i-TREE ECO SAMPLE-PLOT PROJECTS

A Guide to Planning, Designing, and Delivering a Sample-Plot Project

PREPARED BY TREECONOMICS & FOREST RESEARCH

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Overview

This guide has been designed to to facilitate an increase in i-Tree Eco projects across the United Kingdom by enabling Project Leaders to conduct their own, through the provision of guidance, support and experience. Timescales, considerations and suggested equipment for the planning and preparation of projects are detailed throughout.

There are different options to consider when designing your project. In order to make best use of this guide and not overcomplicate the process, we will work to a 'typical' i-Tree Eco sample-plot project template. We will demonstrate where alternative options could be considered, and provide links to helpful resources or examples.

Trees provide a wide range of benefits to people and the environment. Our urban forest encompasses all the trees in the urban realm – in public and private spaces, along linear routes and waterways, and in amenity areas. It contributes to green infrastructure and the wider urban ecosystem'[8].

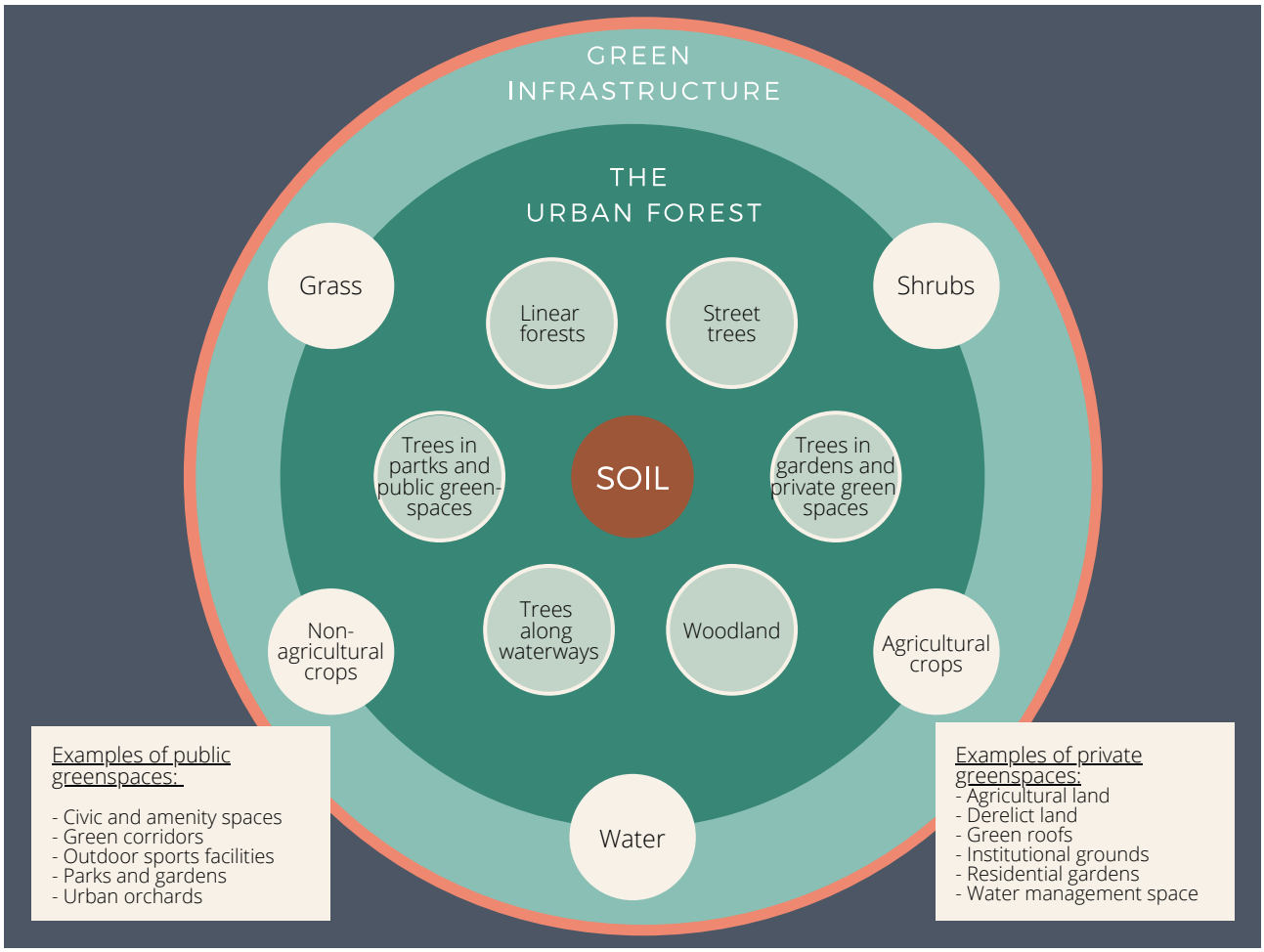

Figure 1: The Urban Forest

Now, more than ever, towns and cities are looking to understand more about their tree populations, and answer questions such as:

- How many trees do we have?
- How many trees are privately owned? And how many are publicly owned?
- Which species of tree do we already have?
- What age are our trees? Do we have more young trees than mature trees?
- How healthy are our trees? Do we have any concerns regarding pests and diseases?

