THE BLEAN WILDSCAPE

BLEAN LANDSCAPE MONITORING

A Scoping Exercise

Digital Ecology 2024

REPORT PREPARED BY
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Kent Wildlife Trust

REWILDING BRITAIN

Digital Ecology

Executive Summary

This document provides an assessment of the available digital technologies to support monitoring biodiversity. It provides and overview and assessment of six different technologies, including the availability of data, tools and equipment. The report also indicates which methods are suitable for collecting data for the indicators selected by the Wilder Blean project to demonstrate change is being delivered. Finally the recommendations for a monitoring scheme are set out alongside an indication of the annual cost of each approach.

KEY FINDINGS

- The chosen indicators for the projects are: habitat diversity, condition and connectivity; grazing impacts on vegetation structure, soil health and ecosystem service delivery; and species diversity and abundance and population health.
- Technologies considered are earth observation (satellite) data, UAV imagery, laser scanning, bioacoustics, eDNA, and image capture (cameras).
- The technologies explored can collect appropriate data for all of the chosen indicators.
- Additional field survey approaches will fill gaps in digital data collection, as well as meet regulatory requirements. Some field based approaches are more cost effective than pure technological approaches.
- The recommended technologies are earth observation data, UAV surveys, bioacoustics and eDNA, supplemented by field based habitat surveys and condition assessments.
- Good monitoring design is key to collecting data that are appropriate and sufficient to meet the needs of the project and the Wilder Blean project team should work with ecologists to design such a scheme.

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INTRODUCTION

1.1 Scope

Kent Wildlife Trust (KWT) have commissioned Digital Ecology to produce a Monitoring Scoping Report for the Blean landscape. This report will identify approaches to monitoring biodiversity, providing a summary of various monitoring techniques with a focus on digital and remote sensing.

1.2 Background

KWT has received funding from the Rewilding Challenge Fund, to contribute to the development of a landscape scale monitoring plan for the Wilder Blean project and the wider Blean Landscape. The Blean landscape covers an area of approximately 10,000 – 12,000 hectares in the south east of England.

The Wilder Blean project involves the use of European Bison, which were introduced in July 2022, to create a sustainable approach to woodland management. The Bison act as 'ecosystem engineers' and help to create a mosaic of habitats which contribute to species rich woodlands. The project also involves a variety of other grazing animals, such as pigs and ponies, which will create an even greater diversity of habitats and species through variation in grazing regimes. Monitoring the changes in habitat complexity and thus biodiversity will need a large scale monitoring scheme which employs a variety of monitoring techniques.

KWT wishes to focus on 3 main areas:

- Habitat diversity and connectivity (e.g. how is the type and condition of habitat changing to improve habitat connectivity and diversity)
- Grazing impacts (e.g. are wilder grazing approaches providing ecosystem functions and services)
- Species diversity and abundance

1.3 Experience

Digital Ecology has a wide range of experience of embedding digital technologies into ecology. We have worked with KWT's consultancy, Adonis Blue Environmental Consultants (ABEC) to support their ecologists to use digital technology, including the use of bioacoustics and eDNA in survey work. We have also carried out acoustic surveys for winter birds and made wide use of earth observation data for habitat mapping and other habitat data analyses. We have used habitat data to measure and analyse patterns of habitat fragmentation as part of work with Havant Borough Council with our partners, Ethos Environmental Planning.

Digital Ecology's parent company, Map Impact Limited, are earth observation data experts. They produce products and services for a wide range of international clients, including habitat mapping and analysis. As such our combined expertise in the use of digital technology in environmental and biodiversity monitoring is considerable.

Monitoring Techniques

There are an increasing array of digital technologies available to support biodiversity monitoring. However, it is important to ensure that the right technology is deployed for the right outcome. Not all technologies measure biodiversity in the same way, with some having very narrow applications, while others have broad, but low resolution applications. The challenge therefore is to mix the technologies to ensure that data are collected to support monitoring outcomes. While technology can provide data collection at scale, there are many aspects of biodiversity that cannot be captured through technology. It is therefore important to identify those metrics or aspects where technology does not yet have a solution and to fall back on tried and trusted methods of surveying carried out by qualified ecologists. In this section we review the different technologies available to the Wilder Blean project, detailing the pros and cons of each, with respect to the monitoring aims of the project, and provide an indication of cost where available. We also highlight gaps in technology and suggest where more traditional ecological surveys might be needed to fill those gaps.

EARTH OBSERVATION DATA

Overview

Earth observation data uses satellite imagery to capture a comprehensive view of the earth's surface and how it is changing. A huge number of satellites orbit the earth every day taking images of the surface. Combined these images can provide a composite understanding of the land cover and land use and how it is changing. For biodiversity monitoring these images can provide regularly updated information on habitats and land use over a wide area and more regularly than can be obtained purely through ground surveys. Earth observation data and satellite imagery do require a great deal of processing and analysis to obtain meaningful information for ecologists and conservation managers. There are a range of open source tools to help with this, but to create habitat maps from the imagery requires someone with skills in geospatial analysis.

