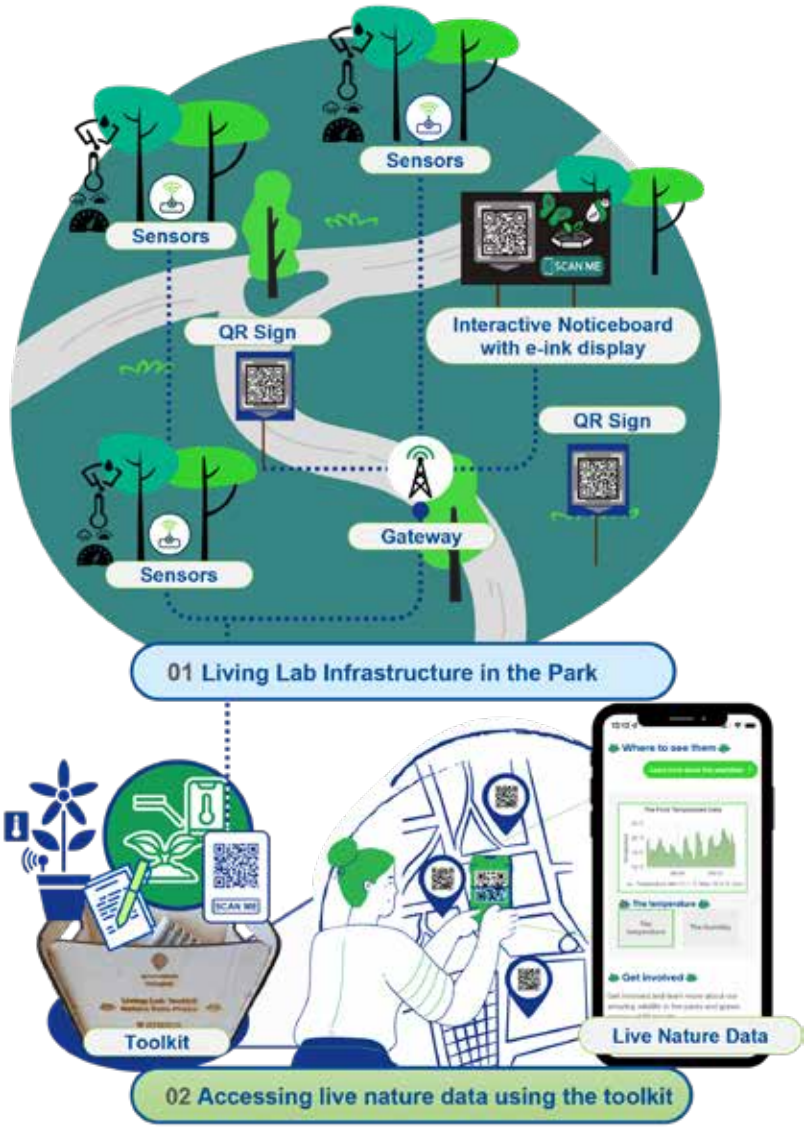
## Digital infrastructure

We installed in the park a series of digital technologies: low-cost, low-power live sensors, and interactive signage with e-ink displays and chatbot interfaces for accessing live nature data to monitor wildlife, general environmental conditions (such as air quality, temperature and humidity) and the impact of human activity in the park using the LoRa WAN[1] technology (see page 7).

## The Nature Data Probe Toolkit

We implemented the Living Lab approach using a **'Nature Data Probe toolkit'**. The toolkit was developed as a way for people to engage with data about the park. The design and its components were structured around simple nature-based activities to reveal hidden nature and create intentional engagement with nature in the park.