When deciding whether this project approach is right for you, it's important to understand the reason for choosing this approach, and the expected outcomes. In order to understand the value of your current tree stock, a tool called i-Tree Eco can be used. '*i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools*'. The i-Tree Eco Tool [referred to as 'Eco' throughout], is one of a suite of tools and is designed to use data collected in the field along with local hourly air pollution and meteorological data to quantify the structure, environmental effects, and value of an urban forest. Eco calculates a wide range of values using field data including pollution removal, carbon sequestration, carbon storage and avoided runoff. These variables can be valued using UK relevant costs detailed by The Government.

To run an Eco project, we need to provide field data for the area you have chosen to study. This can be either a full inventory of trees (where all trees are included) or sample-plot (where only trees within specified plots are included). This guide will assist you in using a sample-plot methodology to collect your field data. This approach is often used where it would not be realistic or practical to survey each individual tree, such as when the study area encompasses a whole town, city, or county. As part of the process you collect data from a number of randomly distributed plots throughout your study area, rather than collect data for each individual tree[1].

I. Project Planning

Sample-plot projects tend to span a 12 month period of time, and involve a great deal of preparation. A project planner will help to ensure that each stage of the process is completed in good time to allow successful collection of field data. Included below is a generic project planner which is intended to provide guidance on how long each stage of the project is likely to take.

Generally speaking, it would be recommended that you start your project as close to January as you are able, to allow plenty of time for project design, recruitment of surveyors, sourcing of equipment and providing training. Consider particularly costs or events which should be booked in advance as these will need allocated preparation time. You will want to start field data collection with your surveyors as early in spring (when leaves are fully out) as possible. Surveying often takes longer than you might expect, and starting early will allow time for any complications or re-surveying you may choose to do. Surveying will need to be complete by Autumn, as once the leaves begin fall it becomes increasingly more challenging to identify

[1] i-Tree Tools, 2020

trees and assess their condition. Reporting can then take place during the following winter months.

Use the attached project planner as a helpful guide. Once you have a more clear idea of what you will need to prepare, and organise, you can redraft to reflect your timescales more accurately.