Tools

Within QGIS, the free open source GIS software, there is the Sentinel Hub plugin that enables you to add satellite data to your QGIS projects. The plugin is made by the Copernicus organisation and allows users to bring Sentinel satellite data into QGIS. This is a very user friendly tool for viewing satellite imagery, requiring a free account with Copernicus. However, this tool only provides access to imagery; it does not facilitate analysis. To create land cover or habitat maps, or derive other indices from the imagery, requires additional tools and knowledge.

The tools to create habitat maps and derive indices (such as NDVI vegetation health index) are also available in QGIS.

Within the programming language R, there are a range of tools for accessing and analysing satellite data. The CRAN Task View for spatial lists a huge number of packages (libraries) for accessing, managing and analysing spatial data. For satellite data, the packages mapme.landcover and mapme.biodiversity from the MAPME initiative provides access to Sentinel2, MODIS and LandSat data and biodiversity indices. This suite of tools allows a user to access imagery and carry out a range of analyses relevant to nature conservation. Of relevance to the Wilder Blean project is the landscapemetrics package, which allows users to calculate habitat connectivity metrics (among others) using raster data (such as satellite or UAV imagery).

While there are a range of open source tools available, the use of these requires an experienced analyst to access, analyse and interpret satellite data. It therefore requires a significant investment in time and resources to carry out monitoring in this way.

Data
There are a range of habitat data products that are available that are derived from satellite data. The following section details some of these products.

Natural England's Living England data is satellite derived habitat and land use data. The latest version, phase 4, was released in 2024 and it is free to use. A previous version from 2022-2023 is also available. Our assessment of the Living England data is that while promising, it has a low accuracy of habitat type identification and lacks spatial correlation with habitats on the ground. Many habitats are misidentified and the segmentation (the process of defining contiguous habitat parcels) bear little resemblance to actual habitats on the ground. It is also not clear whether these data will be updated annually and therefore whether it can be used for monitoring.

UK Centre for Ecology and Hydrology produces Land Cover Map. This is an annually updated, satellite derived land cover map for the UK. UKCEH have been producing these data annually and consistently since 2015 and have a refined method for doing so. Land Cover Map uses BAP habitat types in its classification system and has a resolution of 25 metres per pixel and a vector data set which identifies land parcels.

Our assessment of these data is that habitat identification is generally very good, but there are issues in agricultural landscapes where land uses can be particularly heterogeneous. However, generally speaking these data can be used for monitoring habitat change.

Map Impact produce a product call BiodiversityView. These data use best available habitat data to create a comprehensive habitat map for Scotland Wales and England. These data combined UKCEH land cover data with other sources of land use and habitat data. In addition their approach uses satellite data to assign habitat condition to each habitat parcel. The BiodiversityView data have the advantage of the UK wider coverage of the UKCEH data, with specific habitat data, providing a more detailed understanding of habitats across the UK. Data are available for 2023 and 2024, and will be updated annually, making them suitable for monitoring habitat and condition change.

Pros and Cons

Satellites operate in a fixed orbit, allowing them to capture imagery consistently and at regular intervals. Images can be taken of vast areas, including remote and inaccessible regions, providing a comprehensive view of the Earth's surface. This means that data are standardised and repeatable, which is essential for monitoring change across both space and time.

However, imagery is often obscured by clouds and requires the piecing together of imagery from cloud-free days. In very cloudy years, there can be a significant gap between images, which may skew certain metrics.

Any land cover or land use data set derived from satellite imagery does require groundtruthing or local knowledge to ensure accuracy. This is especially true for regional or national scales where algorithms cannot differentiate certain types of habitats on the ground. Therefore field survey is recommended to support imagery analysis to ensure good quality outputs.

Earth observation data can also be expensive, especially when opting for more high resolution images. There are free to access data from Sentinel2, but if higher resolution imagery is required for a project this can add considerable cost.

UNMANNED AERIAL VEHICLES / DRONES

Overview

Unmanned Aerial Vehicles (UAVs), or drones, can be used to collect imagery, using a relatively small remote controlled aircraft that can carry a recording device for imagery or video. Drones are relatively inexpensive and are increasingly versatile in collecting imagery for conservation purposes.

Drones have been used to collect imagery for habitat mapping and vegetation assessment, as well as surveying for species, for example ground nesting birds, large mammals and even reptiles using thermal cameras.

Drones can carry a range of sensors, from RGB colour sensors, to infrared, thermal and for larger drones LiDAR. This flexibility means that drones can return several types of data, sometimes from the same flight.

The operation of UAVs, especially by commercial organisations, does require appropriate training, certification, licences and insurance. These can become quite expensive but there are a number of commercial drone operators in the UK, many of which specialise in biodiversity and nature conservation applications.

Data

Drones can carry a range of sensors. Typically drones come with a colour camera preinstalled, but there are some types of drones that can have different payloads installed for different purposes. Colour imagery is useful for interpreting and mapping habitats and land use; but it can also be used to generate a number of vegetation indices which can be used to analyse plant health or patterns of spatial heterogeneity. Cameras with infrared sensors expand the capabilities of UAVs, allowing further indices to be calculated, such as NDVI.