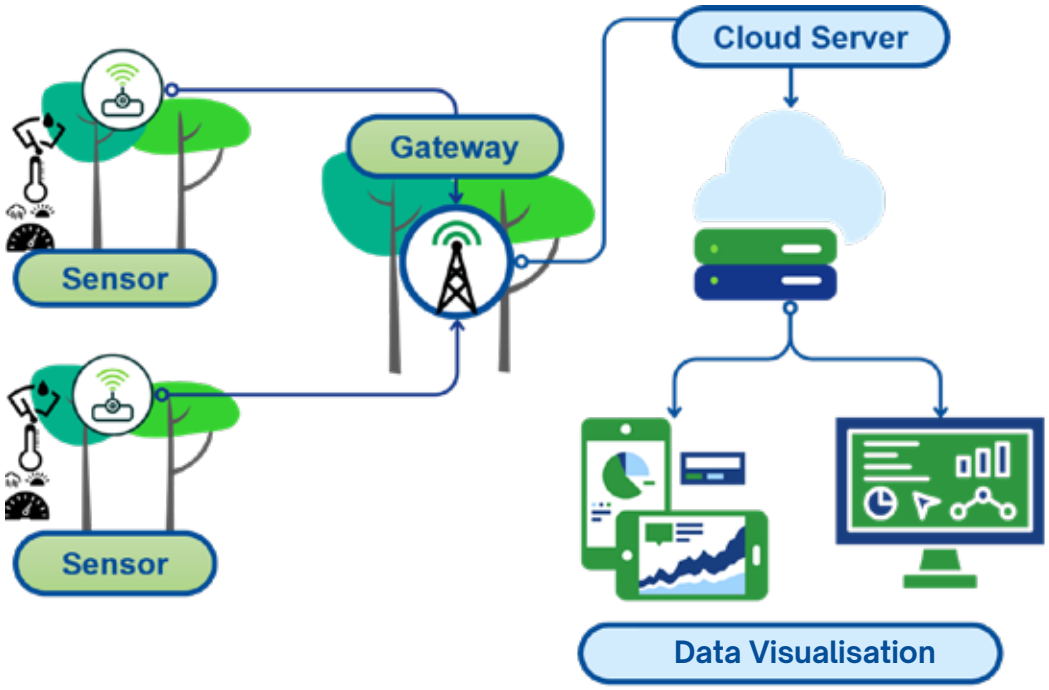
Treating non-human, natural inhabitants as **equal participants and stakeholders** in the project, the toolkit components use nature-based data for narrative building with digital technologies for green space engagement. By giving nature a voice this can help create active participation by building empathy for nature in the end-users. A combination of physical and digital interfaces which can be particularly effective for engaging users with nature in green spaces was also incorporated.




1. LoRa WAN - Long Range Wide Area Network

# Digital infrastructure

Data is an important tool to help us understand what is happening in our natural environment and the impact of human activity. We have used digital technologies such as live sensors in the park that monitor wildlife activity, air quality, temperature, humidity and the number of visitors.




## LoRa WAN infrastructure

We installed a series of low cost and low power sensors using a technology platform called LoRa WAN. LoRa is the abbreviation of “Long Range Wide Area” and is an open source, low-power and low-cost wireless network platform. It enables sensors to send and receive data without an internet connection and with very little power (the sensors use batteries). This means we can gather nature data without power or an internet connection which enables the sensors to be placed in remote locations. Live nature data can be accessed using interactive QR signage across the park. We incorporated a chat-bot interface and mini QR signs within the Nature Data Probe toolkit.

## Living Lab Infrastructure in the Park

We deployed a combination of different sensors in the site using LoRa WAN technology.

- Environmental Sensors[2] in various habitats for ambient temperature, relative humidity and air pressure
- Soil Moisture sensors[3] to monitor orchard and garden conditions
- Air quality sensors[4] for CO2, CO2e, Bvoc, PM1, PM2.[5], PM4, PM10, ambient temperature, relative humidity to monitor air quality around beehives for effective pollination & general differences air quality in site locations.