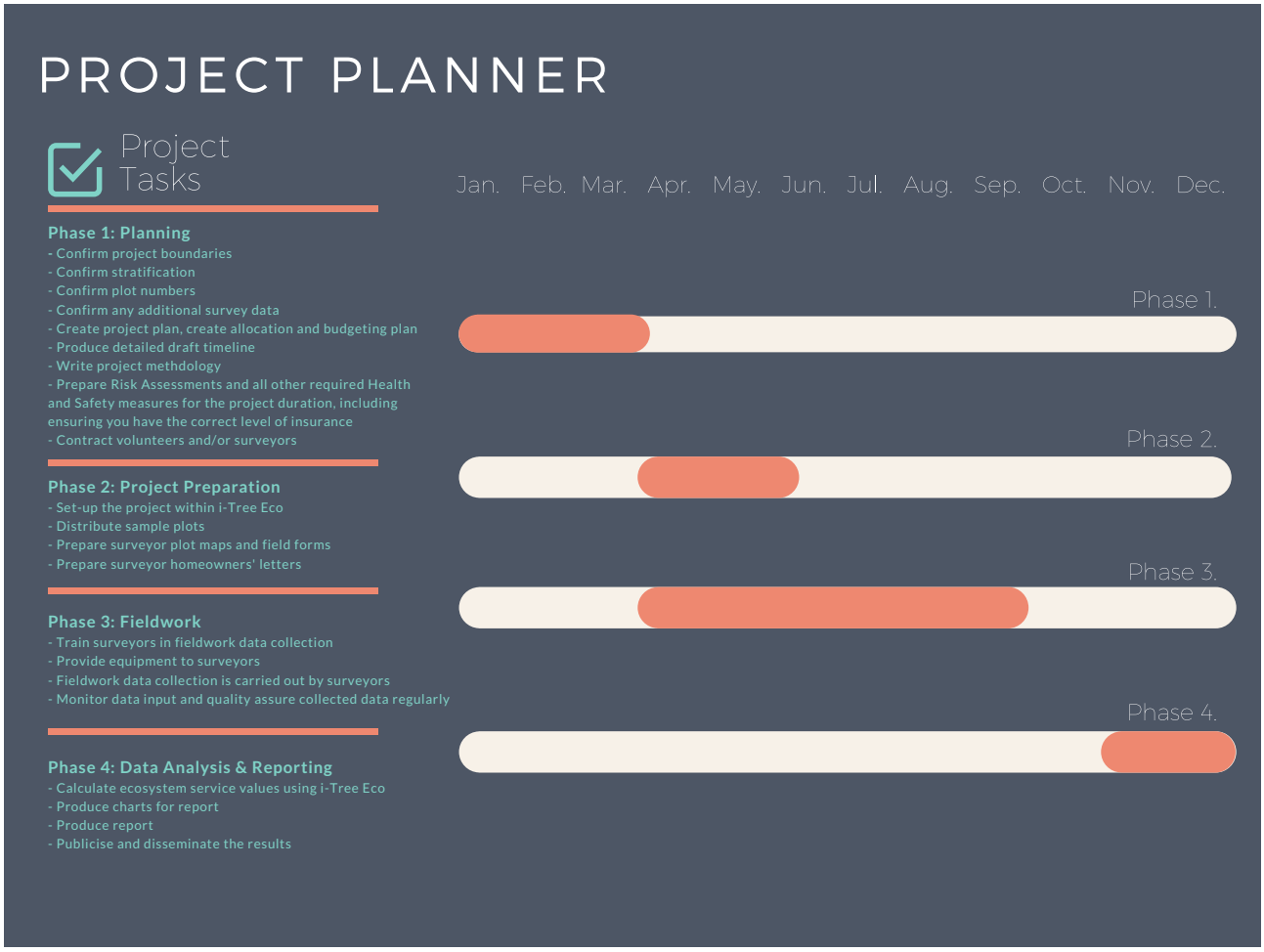

Figure 2: Project Planner

II. Designing an Eco Sample Project

At the beginning of your project it's important to gain a clear understanding of what you are hoping to achieve from the study. It's a good opportunity to get together and look at examples of previous projects, to really understand what can be achieved, and perhaps consider any limitations or challenges. Later in this guide we will provide a few examples and explore how they designed their study, and why.

Define the area of study

You will need to decide upon the boundary. It might be that you are interested in the urban, 'built up' areas, or perhaps you will want to include some of the wider rural boundary. This decision should be informed by the outcomes you identified earlier, and it's important to be clear about what you decide as this will form the foundations of your project.

What data will you collect?

Table 1 (below) shows the standard list of data collected for Eco projects within the UK and some additional data variables you may wish to consider. There are pro's and con's to additional data collection, it will take more time to survey each plot, but if the information will be of use to your project it may be worthwhile.

Standard Eco Survey Data Variable	Descriptions	Possible additional data collection
Plot Details		
Tree cover (%)	The percentage of the plot which is covered by tree canopy.	Plot address
Shrub cover (%)	The percentage of the plot which is covered by shrubs.	Map coordinates
Plantable space (%)	The amount of the plot area that is plantable for trees (i.e., plantable soil that is not under tree canopy or other overhead restrictions and where tree planting/establishment would not be prohibited due to land use, such as footpath, sports field, etc.). Planting underneath utility wires is permitted. Project managers should clearly define what counts as plantable space during crew training for consistency within a project	Reference objects
Land use (%)	The percentage of the plot each land use type covers. Land use types include; agricultural, cemetery, commercial/industrial, golf course, institutional, multi-family residential, park, residential, transportation, utility, vacant, water/wetland, other.	Public/privately owned
Ground cover (%)	The percentage of the plot each ground cover type covers. Ground cover types include; building, cement, tar, rock, other impervious, bare soil, mulch, unmaintained grass, grass, herbs, water	Public/privately managed
Shrub Details Shrubs are treated as 'blocks' within i-Tree.		
Species	Record the most dominant species within the 'block'.	
Height	Record the height of the tallest section of the shrub 'block'.	
Percent area (%)	Record the amount of total shrub area that each block represents.	
Percent missing (%)	If we imagine the 'block' was a perfect cuboid shape, how much of the cuboid is currently 'missing'.	
Tree Details Trees are all measured and recorded individually		
Species	Tree species. If species level identification is not possible, it would be recommended that you record to genus level.	Distance and direction from plot centre
Diameter at Breast Height (DBH)	The diameter of the trunk. This measurement is taken at breast height (1.5m height).	Street tree/ non-street tree
Height	The straight line vertical distance between the ground and the highest point of the crown.	Crown Health - Percent Dieback