It is also possible to mount both thermal cameras and LiDAR on drones. Thermal cameras detect heat, which can be used to monitor species. Examples of thermal imaging include reptile monitoring, large mammal monitoring and nesting bird counts. LiDAR requires a large drone as LiDAR payloads can be quite heavy. However, LiDAR data can be used to determine the height of vegetation which facilitates the creation of canopy height maps for woodland monitoring. It should also be noted that LiDAR can be mounted on a backpack and used to measure the structure of woodlands and other more complex habitats.

Tools

UAV imagery requires post-processing to create products that can be further analysed. This main process creates an orthomosaic, where the different images captured by the sensor are stitched together into a single image. To do this requires a specific piece of software, of which the leading open source solution is OpenDroneMap (ODM) . ODM is available in different formats, with the simplest being a web interface that can be run on a cloud-hosted virtual machine. ODM does much more than orthomosaics and can create point cloud and 3D layers.

The outputs from ODM can be further visualised and analysed in QGIS and R, using the same libraries as described in the satellite data section above.

Equipment
The basic requirement is a drone. There are a huge range of commercially available airframes with a range of price. However, the key choice of airframe is the number and type of sensors that a user wishes to deploy. Larger vehicles are required for LiDAR, but as LiDAR is very expensive, generally it is better to use a smaller airframe that can accommodate one or two sensors. This also means it is easier to achieve the necessary licences and certificates for operating a drone commercially.

There are open source DIY drones which can be built using components. This has the advantage of being able to customise a drone to the users requirements. However, there is a requirement for electronics and programming knowledge to build these aircraft.

There are also a range of sensor providers, the cost for which can vary hugely. There is one manufacturer who produce low cost and adaptable cameras, which include infrared sensors, called Mapir. These cameras can be mounted on existing drones, providing a low cost way of collecting more than one type of data per flight

Pros and Cons

Drones are small, lightweight and can be transported easily. They are relatively easy to operate and can conduct semi-autonomous surveys. They collect standardized data that can be easily analysed in free open source software such as QGIS and R.

However drones can influence the behaviour of many bird and mammal species and disrupt natural behaviours. Privacy concerns also arise with the proliferation of drones equipped with high-resolution cameras and video recording capabilities. Drones can invade individuals' privacy by capturing images or videos without consent, leading to potential misuse of personal information.

Data capture by drones also depends on the battery life, and can be hindered by weather conditions. This can impact the standardization of data collection.

E DNA

Overview

Environmental DNA (eDNA) is DNA that is collected from the environment. eDNA can be collected from a range of environments, including water, soil and air, as well as from organisms themselves directly. This is an advantage where there is either a lack of necessary taxonomic expertise (such as for insects or fungi) or where taxa are difficult to survey via other methods. eDNA allows researchers to build up a far more detailed understanding of the species that live in an environment than would be possible relying solely on identifying species by sight.

The collection of eDNA can be carried out by ecologists using simple field equipment, using more traditional survey methods (especially for insects), or with a range of automated equipment. The approach taken depends on both the target environment and the target taxa, as well as the number and timing of surveys / samples.

Equipment

Equipment can range from simple scoops and buckets to more complex automated samplers. This depends on the environment and taxa. For water, simple equipment can be used to sample water, such as scoops, buckets and bags. Samples are stored in tubes before eDNA extraction and analysis. However, there are emerging technologies that can standardise and automate water sampling for eDNA extraction. A new company called BiotaTrace has designed a range of equipment for extracting water samples for eDNA extraction and analysis. It is also possible to mount sampling equipment on boats and aquatic drones to sample larger water bodies.

For insects, there are two main approaches. The first is to use standard field equipment, such as malaise traps, to collect insects, which are then preserved and samples sent to eDNA labs for extraction and identification. This approach allows the use of low cost equipment which can be located in appropriate positions for the field site. It is also possible to use a range of equipment to extract invertebrates, such as combining a range of trapping techniques to collect insects from a range of situations or in response to different behaviours. The second is to use an 'air sampling' approach. This entails a small device which draws in air and with it insects which are then filtered and preserved. This approach can be run autonomously, but like all insect approaches, it is selective, as well as having significant 'by-catch' of non-target organisms.

Soils can also be surveyed using eDNA, where soil samples are taken and preserved. Generally this targets the microbial community, but it is also possible to detect invertebrate species in soils. For any approach, eDNA needs to be subtracted from the sample and then analysed. This requires sending samples to a lab. The lab will extract, purify and amplify the eDNA, before sequencing it to compare it with libraries for different species. It should be noted that for each taxonomic group, different primers are required to ensure DNA can be identified to a species. So, for a water sample, if a user wanted both fish and invertebrate species, they would need to use twop different primers, meaning two analyses need to be performed. Each of these groups carries its own cost, so would double to cost per sample to extract data for two groups.

Data
eDNA detects DNA within the environment and determines which species are and have been present. It is possible to target specific species but also get data on the range of species present in the survey. Not all species can be detected, with data frequently returning matches for genera or family. This is particularly true for invertebrates. However, once sequenced, these data can be stored and as new species are added to the database, sequences can be re-run to see if new matches are made.

Data are typically supplied as a csv with a list of taxa identified for each sample. Abundance data are not possible with eDNA, as the rate at which each species sheds DNA is different and can depend on the environmental conditions. eDNA also has a life span within the environment and also degrades at different rates. As such a lot of DNA in a sample does not necessarily mean that species is more abundant. However there are emerging techniques (known as quantitative PCR) that can measure the relative abundance of eDNA within samples.

