**Community Science Urban Monitoring Framework**

**Supporting Information**

**Appendix 1: The need for a Community Science Urban Monitoring Framework**

Several assumptions underpin the need for a comprehensive Community Science Urban Monitoring Framework:

* Professional survey has limited capability in this space – access restrictions, dynamic land management/use and habitat heterogeneity contribute significantly to this.
* Remote sensed interpretation of land cover and habitat from satellite imagery is challenging without field survey data, e.g., ground-truthing habitat and naturalness mapping.
* Green/Blue Infrastructure and habitat mapping is the preferred way of describing the distribution of ecology and natural capital across urban spaces.
* Existing G/BI and habitat data from urban environments is incomplete and where it does exist it needs ground-truthing or enhancing in granularity (e.g., providing species level information about how habitats are being populated).
* A high proportion of the population (80%) live in urban and residential areas of England. There is a significant pool of people in, or close to, the locations we need to acquire field data for.
* Few of these people will be professional ecologists, but many have the potential to contribute as community scientists and participate in supported study of the natural environment within urban and residential spaces.
* There is limited interaction or coordination between existing schemes and there is the potential to develop means of working or infrastructure that would help facilitate join up, mobilise data and provide a clearer landscape for members of the public to contribute.

**Appendix 2: Emerging Needs and Current Gaps**

* **There are no common aims**

Many groups, organisations and partnerships have, and are continuing to carry out, studies in urban areas using community science. Many of these are environmental in their focus. They are often independent in design and sponsorship, making it hard for Defra group to determine what to support. There is value in understanding our common aims and survey objectives, which will then help catalyse closer working and align effort and investment.

* **There is limited consistency and compatibility**

A broad range of tools, techniques and protocols have been developed and/or are in use supporting community science, many compatible with, and some specific to, urban environments. Some may also be used or adapted for contracted survey which may have an additional or supporting role. We have collected evidence from urban stakeholders that there is demand for guidance on consistency. There is value in identifying a consistent and transferable suite of these that meet identified needs and can be deployed in a range of situations, both nationally and locally.

* **There are gaps in our data, tools, approaches and infrastructure**

There is a large emphasis on species-level recording and even so, this is dominated by certain popular groups (pollinators, birds and plants being a prime example) so there is huge potential to fill information gaps for certain under-represented taxonomic groups. There is also a lack of mechanism for data mobilisation such that evidence from multiple sources is not delivered in the most streamlined way (e.g., reports of valuable records not reaching end users). Local communities are unable to access their own or local records thus creating data flow challenges in both directions.

* **Difficult terrain.**

Urban environments have a complex and dynamic land cover/use matrix and tenure. This increases the complexity of survey and analysis and the range of approaches required.

* **Surveyor engagement**

Survey in complex and sometimes unattractive environments can create challenges for the direction, engagement and focus of community scientists. It is also currently a confusing (theoretical) landscape for people coming to community science for the first time- how can they most usefully get involved to suits their needs and motivations?

**Appendix 3: Contract uses**

**a) From this contract:**

This framework should guide and assist anyone to plan and deliver a coordinated coherent scientific study of key features, functions and health of ecosystems and natural capital assets across the urban landscape with the support of community scientists. It should help consider and identify sampling locations and methods suited to the unique structure and tenure of conurbations resulting in tangible and useful scientific outputs.

**b) Potential audiences/beneficiaries of Community Survey Frameworks**

Senior Defra: The framework will help to identify gaps and support regulation and standardisation

Investors: Public agencies to NGOs with their own programmes and projects, but are struggling for resource in surveying. Have identified need for community help, but is not currently practical (e.g., community not monitoring right sites) The framework will support more joined up approaches.

Local users: The framework will support people on how can they get involved? What are the current opportunities? How might they learn/how might we nurture that

Local authorities and planning: The framework will support nature recovery space and create robust solid foundations. National policy at local scale.

Partners: The framework will support and engage people already working with volunteers

Internal: The framework will assist those not already working with volunteers but have identified potential areas for citizen scientists to contribute

**c) Using the output of this contract**

Defra group want to help organisations and collaborative partnerships coordinate and deploy surveyors, survey methods and tools to study ecosystems and natural capital within and across urban areas.