Standard Eco Survey Data Variable	Descriptions	Possible additional data collection
Height to live top (of crown)	The height to the top of the live canopy, this height excludes any dead branches at the top.	Observation of pests or disease
Height to crown base	The height to the lowest section of the canopy, this is defined as the lowest significant branch.	Maintenance recommendations
Crown Width	The width of the crown, taken as two measurements, in the North-South and East-West directions, if accessible.	Distance and direction to buildings
Percent crown missing (%)	When imagined as a perfect crown for the species, this is the percentage which appears to be missing.	
Land use	The land use type on which the tree is located.	
Status (ingrown or planted)	This determines whether the tree was planted or whether it has self-seeded, in urban areas this is most common for species like sycamore.	
Shrub cover under canopy	The percentage of the canopy area which is covered by shrubs on the ground.	
Impervious ground cover under canopy	The percentage of the canopy area which is covered by impervious surfaces.	
Crown Health - Percent Condition (Good)	The percentage of the canopy which is in good condition.	
Crown light exposure	The number of sides of light the tree receives, this is stored between 0-5.	
Life expectancy	An estimation of life expectancy within the following categories; 0-5, 5-10, 10-20, 20-40, 40-80, 80+	

Table 1: Data Collection Variables

Sample plots

- Circular in shape
- Area of 0.1 acres (0.04 ha)
- Radius of 11.3m

There are situations where larger or smaller plots may be considered, for example Highways England Area 1 and Area 2 involved surveying trees along road verges. The standard plot dimensions would be too large and so smaller plots were defined for this study.

The standard number of plots for an Eco study is 200. Some projects have opted for more plots based on factors such as the study area size, variability and budget. To understand a little more about how these decisions were made, see the project example section later in this guide.

In terms of plot distribution, the standard approach is to distribute the 200 plots randomly within your boundary. An example of this type of distribution can be seen in Figure 2 (below). This can be done using Geographical Information Systems (GIS) software and through this process you will be able to export x-y coordinates, or a What3Words reference for each plot.

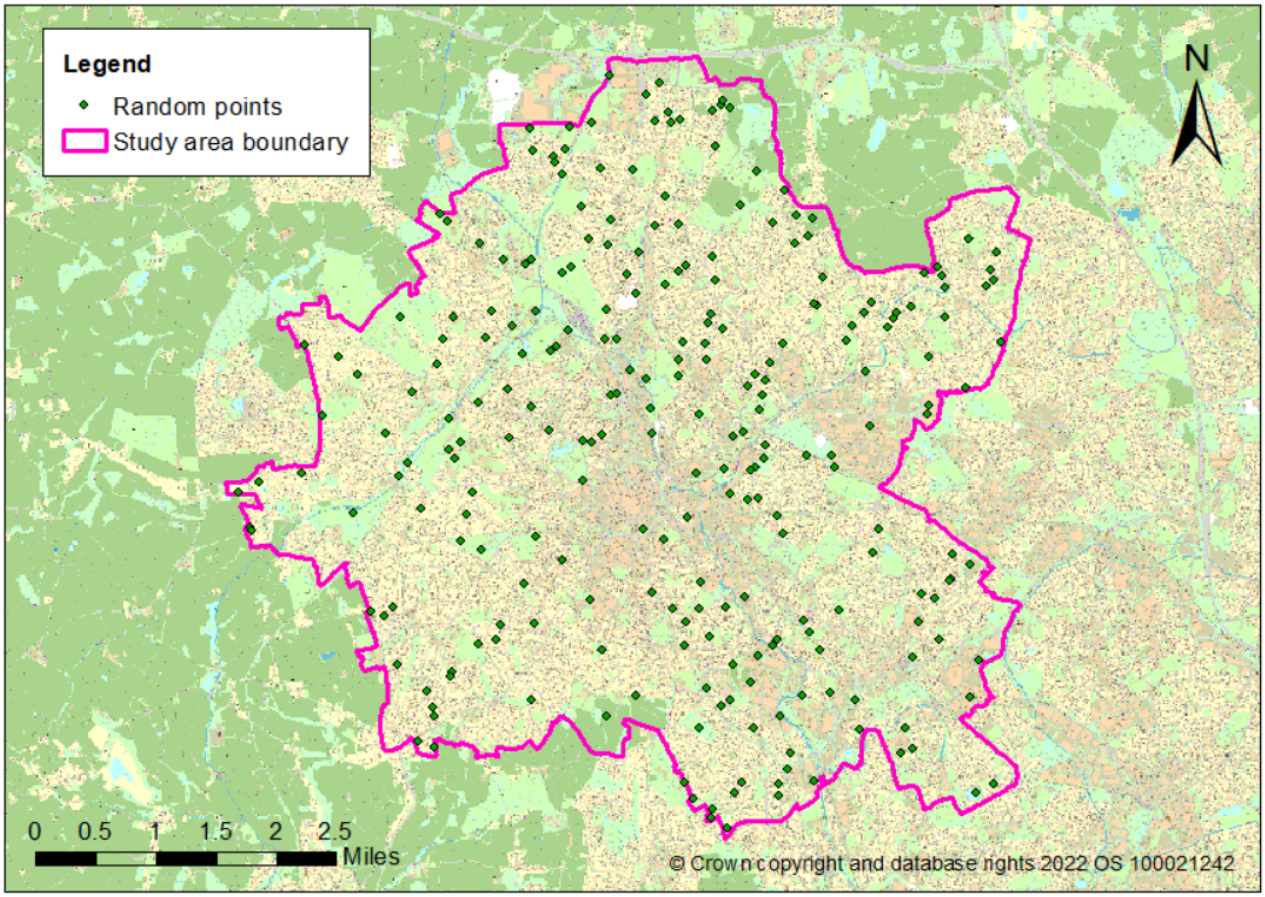

Figure 3: Random Sample Plot Distribution

It can also be useful to grid the area and distribute the plots randomly within each grid square. Using a grid will help to avoid clustering of some points as seen in Figure 3 (above). An example of using a grid to distribute plots can be seen in Figure 4 (below).