Per sample, eDNA processing is £200 - £500 per sample.

Pros and Cons

eDNA can detect large organisms to micro-organisms that may not have otherwise been found, for example many small invertebrates and microorganisms that are not easily detected. These tiny creatures play a vital, if often overlooked, role in healthy environments, yet they are rarely counted due to their size, sheer diversity and the level of time and expertise required to identify them visually.

Collecting samples for eDNA analysis requires deploying equipment in the field, as well as managing samples. This requires some knowledge and training to accomplish, as well as appropriate facilities to store samples before going to the lab.

Heath Fritillary Butterflies East Blean Woods © Beth Hukins

IMAGE CAPTURE

Overview
Image capture involves deploying equipment that can capture images either to a schedule or via movement detection. Image capture is a widely used survey approach using camera traps and is particularly useful for mammals and birds. Camera traps utilise infrared sensors to take photos when movement is detected and store images until collection after the designated time period. Camera traps are good for capturing shy species, or nocturnal species. They can also be used with bait stations.

Another image capture approach is used specifically for insects. This uses both still and video imagery to identify insects. Typically these types of cameras are pointed either at 'bug hotels' or at insect bait or pan traps/stations. These devices either have image detection software mounted on them, or images are relayed to a server for further processing.

Data
The data returned by these devices are usually images and videos captured upon movement. In some cases, camera traps can return many hundreds of images, many of which will not have a species on them. This creates a problem of sorting through images looking for and then identifying animals in the data.

This can be done manually with a person viewing all of the images. This is of course time consuming, and requires a good level of identification knowledge of the target taxa. Alternatively there are software programmes that can do this, but these are paid services. It is possible to write a model to identify species in camera trap images, but this requires several hundred pictures of each species likely to be detected to build a model. With insect focussed imagery, typically the identification is provided by the equipment supplier, but again these come with a cost as part of the package.

It is important therefore to consider the time required to extract species identifications from camera traps and the value of those to a monitoring scheme. It may be more appropriate to use camera trapping to supplement monitoring, or to target specific locations where species are known to be present.

Equipment
Camera traps are popular and there are a range of models available to buy off the shelf. The limitation on use is battery life and SD card capacity, but these limits are more to do with the number of images captured that require processing. It is easy to collect large amounts of data with camera traps.

Insect imaging options are more limited and generally in development. At present there are better approaches to insect surveying and monitoring than imagery based approaches, but as the technology matures these options will become more viable for monitoring schemes.

Pros and Cons

Camera traps are light, portable and easy to use. They can be used multiple times as data is stored of offloaded from an SD card. They have little to no effect upon the environment as they silent and well camouflaged. They can identify elusive animals that may not otherwise be detected.

Despite camera traps becoming cheaper and more accessible, using multiple traps for a study means the cost can quickly increase. Camera traps can also be triggered by unwanted movement, for example, moving plants or people which can lead to an excess of unwanted data to be analysed.

The main drawback is the volume of images collected and the time and expertise required to detect them. Camera trapping is also generally only useful for larger mammals, and birds when combined with a feeding station. The range of species captured is likely to be limited and may not be the best taxa for demonstrating change in many projects.

Hedgehog © Kent Wildlife Trust

BIOACOUSTICS

Overview

Bioacoustics is the analysis of biodiversity via sound. Most ecologists will be familiar with the concepts from bat surveying and bird surveying, where species are identified according to the calls and songs they make. Bioacoustics takes this a stage further and uses recording equipment to capture the sounds of nature and then uses machine learning to identify those sounds automatically.

Bioacoustics has been used to monitor birds, bats, some insects (e.g. grasshoppers) and some small mammals (e.g. shrews). Bioacoustics can also be used as an overall measure of quality of nature, by assessing the diversity and complexity of sound, as well as the contribution of human sources of sound in the environment.

The limitations of using bioacoustics are battery life, SD card capacity and the time and cost of processing audio files. However, a range of tools and services are available to support this, making bioacoustics generally a low cost approach to biodiversity monitoring.

Data and Tools

The data from audio recording devices are generally sound files; to extract species level data they need further processing to identify the species recorded in those sound files. This can be achieved by experienced ecologists listening to the recordings, but the advantage of audio deceives is that they can be left unattended often for weeks at a time, meaning this becomes a time consuming task and defeats the object of this approach.

As such there is a need to use machine learning approaches to classify and identify species on audio files. There are a number of services that can be used to do this. However it is possible to develop machine learning models to do this. The latter approach again requires considerable training data, time and expertise to achieve.

BirdNET is an existing bird call identification project from Cornell University. It is an open source software for non-commercial use only, but it can be used to identify birds from audio files.

For bats the BTO Acoustic Pipeline can be used for free for bat recordings, as long as users share their recordings with the British Trust for Ornithology (BTO). This online app can also identify small mammals and some insects as well. Otherwise options for small mammals and insects are limited.

To use sounds to understand the diversity and complexity of the environment, acoustic indices can be calculated from audio files. In R, the soundecology package can be used to calculate a number of these acoustic indices, The indices allow conservationists to compare different locations across sites or landscapes to determine how diverse or complex these locations are based on the soundscape. These indices are useful to get an overall picture of the environment and to highlight patterns of change over space and time.