The contract will be used to:

* stratify data for local use, by meaningful components, features, infrastructure (natural, functional, administrative)
* propose how independent protocols and techniques might be harnessed more collaboratively to study and understand urban spaces more comprehensively
* provide a practical survey framework that can be deployed (piloted) to prescribe and carryout a comprehensive study of ecosystems and natural capital (largely by community scientists) within a given urban space (city or urban conurbation) and which will allow for cross-compatibility between these areas and others.

**Appendix 4: Community Science**

It is important to acknowledge that participants will arrive at different stages of their citizen science journey. CS within the context of this work pertains to all forms of Community/Citizen Science, including various levels of engagement to encourage inclusivity and allowing participants to develop skills and progress over time. The framework could cover CS across:

**Different levels of engagement:** Passive (e.g. distributed computing), Contributory (e.g. observational measurement), Collaborative (e.g. observational analysis), Co-created (e.g. jointly derived by professional and community scientists). [8]

**Investment and scale of participation**: from elemental to elaborate and mass participation to scientific sampling [9]

**Different modes** e.g.

* *Crowd-sourcing* - enables volunteers to remotely participate in desk-based data collection or analyses;
* *Long-term surveys or experimental studies -* where volunteers are more deeply involved in co-creating, planning and/ or managing of experimental studies and long-term surveys;
* *Field-based environmental monitoring and surveillance -* the most common and most traditional forms of community science. Schemes usually involve varying levels of training for skilled and unskilled volunteers;
* *Working with practitioners -* direct survey/studies
* *Activities undertaken by voluntary groups whose data can be used to deliver NCEA objectives -* e.g., RSPB; Urban Pollinator Survey
* *Types of data collected -* e.g. species records, habitat information, physical variables, eDNA etc.

**Appendix 5: Key Objectives**

1. **Define the Who?** *Identify stakeholders (including information users, delivery partners, community scientists)*

Community science, operation in the urban environment and the nature of a comprehensive survey all require extensive engagement with a range of stakeholders and partners. The strategy will require an analysis of these in each context and indicative plans for their engagement. These could include (not exclusive):

**Information customers**

* National policy leads
* Existing national programmes
* Local policy leads
* Land managers
* Community scientists
* NGOs
* Education sector
* Research fields

**Delivery partners**

* Experienced urban CS operators e.g., Natural History Museum
* Regional NGOs e.g., Wildlife Trusts
* LNRS partnerships
* Land managers
* Community bodies e.g., schools; ‘Friends Of’ groups; community nature partnerships

**Existing interests**

* England Ecosystem Survey
* Living England
* National biological recording schemes

**Community scientists**

* Existing networks
* Community bodies as gateways

An integral part of this body of work will be interacting with contractors who will be planning and evaluating a parallel project assessing the needs of local communities monitoring their local environments. This will help inform who the stakeholders are and their needs.

**Project output:** An analysis of programme stakeholders likely to be involved in consultation and delivery. This should be delivered in detailed form as a spreadsheet and in summary form in the final report.

1. **Define the Why?** *Draw together research which identifies data/information needs that can be realistically met through CS [3,4,5]*

A monitoring framework should be built around a range of strategic data/information need drivers. Community science will never meet all urban data/information needs, so a selective approach will be required that acknowledges the specific capabilities and limitations of CS. There has been research conducted into needs of the NCEA programme [4] and NCEA data gaps identified [1] as well as discussions across the NCEA programme as policy drivers evolve, for example:

* 1. We want to improve our ability and confidence in evidence used to identify, map, and understand different types of **Green and Blue Infrastructure (GBI)** (25YEP indicator G3) present in urban and residential areas of England.
	2. We want to improve our ability and confidence in evidence used to confirm, map, and understand the presence of **ecologically significant habitats** (broad/priority) and their **connectivity** (25YEP indicator D1) within urban and residential areas of England.
	3. We want to improve our ability and confidence in evidence used to determine the location and **quality of freshwater** (25YEP indicator B6) (ponds, lakes, canals, rivers) within urban and residential areas of England.
	4. We want to improve our ability and confidence in evidence used to determine **the health of soils** (25YEP indicator E7) within urban and residential areas of England.
	5. We want to improve our ability and confidence in evidence used to determine **air quality** within urban and residential areas of England.
	6. We want to improve our ability and confidence in evidence used to determine the status of species supporting **ecosystem functions (*pollinators*)** within urban and residential areas of England (25YEP indicator D7).
	7. We want to understand community **engagement with the natural environment**, their environmental attitudes and behaviours, health and wellbeing benefits (25YEP indicator G4, G6 and G7), and their engagement in social action (including CS) for the environment (25YEP indicator G5).