There is the option to stratify your project. Stratifying any project will require a larger number of plots, and will likely involve more surveying time. It can be very useful to stratify if you wish to compare for example, urban areas with the wider rural boundary, or perhaps for comparisons at ward level.

Consultants at Treeconomics and Forest Research offer plot distribution using GIS as a service, get in touch for more information: info@treeconomics.co.uk or kieron.doick@forestresearch.gov.uk.

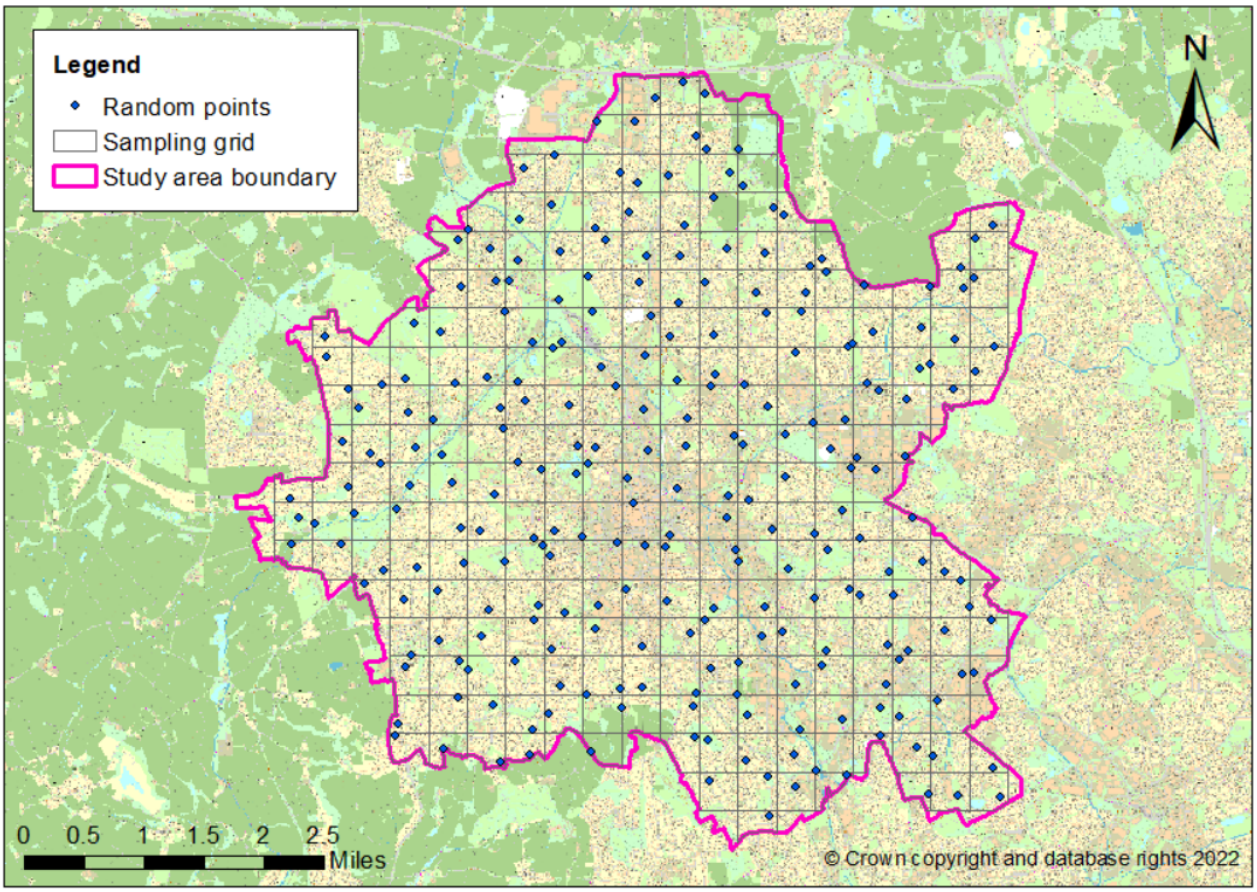

Figure 4: Grid Sample Plot Distribution

Who will collect the data?