Equipment
There are a range of audio recording devices available, including both proprietary and open hardware.

AudioMoth devices are open source acoustic loggers, listening at both audio and ultrasonic frequencies, for birds and bats. They can be used in multiple applications, including searching for species, monitoring, and identifying. It is capable of recording uncompressed audio to microSD card at rates from 8,000 to 384,000 samples per second and can be converted into a full-spectrum USB microphone. Audiomoths can be purchased for around £150. A list of credited sellers can be found on the Audiomoth website.

Pros and Cons

Acoustic recorders are small and discreet and have little to no effect upon the environment and its wildlife. They are battery powered and can left out for long periods of time to collect multiple data. They can be configured to only capture data at certain time period, for example only at dawn and dusk when targeting bats.

Noise disturbance such as high winds, or noise pollution can effect the quality of the recording and can make analysis challenging. Generally, extracting species information from recordings requires use of an existing services, but models can be built given sufficient time, data and expertise.

However soundscape analysis is achievable using open source approaches and can be a really useful measure of overall environmental quality, especially useful in monitoring situations.

Song Thrush © Tim Horton

LASER SCANNING

Overview

Laser scanning uses light to create an 'image' of surfaces. Laser scanning is essentially the same technology as LiDAR, where by light pulses are aimed towards a surface or feature and a sensor records the time it takes for these pulses to return. From this a distance can be calculated and therefore shapes determined.

LiDAR is typically used to create maps of the earth surface, mounted on aircraft or drones. However, the same technique can be used on the ground, with the sensor mounted on a tripod or rucksack. This means that the same technique can be used to measure the structure of the earth's surface from above and within it. Laser scanning techniques are used in building surveys to create 3D maps of structures, but this approach has also been used to understand the 3D structures of woodlands and forests.

The advent of airborne and field based laser scanning instruments has allowed researchers to collect high density accurate data sets and these are revealing a wealth of new information and generating important new ideas concerning terrain characterisation and landform dynamics.

Data

LiDAR data collected from aircraft are available from the Environment Agency. These data have been collected over several years and are from areas of particular operational concern for the Environment Agency. The data do cover the whole of the UK, but in some areas there are data from more than one year. The resolution also varies across the programme; most data are 1 metre or 2 metre resolution, but there are some datasets that have sub-metre resolution.

LiDAR data are available commercially, but usually this requires a bespoke survey and therefore the costs are considerable. A typical survey programme for a landscape using aircraft (typically a small plane) may cost in the region of £20,000 for a one off project. However, these data are usually of high precision meaning more detailed surface models can be made.

As with all data, further processing of the raw LiDAR data are required, but these tools are available as standard within both QGIS and R.

Equipment

LiDAR is an expensive technology, both for drones or for ground applications. LiDAR units can be attached to drones, but they are heavy and therefore require larger drones, with increased licencing requirements. Backpack LiDAR is also available, but these units cost many thousands of ponds.

Equipment hire or rental is the more cost effective solution to LiDAR data, but this is likely to still cost thousands of pounds for an annual survey.

Pros and Cons

LiDAR provides detailed structural data for the ground surface and forest structure and can be used to assess changes in this structure with repeated surveys. However, open data are not updated regularly enough to be relied upon in a motoring scheme, and collecting data for a project is usually prohibitively expensive.

Alternative ground based approaches are most cost effective, and when combined with other ecological surveys being carried out anyway, can collect suitable data to effectively measure change.

Application of Monitoring Techniques

The previous section set out the available biodiversity monitoring technologies. In this section, the technologies are considered against the monitoring focus areas for the Wilder Blean project.

In addition, appropriate ground survey approaches are also included in this section. The balance between an entirely technology based approach and an entirely ecologist based approach is important. There are synergies in combining the best available technologies with the best available methods used by ecologists to gather the best possible data to monitor biodiversity change.

For each focus area, the key indicators are set out, followed by the approaches that can be used to measure them.

HABITAT DIVERSITY AND CONNECTIVITY

Indicators: habitat type, habitat condition, habitat connectivity

Changes in habitat type can be monitored using remote sensed earth observation data (from satellites) or from UAV imagery. Earth observation data do not require any processing by the end user if using one of the existing land cover products, whereas UAV imagery will require considerable post-processing to achieve habitat maps. However, there is also a need to carry out field based verification of remote sensed data, so periodic habitat surveys by trained ecologists will ensure that remote sensed data are accurate.

Habitat condition can be monitored using satellite data (see BiodiversityView product above), and this provides annual and standardised data. Again, periodic field verification by ecologists will ensure these data are accurate. Indeed, if entering into biodiversity net gain agreements, field condition assessments will be required to be carried out against an agreed monitoring plan. However, remote sensed data can fill in the gaps between field surveys.

Habitat connectivity metrics rely on habitat data, which can be derived from any source. But earth observation data are suitable for these metrics. These metrics require calculation for the project area by someone with experience in the approaches, but open tools for this are widely available.

While there are a range of open source tools available, the use of these requires an experienced analyst to access, analyse and interpret satellite data. It therefore requires a significant investment in time and resources to carry out monitoring in this way.