**In absence of a wired internet connection, wireless internet connectivity was established using a 4G sim card.**

## Case Study: Saltram, National Trust

We implemented the **Living Lab at Saltram**, a National Trust site in Plymouth. Using the Nature Data Probe toolkits to run community workshops, we shared live nature-data with park visitors to increase engagement with nature, and enabled monitoring of different parts of the site for better management.

**LoRa WAN gateways** were first set-up on site at high altitude, obstacle free spots with access to a power source. Potential locations for sensor installation were identified with National Trust considering gateway signal strength, obstruction-free transmission pathways, even distribution across the site, varied habitats, and access to a power source.

LEFT: Students holding Living Lab Nature Data Probe Toolkits

2.Senzemo Senstick SMC20 – Environmental Sensor
3. Tektelic KIWI Agriculture – Soil Moisture Sensor
4. ynetica enLink OAQ-C – Air Quality Sensor
5. Senzemo Senstick SMC20 (environmental sensor)

# Digital Toolkit: The Nature Data Probe

**The Nature Data Probe toolkit is a tool we developed for people to engage with data around the Living Lab sites.**

The design and its components are structured around simple nature-based activities to reveal hidden nature, create intentional green space engagement and in-turn create empathy for nature. The toolkit sensors and data feeds are provided through the LoRa data infrastructure.

### The toolkit consists of:

1. A combination of LoRa WAN enabled sensors:
   - a soil moisture sensor[6]
   - light detection and measurement
   - a leaf moisture sensor[7] for leaf surface moisture
   - leaf temperature
   - ambient temperature and humidity
   - enabling monitoring of plant/tree health
2. Wooden QR codes signs to access live data dashboards for each sensor
3. Nature data probe logbooks with prompts to engage with Living Lab sensors and nature data, and to record reflections.

The toolkit can be modified by selecting different components depending on the nature of the project. For example, sensors to monitor elements like air quality, carbon dioxide, ultrasonic distance or people counters, can be added.

Components of the Nature Data Probe Toolkit




6. Tektelic KIWI Agriculture (soil moisture sensor) 7. Dragino LLMS01 Leaf (leaf moisture sensor)

## Examples of activities using the toolkit:

The combination of digital and paper components within the toolkit can be used to deliver a wide range of activities around engagement with nature and nature data such as mapping activities, paper-prototyping, nature discovery and citizen science.

## Outcomes:

Evaluations around nature connectedness revealed that simple nature-based activities using digital tools are effective in creating better engagement with nature in green spaces. We found that **nature connectedness was created** where participants were able to identify nature using more descriptive and specific vocabulary after the Living Lab intervention.

PHOTOS: engagement sessions with local secondary school students in Central Park

# Engaging with the data

**Narrative approaches are central to behaviour change practice and have been evidenced to aid active participation in place-based citizen science interventions. This storytelling using digital technologies can thus contribute to building better connections with nature in urban green spaces.**

## Narratives of data and place-based technology

Informed by stakeholder consultations and research around designing digital interfaces for parks, we developed our digital prototypes using this narrative approach. The outcomes highlighted the following key characteristics:

1. an engaging, immersive experience
2. in a form of storytelling
3. share knowledge about the park's wildlife
4. accessed via a mobile device
5. text-based, including visuals.

**We developed chatbot interfaces to bring live data from the park to its users and gather feedback from them.**

## 'Talk to the Park' chatbot interface

RIGHT: interactive interpretation in Central Park

The flexibility of the chatbot tool enables ongoing co-design of the dialog between the park and users, how the space can be used, and for what purpose.

By facilitating two-way communication between park users and the chatbot, we aimed to provide up-to-date and accurate information about parks based on individual preferences. This information can be used to inform park managers' day-to-day activities, as well as longer-term investment decisions like the provision of new infrastructure or adapting management regimes.

**The prototypes were developed using common digital tools – QR codes and chatbot interfaces.**

**Accessing Live Nature Data from the Park**


ABOVE: Example of Living Lab in Central Park: Scanning QR codes on park signage to access the 'Talk to the park' chatbot and view live nature data.