An Eco project is a wonderful opportunity to up-skill and engage with local community groups and volunteers for data collection. Some projects (where budget allows) also recruit professional tree contractors to survey some or all of the plots. We will refer to volunteers and contractors as 'Surveyors' throughout this guide. Your surveyors will need some simple equipment and training in how to collect the data.

Equipment;

- DBH Tape
- Surveyors Tape (30m length)
- Clinometer - MK1 clinometers are a good option for beginners, alternatively there are apps which also can be used to measure tree height, see Table 2 (below).
- Tree ID book

You will need to train your surveyors in collecting field data for your project. The 'i-Tree Eco v6.0 Field Manual' is a helpful written guide in collecting field data, follow this link to access the manual: https://www.itreetools.org/documents/274/EcoV6.FieldManual.2021.10.06.pdf. Additionally, this video[2] provides step-by-step visual demonstrations of the surveying process.

Begin to schedule key activities and tasks

At this stage, before starting, take the project planner (Figure 4, above) and amend to suit your project, your timescales, and also consider costs or events which may need booking in advance as these will need allocated preparation time. As discussed earlier, generally Eco projects span a full year, starting with the planning phase in January, the surveying taking place during summer, and reporting over the winter.

Contact and engage chosen surveyor group

It's a good idea to engage with your surveyor groups as early in the process as possible, this allows time to learn about the project, to get to know the project team, wider surveyor group, plan for surveying during the summer, and to ensure they are available to attend training. It's important to scope out people's availability and engage a good number of volunteer surveyors. Usually for a standard 200 plot Eco project, 20-30 volunteer surveyors is a good number. This allows for a few people who may decide to not continue, or have restricted time available to support, but it's not too many people that the group becomes more difficult to manage.

Organise training for surveyors

Watching the surveying video[2] in preparation or during the training will help you to visualise the techniques described in the 'i-Tree Eco v6.0 Field Manual'. You will want to choose a venue which has access to some outside space with trees to practice the techniques. You may choose to deliver your training entirely outdoors (weather permitting) and there can be benefits to this, or perhaps you would prefer to recruit an experienced consultant to deliver the training on your behalf, in which case usually an indoor space with projector and facilities would be good.

Organise equipment (if required)

Earlier we listed the suggested equipment, there are some options which enable the surveyors to carry out surveys using typical household items. It is better to use the listed equipment if budget is available, however, if there is no budget, it is still possible to conduct your survey. Table 2 (below) lists the equipment and also the alternatives you may wish to consider.

[2] https://www.treeconomics.co.uk/resources/recordings/

Equipment	Used For	Alternatives if equipment not purchased	Cost	Where to Buy
DBH Tape	Measuring the trunk Diameter	A standard measuring tape or measured string, this will give you the circumference, it will need to be converted into a diameter measurement (Diameter = Circumference / 3.142)	£17.00 per tape	Invicta
MK1 Clinomteter	Measuring the height of the tree	There are a few Apps such as Arboreal and Trees which allow up to 10 free measurements and are super simple to use - between a pair this would be 20 trees.	£10.00 per clinometer	Invicta
ID Book	Identifying trees and shrubs	Apps are available but it can be a nice incentive for taking part. Collins is a wonderful book but cheaper alternatives are available.	Collins £14.69 DK £5.99	Amazon/ book shops/ garden centres
30m Surveyors Tape	Used to mark out the plot and measure crown dimensions	Use long pre-measured string or ask vols to know their stride and pace the distances.	£5.87	Amazon
High Visibility Vest	Visibility	You may have some of these which could be lent to surveyors, or these may be purchased and given to the volunteers as an incentive for taking part. You may even like to have them branded with the project logo.	£3.38	Amazon

Table 2: Volunteer Equipment Options

Set up the project in Eco

When setting up a new project we will want to have downloaded the most up-to-date version of Eco from i-Tree Tools[3]. To create the project we need to press 'File' > 'New Project'- select 'Plot Sample' from the drop down list. Name and save your project on your computer and follow the steps in the flowchart below.

Set-up field data collection

During the project set-up process above you have the option to set up mobile data collection for your surveyor team. This means they can upload their data using a smartphone or tablet, and you can import this data directly into the project.

You can also choose to not use this option, and collect the data using paper field forms and input the data manually.

There are pro's and con's to both options, you can find more information in the 'i-Tree Eco v6.0 Field Manual'. You will also need to complete a final thorough review of all the data once all the plots are completed.

Train surveyors and launch fieldwork stage

It's important to start surveying as early as possible in the year to maximise your time. Surveying takes places during the leaf-on season, as the leaves are used to identify trees, assess condition and measure crown dimensions.