GRAZING IMPACTS

Indicators: vegetation structure, soil health, ecosystem service assessments

Monitoring vegetation structure can be carried out from the air, or from the ground. LiDAR data can be used from aircraft, or from the ground to create data that captures vegetation structure. However, the cost of doing this is considerable, particularly for a large project area. Airborne LiDAR will be able to detect changes in canopy structure, whereas laser scanning from within woodlands can detect changes in age structure of trees. In both cases, due to cost, the best approach may be to have permanent plots for monitoring change,rather than trying to measure entire woodlands. Neither of these approaches work well for non-woodland habitats, due to the lack of height variation. Field surveys carried out by ecologists can not only capture structural diversity, but also species diversity and a number of other characteristics for woodland structure and condition. Field surveys, either for entire sites, or for permanent plots, may be a more cost effective way to measure structural change.

UAV imagery can also be used to measure structural changes in vegetation. For woodland in particular, imagery can be used to generate canopy height maps, but this technique does not work as well for non-woodland habitats. Again field surveys may be more cost effective at getting structural data for non woodland habitats. However, UAVs with colour cameras are cheaper to operate and could be used to collect data over a wider area more cost effectively than with LiDAR.

Soil health needs to be clearly defined to determine how best to monitor it. Soil health could encompass soil biodiversity, soil chemistry, nutrient availability, soil structure, soil composition, or the microbial diversity. Some of these measure can be captured using the technologies mentioned above. For example, soil microbial diversity and composition can be determined using eDNA, but there needs to be a good understanding of these microbial populations to understand how soils are changing. Many other aspects of soil health can be monitored using simple soil samples and laboratory analysis. Alternatively, using earthworm or invertebrate metrics can also be good indicators of soil health.

Ecosystem service assessments are typically driven by habitat and land use data, which can be monitored using remote sensing methods as set out in the previous section. There are a number of different approaches to assessing ecosystem services, and the data requirements can be quite different. The Ecosystems Knowledge Network provides a tool assessor for ecosystem services assessments, which includes details of the data requirements for each. Much of the work to produce ecosystem services assessments is analyst time, and having reliable land use data that is up-to-date for each time period being assessed is crucial to the product of these assessments.

SPECIES DIVERSITY AND ABUNDANCE

Indicators: species richness, species abundance, population health.

Several of the technologies explored in this report can capture species level data.

Bioacoustics is a technology that can be used to capture species diversity of birds and bats, as well as some insects and small mammals. Using bioacoustics means collecting standardised data, typically over much longer periods than possible with ecologist surveys. Bioacoustics also tend to detect more species (particularly for birds) than ecologists surveys. It is possible to determine relative abundance of species using bioacoustics, but actual abundance data are not possible.

Camera traps and other imaging techniques can be used to determine species diversity and abundance data. However, they do require a lot of post-processing and are best suited to either known locations used by wildlife (e.g. burrows or water bodies) or baited stations (e.g. bird feeders or other bait stations). Baited stations for insects are very effective, but at present the technologies are still in development so they are not reliable for this application at present.

eDNA can be used to determine species diversity, as well as measures of relative abundance. However, collecting samples from which to extract DNA requires additional equipment. Water samples are relatively easy to collect and can be used to determine the presence and diversity of fish, amphibians and insects. Soil samples can reveal microbial diversity and composition.

Insect trapping can be used to collect insect samples to identification using eDNA. For example, Sea, Land, Air Malaise (SLAM) traps are a type of malaise trap for trapping flying insects. They are a passive trap, meaning there is no attractant, but exploit insects natural behaviour. Vertical black mesh nets stop insects in flight. When this happens insects generally do one of two things. Some close their wings and fall to the ground while others fly upwards, in the case of the SLAM trap, attracted by the white roof. Those that fly upwards towards the white roof eventually make their way into a collection bottle of preservative. SLAM traps are like small dome tents; they consist of two mesh nets at right angles, with a domed mesh roof.

The advantage of these approaches is that they are standardised and repeatable. They do not rely on surveyor effort to collect comparable data between years. However, additional survey approaches can be used to supplement these standardised data. For example bioacoustics does not provide information about behaviour or the use of a landscape by wildlife. In addition, visual surveys can detect bird species that are not detected by sound.

Some taxonomic groups are easier to survey using standard methods. For example, reptiles are more easily surveyed using refugia check by ecologists, and dormice are better surveyed using nest boxes. Neither of these approaches require a technological approach and are well established methods. A list of target taxa should be prepared and then the most appropriate methods chosen to monitoring them.

Population health needs to be clearly defined, but all of the methods set out above will provide some data that can be used in population health metrics. For example, Digital Ecology's Integrated Biodiversity Monitoring approach uses a range of biodiversity data to calculate taxonomic, functional and phylogenetic diversity. Taxonomic diversity relies upon the assumption that a species contribute to ecosystem functionality equally. In reality, the impact of a species upon ecosystem function is heavily influenced by its evolutionary history and functional traits, making taxonomic diversity and inefficient predictor of ecosystem function. Functional diversity measures diversity at the trait level, accounting for differences in species ecological niches and functions. Functional diversity directly examines trait variation within a community, bridging the gap between biodiversity and ecosystem function. Functional diversity is recognised as a crucial aspect of ecosystem service provision. Phylogenetic diversity measures diversity at the genetic level, reflecting how evolutionary distinct a community is. As many traits show a phylogenetic signal, it is thought that conserving a wide range of phylogenies will preserve a wide range of ecological functions. By considering biodiversity in these different ways, Digital Ecology are able to provide a better measure of ecosystem health, as well as highlighting where management approaches can provide niches for missing species. As such this integrated approach is one way of assessing population health.