# Digital infrastructure for nature connectedness

**The Living Lab approach with an open source IoT LoRa WAN infrastructure installed in a park together with a series of engagement activities with local stakeholders provides a digital infrastructure to support active green space engagement and in-turn create nature connectedness.**

## Technology in the wild

Against the limitations of conventional methods for participation, technology has emerged as a promising tool for better engaging with green spaces in a more participatory and engaging manner; encouraging more people to explore and engage with nature and take advantage of its benefits.

LEFT: Local school students using the data toolkits

## Engaging with nature data

A place-focused approach to citizen science in this regard can not only create literacy around digital sensing tools and making data accessible but also empower citizens by creating a deeper awareness of nature in urban green spaces, leading to well-informed decisions using the evidence-base generated during iterative cycles of data collection.

## Young people and digital

We found that engaging a younger audience can be particularly effective in establishing a long-term and sustained stewardship of natural environment by giving them the tools and know how to care for their local green spaces. In this context, Living Labs can be an innovative pathway towards creating a more participatory and inclusive green space and may have positive spillover effects towards community cohesion.

LEFT: engagement event in the west of the city

# Appendix: Digital infrastructure installation guide

## Selecting location for infrastructure

An onsite habitat mapping prior to sensor installation is recommended to identify locations with a mixture of habitats i.e., meadows vs woodlands vs wetlands - hosting a diverse range of species. This ensures generation of rich data sets enabling effective narrative building around nature in the park and, in turn, compelling stories about these habitats and their inhabitants.

## Gateway catchment

Installing locations at higher altitudes on site with minimum obstruction (such as hills or tall buildings) are recommended to ensure all sensors have good connectivity to the gateways. A power source and internet connectivity at the installation site are required. Internet connectivity via ethernet cable is preferable for undisrupted operation but mobile connectivity using a 4G SIM card is also reliable. These SIM cards are the most affordable option but would need to be replaced every 24 months.

## Installation considerations

- Fixing sensors to trees: we opted for plastic cable ties, which although are not made from sustainable materials, could be reused if untied with a thin screwdriver. These ties can also be easily replaced if damaged by weather or wildlife. While stainless steel screw ties can be considered as an alternative, these were not trialled as they can damage tree bark, subsequently putting the tree at risk from infection.
- Consider finding installation locations that are sheltered from the elements to minimise the chances of damage to the sensor and lower maintenance costs
- Consider reducing data streams to minimum to prolongue battery life. Most sensors are set by manufacturers to send out readings every 15 minutes but in many cases this granularity of data is not needed. Our recommendation is 30 minutes to 1 hour data stream intervals.

## Choosing toolkit components

While choosing toolkit components it's important to note the following:

- Portability, reliability, and robustness to withstand the transportation and deployment by individuals without much experience.
- Components that can be used on the go but also deployed in location for longer periods of time.
- Long battery life.
- Capacity to send data to the cloud without the need of LTE or Wi-Fi connectivity to work in remote locations.
- Toolkits can be expanded by incorporating additional Lora WAN sensors according to the purpose of the study.

### SIGNAL STRENGTH

**Gateway coverage for sensors to connect depends on multiple factors such as weather conditions, material, and obstructions in the pathway. On a clear day a gateway may be able to receive data from sensors 10+km away. The signal strength is low in valleys and doesn't travel well through solid structures.**

RIGHT: installation of a sensor at Central Park

**Authors:**

**Prof. Katharine S. Willis, Ashita Gupta and Marcin Roszkowski**

**School of Art, Design and Architecture**

UNIVERSITY OF PLYMOUTH

greenminds

| | |
|---|---|
| Website | www.greenmindsplymouth.com |
| Facebook | @NaturePlymouth |
| X | @GreenMindsPlym & @NaturePlymouth |
| | #GreenMindsPlymouth |

This project is co-financed by the European Regional Development Fund through the Urban Innovative Actions Initiative.