[3] https://www.itreetools.org

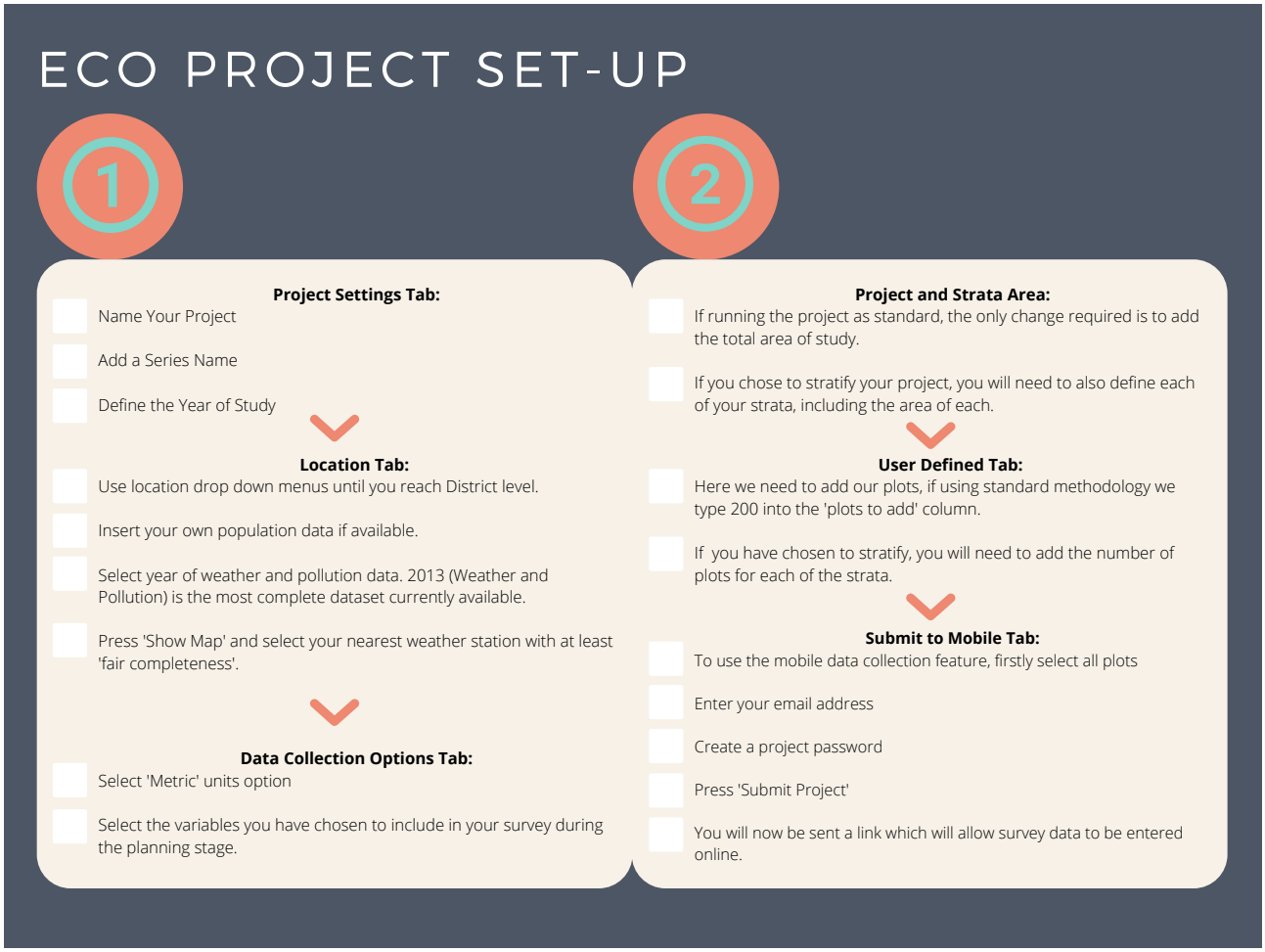

Figure 5: Project Set-Up Checklist

It often takes longer than you expect to complete your surveys, and often surveyors will need to balance their time on the project with other commitments.

It would be recommended that you have everything in place so that surveyor training takes place between May and early June, surveying would then start immediately after the training session.

Health and safety requirements vary with each project, therefore this guide does not seek to provide health and safety guidelines, and the project lead will need to seek advice from their own Health and Safety or Human Resources teams to produce their own processes. As a minimum, we would expect risk assessments to consider: adequate insurance, first aid, risks associated with working in public spaces, surveying trees, weather conditions, equipment, and be tailored to the particular locality of the project.

III. Project Design Examples

Project Name: Valuing Newport's Urban Trees
Area of Study: 4,854 ha
Estimated Canopy Cover: 12%
No. Of Plots: 201
Plot Density: 1 plot per 24 ha
Distribution Method: Sample grid with randomised plots, one per grid cell
Stratification Method: Unstratified
Surveyors: Forest Research, Technical Services Unit
Reasons or notes as to why the above were chosen specifically for this project:
The primary aim of this project was to gather a baseline understanding of Newport's urban forest, including species mix, size, and distribution across land uses. Therefore a simple approach was used, without stratification, and seeking to ensure comprehensive spatial coverage.