SLAM trap samples in West Blean © Kent Wildlife Trust

Recommendations

MONITORING RECOMMENDATIONS

This section sets out the recommendations for a comprehensive monitoring approach for the Wilder Blean project, combining the best of the available digital technologies with field based monitoring approaches. This combined approach will ensure the best available data are collected to be able to meaningfully understand change across space and time in the Blean landscape area. Where possible we have provided an indication of the annual cost of a specific technique. We have also set out a high level timeline for monitoring, showing the frequency of each approach and indicating and seasonal limits.

Indicator	Method	Periodicity	Annual Cost*
Habitat type	Earth observation data We recommend Map Impact's BiodiversityView product due to the inclusion of habitat condition measures	Annual	£5,000
	Field survey	Every 5 years, or a rolling annual programme	£5,000
Habitat condition	Earth observation data We recommend Map Impact's BiodiversityView product due to the inclusion of habitat condition measures	Annual	£5,000
	Field survey using the DEFRA BNG metric method	Every 5 years, or a rolling annual programme	£5,000 Note this is a survey cost, not a per indicator cost

Indicator	Method	Periodicity	Annual Cost*
Habitat connectivity	Data Analysis using habitat data	Annual	Staff or consultant time
Vegetation Structure	UAV Survey	Every 5 years, or a rolling annual programme	Unknown
Soil Health	To be confirmed pending metric decision		
Ecosystems Services assessment	Data Analysis using all data collected by programme	Annual	Staff or consultant time
Species diversity (Richess & abundance)	Bioacoustics For Birds and bats	Annual 2-4 week periods in Spring, Summer, and Autumn	£500 per survey point
	eDNA SLAM traps for insects	Annual 2-4 week periods in Spring, Summer, and Autumn	£500 per survey point
Population health	Data analysis	Annual	Staff or consultant time

* annual costs are indicative. Quotes should be sought from suppliers.

MONITORING DESIGN

It is crucial that an appropriate monitoring design is created for the Wilder Blean project and wider landscape. This design needs to reflect the proposed interventions in the project, the spatial diversity of habitats and species as well as meeting the requirements of the stated indicators. It is important the sufficient data are collected so that the impact of interventions in the project area can be detected.

While the above recommendations can help narrow down the monitoring approaches required for the chosen metrics, further work is required to design a scheme that demonstrates that the conservation objectives of the project are being achieved.

It is recommended that ecologists and project managers work together to design the monitoring scheme for the Blean using the above recommendations as a starting point.

INTEGRATED BIODIVERSITY MONITORING

Digital Ecology has created **Integrated Biodiversity Monitoring (IBM)** to help harness the power of digital technologies for biodiversity monitoring projects.

Integrated Biodiversity Monitoring is a holistic, ecosystem function focused monitoring approach that considers the multiple facets of biodiversity; taxonomic functional and phylogenetic diversity.

Taxonomic diversity measures diversity at the species level.

Taxonomic diversity relies upon the assumption that a species contribute to ecosystem functionality equally. In reality, the impact of a species upon ecosystem function is heavily influenced by its evolutionary history and functional traits, making taxonomic diversity and inefficient predictor of ecosystem function.

Functional diversity measures diversity at the trait level, accounting for differences in species ecological niches and functions. Functional diversity directly examines trait variation within a community, bridging the gap between biodiversity and ecosystem function.
Functional diversity is recognised as a crucial aspect of ecosystem service provision.

Phylogenetic diversity measures diversity at the polygenetic level, reflecting how evolutionary distinct a community is.

As many traits show a phylogenetic signal, it is thought that conserving a wide range of phylogenies will preserve a wide range of ecological functions.

We integrate a range of monitoring data to build a detailed, integrated picture of biodiversity. Our system provides a range of metrics to measure changes in biodiversity and ecosystem resilience, allowing land managers to target interventions to further strengthen ecosystem integrity and deliver better outcomes for nature.

Digital Ecology can deliver IBM either as a complete service, or provide a data analytics service, backed up by interactive reporting.

Case Studies

LOCAL NATURE RECOVERY STRATEGY - WILTSHIRE COUNCIL AND MAP IMPACT

Map Impact was commissioned by Wiltshire Council to support the mapping component of their Local Nature Recovery Strategy (LNRS). Wiltshire Council required assistance with ecological mapping and species connectivity modelling during their LNRS journey due to a shortage of internal resources. The success of their LNRS relies on effectively informing both internal and external stakeholders about the potential to enhance biodiversity. This is in order to encourage funding and investment for nature-based solutions.

The basis of the work was Map Impact's BiodiversityView data – a national habitat type and habitat condition dataset. These data provided the inputs for a species based connectivity analysis, as well as a process to identify key areas for biodiversity across the county.