Existing local and national programmes and initiatives, with specific reference to:

* 1. Cross-compatibility – ensuring data is cross-compatible with other existing and planned programmes to maximise and contribute to urban/non-urban comparative ability.
	2. Data/information gaps – including geographic coverage, thematic coverage and with particular reference to quick wins: where partial data exists and increased/wider effort can add value.
	3. Enhancement/support for existing programmes by increasing participation e.g., through integration of existing protocols.
	4. Balance of need between spaces (habitat, GBI, land-use, management) and species (indicators, services (e.g., pollinators), invasives).

The following existing programmes within the NCEA family are likely to have relevance nationally:

* England Ecosystem Survey (EES) workstream is developing the most significant use of manual human effort, directing professionals to visit a sample of Monads (1km squares) to study and measure specific elements of the natural environment. This survey effort is designed to measure the presence and health of natural habitats, ecological functions, and landscapes to determine information at a national scale. EES will not provide information suitable for use at local scales, and it will not survey urban or residential areas across England.
* Living England is developing models to interpret satellite imagery to classify land cover and habitat type for the whole of the country. This remote sensed survey data is being used to inform National Maps of Habitat and Green/Blue Infrastructure. The precision of imagery and model-based interpretations are limited, and classification depends on ground truth data collected at sample locations, ‘in the field’. The dynamic and complex structure of urban and residential spaces makes classification of land use from satellite imagery more challenging. Observations and data collection by people on location will be particularly beneficial for accurate classification of land cover and habitat within urban and residential spaces.

**Project output:** An assimilation of existing research on data needs in NCEA and NCEA stakeholders to prioritise data/information needs in the urban space that can be met through community science. This should be delivered in detailed form as a spreadsheet and in summary form in the final report.

1. **Define the What and How?** *Draw together research on the range of frameworks, tools and techniques suitable and available [2.3], how and where these can be combined, deployed and by whom. Where there are identified gaps, what may need to be adapted or developed.*

Research has been conducted into how citizen science can meet the needs of NCEA [5], which covers:

* An audit of community/citizen science projects in England
* Consultation on Natural England’s involvement with CS projects
* Consultation on NCEA Data Needs and Evidence gaps for Green Infrastructure/Urban Environments, freshwater, landscape and habitat monitoring

A broad range of tools, techniques and methodologies have been developed to support community science, many compatible with, and some specific to, urban environments. Some have been developed in connection with the NCEA partnership (listed below) and many more by other actors including Natural History Museum, OPAL, Butterfly Conservation etc.

* **GenePools** – NE is sponsoring Natural History Museum to run community science eDNA study of urban ponds, based on collecting and analysing water samples using cutting edge genetic sequencing technology. There is potential for learning from this project to be applied to other forms of sampling
* **Nightwatch** – JNCC is sponsoring the new community science project coordinated by BCT that uses cutting-edge ‘AudioMoth’ listening technology to discover the hidden world of night-time wildlife
* **MyBackYard** – NE sponsored MMU in 21/22 to develop and trial a community survey by urban residents in Greater Manchester to record greenspace details about their properties (yards and gardens)
* **Urban pollinator survey** - JNCC is sponsoring UKCEH to investigate possible methods for an urban monitoring campaign

In addition, research into future development of community science for NCEA has been outlined by Pocock (2021) [2]. A number of key elements have been identified to consider when developing new community science e.g.

* What is the purpose of community science for NCEA?
* How can community science be more inclusive?
* To be strategic about the science within NCEA
* Make actionable, precision, multiscale, personalised and customisable tools

Development of the comprehensive Community Science Urban Monitoring Framework should consider first how existing schemes can meet needs and the practicalities of their adoption/integration. Development of new tools should only be recommended where there are clear unmet needs that justify the investment required.