Project Name: Valuing Urban Trees in Cardiff
Area of Study: 14,064 ha
Estimated Canopy Cover: 19%
No. Of Plots: 203
Plot Density: 1 plot per 71 ha
Distribution Method: Random Sample
Stratification Method: Unstratified
Surveyors: Forest Research, Technical Services Unit
Reasons or notes as to why the above were chosen specifically for this project:

Project Name: Valuing Belfast's Urban Forest
Area of Study: Urban strata: 9,209.59 ha; Rural strata: 4,126.84 ha
Estimated Canopy Cover: 23%
No. Of Plots: 300
Distribution Method: Random Grid Sample
Stratification Method: Urban : Rural Stratification
Surveyors: Contractors and Volunteers
Reasons or notes as to why the above were chosen specifically for this project:
Stratifying the study area into urban and rural enables reporting on these two strata separately, and furthermore for decisions to be made strategically, which are appropriate to the characteristics of their urban and rural areas individually.

Project Name: Urban Forest 1066, Rother District Council
Area of Study: Urban strata: 1,311.31 ha; Rural strata: 1,554.93 ha; Countryside Park strata: 581.75 ha
Estimated Canopy Cover: 22%
No. Of Plots: 300
Distribution Method: Random Grid Sample
Stratification Method: Urban : Rural : Countryside Park Stratification
Surveyors: Volunteers
Reasons or notes as to why the above were chosen specifically for this project: The data from this Eco project was to be used to inform the new Local Plan. Given the unique challenges of coastal urban areas, it was essential that the data could be reported as a whole for the total area, but also broken down into the major land-use types, rural, urban and the countryside park.

IV. Project Data Collection

Please refer to the 'i-Tree Eco v6.0 Field Manual' for a breakdown of the field data collection process.

V. Data Analysis and Reporting

Once you have run your project, the results will be available to download in PDF/spreadsheet format. Eco is developed in the US and so you will need to do some calculations to translate the values using appropriate UK sources.

- The Government's Department for Business, Energy & Industrial Strategy (BIES)[4] provide guidance on the valuation of carbon within the United Kingdom.
- The Government's Department for Environment, Food & Rural Affairs[5] provide guidance of the valuation and damage cost of air pollutants.
- Water treatment companies in your local area will be able to provide you with a cost for the avoided cost of surface water treatment.

Our consultants at Treeconomics and Forest Research would be happy to support you through this stage of your project. Get in touch for information about our costs and turnaround times: info@treeconomics.co.uk kieron.doick@forestresearch.gov.uk

There are a number of example reports which we have produced for Local Authorities, follow the link to the Treeconomics[6] and Forest Research[7] websites to download.

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[4] https://www.gov.uk/government/collections/carbon-valuation

[5] https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance

[6] https://www.treeconomics.co.uk/resources/reports/

[7] https://www.forestresearch.gov.uk/research/i-tree-eco/i-tree-eco-projects-completed/

VI. Key Definitions

Diameter at Breast Height	This is a measurement taken during the survey process. A DBH tape is wrapped around the trunk of the tree at breast height, which is 1.5m in height. The DBH tape has scaled measurements which allows the surveyor to read the diameter directly from the tape, rather than needing to convert circumference to diameter.
Ecosystem services	refers to the benefits which trees provide to the surrounding environment and people. This includes a range of benefits, from urban cooling to amenity value. In this report, the ecosystem services which can be measured include carbon storage and sequestration, pollution removal and avoided surface run-off.
i-Tree	'*i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools*'[8].
i-Tree Eco	The i-Tree Eco Tool [referred to as 'Eco' throughout], is one of a suite of tools, is a software application designed to use data collected in the field along with local hourly air pollution and meteorological data to quantify the structure, environmental effects, and value of an urban forest.
Urban Forest	All the trees in the urban realm – in public and private spaces, along linear routes and waterways, and in amenity areas. It contributes to green infrastructure and the wider urban ecosystem'[8].

Table 3: Key Definitions

[8] Forestry Commission Research Report 26, https://www.forestresearch.gov.uk/documents/1038/FCRP026.pdf

[9] www.itreetools.org

Helpful Resources:

i-Tree Tools - Eco Full User Manual:
https://www.itreetools.org/documents/275/EcoV6_UsersManual.2021.09.22.pdf

i-Tree Tools - Eco Full Field Manual:
https://www.itreetools.org/documents/274/EcoV6.FieldManual.2021.10.06.pdf

Treeconomics - Webinar Recording - Webinar 4: Achieving Urban Forest Ambitions:
https://www.treeconomics.co.uk/resources/recordings/

Trees and Design Action Group (TDAG) - First Steps in Valuing Trees and Green Infrastructure:
https://www.tdag.org.uk/first-steps-in-valuing.html