The countywide map supports the development of the LNRS and has improved stakeholder management. Three measures for habitat improvement have been implemented: Bigger, more joined-up, and better. This automated solution can be repeated for consistency in Wiltshire Council's ongoing strategy, highlighting areas of strategic significance for biodiversity net gain (BNG) and land management more generally. And as the BiodiversityView data is updated annually it can be used to monitor the implementation success of the LNRS.

Further details on the project are available here: https://www.mapimpact.io/project/local-nature-recovery-strategy/

TRACKING THE IMPACT – CHILTERNS CONSERVATION BOARD AND DIGITAL ECOLOGY

Tracking the Impact is a comprehensive four-year landscape-scale wildlife survey program conducted by the Chilterns Conservation Board. The program, carried out in the Central Chilterns area, aims to identify long-term trends in the distribution and abundance of bird, butterfly, and plant populations. Tracking the Impact uses volunteers to comprehensively survey over 70 1km squares.

Digital Ecology developed a dashboard using the survey results to explore bird biodiversity and community composition at the site. The dashboard supports integrated biodiversity monitoring in two key ways. Firstly, it supports integrated monitoring of all facets of biological diversity, ensuring that we conserve both species rich AND functionally robust ecosystems. Secondly, the dashboard was created with the express purpose of providing decision makers with all of the necessary data and information to make informed conservation decisions, with minimal input and effort. All the user needs to do is enter survey data, and the dashboard will break down functional and community composition, calculate the various diversity indices, and return graphical representations. This allows for easy integration of biodiversity information and monitoring into habitat management, conservation action, or land development. We believe that this dashboard represents a pivotal step towards achieving the Convention on Biological Diversity's 2030 targets, ensuring better biodiversity outcomes.

Visit the dashboard here: https://trackingtheimpact.digital-ecology.co.uk

HONEYGAR FARM – SOMERSET WILDLIFE TRUST AND WILDER SENSING

Somerset Wildlife Trust acquired Honeygar Farm in 2021 and with it set out to create a flagship project for restoring wildlife and carbon. As part of the monitoring programme for the site, Somerset Trust engaged Wilder Sensing to use bioacoustics to monitor birds on the site.

Wilder Sensing is a company that has developed software to analyse audio files to identify the birds recorded. So far, a total of four devices have been deployed on deep peat meadows and an additional two sensors were deployed near stands of mature oak trees. For a site of 81 hectares including both meadow undergoing rewilding projects as well as the existing woodland, the sensor coverage should provide a very detailed overview of the bird species across the various ecosystems within the site.

So far the project has generated over 2 million records of birds on the site. The 24 hour approach to recording has also identified key movements of certain species between Honeygar and surrounding land, highlighting how birds are using the wider landscape.

Further details on the project are available here:
https://biologicalrecording.co.uk/2024/07/09/bioacoustics-1/

Avalon Marshes © Somerset Wildlife Trust

Summary

This scoping exercise aims to equip Kent Wildlife Trust with innovative monitoring strategies that will enhance the Wilder Blean Initiative's effectiveness in restoring landscape connectivity and biodiversity.

The report reviews the available technology for biodiversity monitoring and makes recommendations for the monitoring approaches that will deliver data to support the chosen biodiversity indicators.

Technology is evolving at considerable pace, and some of the technologies referred to here will develop further in the coming years. New technologies will also emerge and the cost of some of these technologies are also likely to reduce. As such the recommendations of this report should be periodically reviewed to ensure they are still relevant. A review is also an opportunity to assess any new technologies and their application to the Wilder Blean monitoring initiative. However, it is important for there to be some consistency over the timespan of a project to ensure meaningful change can be measured and acted upon.

However, technology will never provide all of the answers in monitoring biodiversity. Well trained and knowledgeable ecologists are a key component in monitoring biodiversity. From designing a suitable scheme to analysing data and interpreting results, ecologists are essential in understanding and evaluating the impact of conservation interventions.

The scoping report has therefore tried to balance the use of technology with the skills of ecologists to ensure robust methods for monitoring biodiversity. There are of course a considerable number of additional survey methods that could be employed, but given the scale of the Wilder Blean project, budgetary constraints mean that a focus on technology has been recommended.

About Digital Ecology

At Digital Ecology, we are driven by a passion for both the natural world and cutting-edge digital solutions. Our team comprises dedicated ecologists and environmental data scientists who understand both your needs, and the transformative potential of digital tools to elevate your work. By embracing open-source digital technologies, we aim to empower all environmental scientists to work smarter, more efficiently, and with greater impact.

Sitting at the interface between ecology and technology, two largely unconnected sectors, Digital Ecology prides itself on the development of platforms, apps and other digital services to support ecological practice. We operate on the guiding principle that data is only as useful as it is accessible; therefore, we continually strive to adapt and improve our digital technology to best serve you.

Digital Ecology are well positioned to support the Wilder Blean project in meeting its monitoring objectives, either through our Integrated Biodiversity Monitoring service, or through further consultancy work to implement a scheme.

THE BLEAN WILDSCAPE

kwtg.uk/blean-wildscape

Kent Wildlife Trust

REWiLDiNG BRiTAiN

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