It is also important that recommended protocols have associated/supported data flows alongside them, so the data is stored and fulfils a useful purpose (and can be extracted back out in relevant ways). Or, if elements of the data flow aren't supported, how and where are developments needed to improve the data cycle.

Consideration should be given to how and when selected tools and methodologies should be deployed. A comprehensive strategy should be able to optimise effort by deploying different sets of tools and methodologies as appropriate to circumstances: geographical; participant ability and capacity; specific local needs etc. The overall methodology should consist of compatible survey units that can stand alone or as plug-ins/extensions.

**Project output:** An assimilation of research into existing tools and methodologies that support community science in the urban environment, their uses and limitations, their availability for deployment, data flows and examples/case studies of practical implementation of multiple tools. This should be delivered in detailed form as a spreadsheet (excluding case studies) and in summary form in the final report.

1. **Create Framework Visualisation** *Draw together all existing research on frameworks [3] to propose a framework for monitoring urban biodiversity and natural capital in England using community science approaches.*

A framework in this context goes beyond simply a set of survey methods and tools. It will describe a holistic approach to allow more comprehensive and structured study of nature & the environment across England. It will capture the bigger picture of the monitoring landscape describing: the inflows and outflows of survey methods, tools and data; what is currently available and what is missing; the relationships and needs of stakeholders. It will also capture the infrastructure needs to bring this all together and create a system that enables effective data mobilisation and effective partnership working to deliver a joined-up efficient means for generating the evidence to support nature’s recovery and the delivery of natural capital needs.

There is currently research being conducted into urban community science monitoring frameworks by NCEA partners at JNCC and liaison with the project lead will help inform this objective.

**Project output:** A visualisation of a model for urban monitoring that is clear, visually appealing and easy for multiple stakeholders to understand how they can feed in or benefit from such a framework.

1. **Recommend a Roadmap for Implementation**

The route to delivery and management of a comprehensive Community Science Urban Monitoring Framework should be specified. The roadmap should detail:

* Structure
* Management/coordination needs
* Specific survey options
* Data management
* Communication, engagement and evaluation strategies

A method for trialling the framework should be proposed which should allow for sufficient testing of the concept as well as a plan for the evaluation of the value and usefulness of a survey framework. This may have a limited geographical focus e.g., one or more cities, but include a clear design and plan for scalability.

**Project output:** a) A proposed roadmap for delivery and management. This forms a key part of the project output and should be detailed in the project report.

**It will: Inform effort targeting**

Comprehensive CS monitoring strategy development should consider survey effort targeting in the design. Design should aim to achieve scientific outcomes and sampling may be deliberately stratified or truly random but with CS may also be subject to additional influences driven by, for example, surveyor availability. Compatibility with other programmes and the need for scientific rigour may favour well defined sample areas. In a CS context then, effort targeting will be closely linked to participant recruitment targeting and consequently affected by a number of factors including:

* Demographics
* Communications and engagement
* Training

To ensure sufficient rigour, a comprehensive CS monitoring roadmap will need to identify and adopt best practice in participant engagement and management, and this should form a key part of the survey specification. Impact and mitigation of short- or longer-term local failure (of e.g., participation) should be considered in design. The use of complementary contracted survey should be considered.

**Project output:** b) a working definition of urban areas for the purposes of this project; c) proposals for initial effort targeting; and d) proposed strategies to maintain useful targeting recognising the limitations of community science.

**It will: Identify common outputs and their collective usefulness**

Outputs and products will reflect identified data needs e.g., feed into and enhance existing datasets but should also produce stand-alone urban data of identified value. With a focus on long-term monitoring, the future development of these products should be considered.

Consideration should also be given to products targeted at the community scientists at the heart of the programme (feedback mechanisms) and these should provide further context, linking individual elements of the programme to the overall survey. What is the overall value and collective usefulness of the survey framework?

**Project output:** e) Identified urban monitoring products linked to data needs, stakeholder needs, policies, programmes, methodologies and design elements they are related to. This should be delivered in summarised form as a spreadsheet and in detail in the final report.